2016

6th International Conference on

BUILDING RESILIENCE

Building Resilience to Address the Unexpected

7th-9th September, 2016 | University of Auckland
Auckland, New Zealand

Edited by:
Dr. Niluka Domingo
Prof. Suzanne Wilkinson

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Welcome

We would like to welcome you to the 6th International Building Resilience Conference 2016, with the theme "Building Resilience to Address the Unexpected". The conference is proudly organised by the University of Auckland's Centre for Disaster Resilience, Recovery and Reconstruction (CDRRR), and the Construction Management Groups at Massey University and the University of Auckland. The Global Disaster Resilience Centre (GDRC), School of Art, Design and Architecture at the University of Huddersfield, UK, is a key partner of this event.

The Building Resilience Conference is an annual international conference exploring resilience as a useful framework of analysis for how society can cope with the threat of natural and human induced hazards. This is the sixth event in the Building Resilience Conference Series and follows on from previous successful events.

With increasing numbers of people being affected by shocks, stresses and strains, resilience building has become one of the key themes for governments. This vibrant annual international Building Resilience Conference brings together researchers, educators and industry practitioners involved in natural hazards and disaster resilience across the globe, providing participants with a strong platform for knowledge sharing, collaboration, disciplinary reflections, institutional exchange and collective growth.

We have been overwhelmed with the interest and enthusiasm shown for this conference. The conference programme contains over 150 papers, 7 workshops and plenty of opportunities to network with old friends, and to make new ones. We are particularly pleased to see so many overseas delegates, and offer a special welcome to those people from countries recently affected by disasters such as the Philippines, Italy, United States, Indonesia, Vanuatu, Sri Lanka, Japan, Nepal and Fiji. We hope you will be able to take some valuable lessons away from the conference to assist you with your continuing recovery. We also welcome those people travelling from neighbouring Pacific Islands, Australia and the Asia-Pacific and hope to see future regional and international collaborations arise from this conference.

We would particularly like to thank all our sponsors who have helped make this conference possible. To the hard working conference committee, we would like to offer our sincerest thanks. To the scientific committee and reviewers, we could not have been more impressed with your dedication. To our conference attendees and presenters, we offer a very warm welcome and hope you will enjoy the conference as much as we have enjoyed bringing the 6th International Building Resilience Conference to Auckland.

We look forward to meeting you at the conference and welcome you to the beautiful city of Auckland.

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DOCTORAL WORKSHOP

EASURING RESILIENCE: "WHY" IS AS IMPORTANT AS "HOW"

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ABSTRACT

Globally, the measurement of community resilience has become a major focus of activity especially as it relates to natural disasters. The number of approaches for measuring community resilience speaks to the subject's importance but also points to the difficulties inherent in measuring community resilience: resilience is a fuzzy concept; a community's resilience is only revealed through disruption; a community's resilience depends on how it is stressed; a community's resilience changes over time; different parts of a community have different levels of resilience; resilience is a manifestation of a community's strengths, but often difficult to measure directly; the user of the data will determine the data needed.

A recent review of community resilience measurement approaches focused on the methods – the "How" – used to assess community resilience. In this paper, the usefulness of four different measurement approaches for informing decisions by community leaders – the "Why" – is considered.

Consideration of the difficulties and the review of the four measurement approaches leads to practical guidelines for development of community resilience measurement approaches. These include: a) identifying the decisions for which data are needed; b) identifying the decision-makers; c) establishing a data collection process that specifies who will collect data, in which domains, by what methods, at what frequency, and when it should be provided to decision-makers; d) ensuring that decision-makers will both understand and trust the data provided.

Key words: Community resilience; resilience measurements

INTRODUCTION

Globally, the measurement of community resilience has become a major focus of activity especially as it relates to natural disasters (Ostadtaghizadeh, et al., 2015). In this paper, "measurement" is used in its broadest sense, including quantitative data, objective non-quantitative data (e.g., lack of a response or recovery plan), and subjective data such as perceptions captured via a survey instrument.

In developing a community resilience measurement approach, it is of paramount importance to recognize that the measurements – while important – are a means to an end, not an end in themselves. Ultimately, the goal of measuring a community's resilience is to assist in making decisions – what Datnow and Park (2014) call *"data-informed decisions"* – about actions that bolster a community's resilience. Action informed by data validates the value of a resilience measurement approach; without action, the approach is at best an interesting intellectual exercise.

The number of measurement approaches for community resilience speaks both to the subject's importance and to the difficulty of actually measuring a community's resilience. In this paper, the difficulties are considered, and general design principles developed. Four measurement approaches are then examined in terms of the design principles. In particular, an attempt is made to identify the types of decisions that each measurement approach might support.

WHY IS MEASURING RESILIENCE SO DIFFICULT?

The difficulty of measuring resilience cannot be overstated. It stems from several causes:

Resilience is a fuzzy concept. Some efforts, particularly when focused on a community's infrastructure, seem to equate *resilience* with *resistance*, thus focusing on the ability to resist damage (for example, Park, et al., 2013). Others, particularly in social and economic contexts, see resilience as the ability of a community to adapt to adverse circumstances.

A community's resilience is only revealed through response to and recovery from a disruption. While the goal of measurement is to enhance community resilience in some way, we can only know a community's resilience after we see it come though a storm. Thus, none of the measurement approaches proposed have been validated by experience. We can, however, use similarity and argument by analogy to partly mitigate this difficulty (Cutter, et al., 2010).

A community's resilience depends on how it is stressed. As Carpenter, et al. (2001) point out, a community's resilience will depend on the type and magnitude of the crisis as well as the nature of the community (its structure and its governance), or, as Plodinec (2015) points out, "Disasters have direction" – different types of crises will attack different parts of a community. Thus, a community may follow a different recovery path after a natural disaster than it does from a pandemic or an economic crisis. For example, Butler and Sayre (2012a, 2012b) found very different recovery paths for US Gulf Coast communities after the

Deepwater Horizon oil spill (an economic disaster for the affected communities) than after Hurricane Katrina (a natural disaster).

Different parts of a community will have different levels of resilience. New Orleans provides many examples to illustrate the point. Some neighborhoods, such as Broadmoor, have not only recovered from the devastation of Hurricane Katrina but have built many new structures (such as a neighborhood center) that are significantly improving residents' quality of life. Conversely, the Lower Ninth Ward, with so many houses still boarded up even a decade after Katrina, has not –and may never – recover. Although the city's population is only about three-fourths that before Katrina, residents' median household incomes and the achievements of their children in the city's schools have both significantly improved above pre-Katrina levels.

Resilience is a manifestation of a community's strengths, but it is often difficult to measure those strengths directly; thus surrogates must often be used. Aldrich (2012), Weil (2011) and many others have pointed out the importance of a community's social capital – the connections that bind the community together and those that extend beyond the community to sources of external resources – to the community's resilience. While these might be determinable by social network analysis, that science is still in its infancy. Thus, surrogates must be used. A surrogate should be relatable to the community attribute it represents; so the number of residents in clubs or associations might be a surrogate for binding social capital.

The decision (and decision-maker) determines the data needed. Too often, the developers of approaches to measure resilience forget that measurement is not the goal; action is. Measurement's role is to inform the decision-makers so that good decisions are made. At the community level, community leaders wanting to invest to improve their community's resilience certainly need to know the strengths and weaknesses of each part of their community. However, they also need to know their community's risk profile so that they can prioritize their investments. Once investments are made, decisions will shift from what should be done toward assessing progress in doing it. Thus, the need for data to evaluate the progress and impact of projects or policy initiatives will replace data relating to strengths or vulnerabilities.

A community's resilience is not constant; it changes over time. It is almost a cliché – in a world of kaleidoscopic change, both communities and the contexts they find themselves in are changing. Former areas of strength may atrophy; increasing complexity of the community may introduce new risks; economic shifts may create new weaknesses.

MEASUREMENT APPROACHES

A recent review by Ostadtaghizadeh, et al., (2015) examined seventeen measurement approaches found in the literature from a methodological standpoint. However, they did not consider the decision-informing nature of these approaches. In the following, four approaches are examined in detail. These have been selected for illustrative purposes because they represent various combinations of data type, hazards, and targeted decision makers.

Approach	Data Type	Hazards considered	Decision-maker
Baseline Resilience Indicators for Communities	Quantitative	Natural disasters	Not specified
Community Disaster Resilience Scorecard	Mixture; primarily non-quantitative but objective	Natural disasters	Leaders in public sector
Community Advancing Resilience Toolkit	Mixture; primarily subjective	All	Community leaders of all types
Coastal Community Resilience Index	Non-quantitative but objective	Coastal storms (e.g., hurricanes, floods)	Leaders in public sector

Baseline Resilience Indicators for Communities

Cutter, et al., (2010) developed Baseline Resilience Indicators for Communities (BRIC) based on the Disaster Resilience of Place model. The stated purpose of these indicators is to provide a snapshot of existing conditions in order to "measure the effectiveness of programs, policies and interventions specifically designed to improve disaster resilience."

The 36 quantitative indicators – primarily census-type statistical data for US counties – are grouped into five categories: social resilience, economic resilience, institutional resilience, infrastructural resilience and community capital. For each indicator, the development team explicitly identified whether the property represented made either a positive or negative contribution to community resilience based on the natural disaster literature. Unfortunately, this means that surrogates are needed for many of the properties of interest; there are no complied direct measurements of them (e.g., community connectedness). This then requires that decision-makers accept the representativeness of the developers' choices of surrogates.

A composite index is calculated for each category; thus providing some guidance for prioritizing investments. It is assumed that the developers will provide the data.

The development team chose not to include indicators for the natural environment because of the lack of relevant and and consistent data. The indicator set also does not consider either the type or the magnitude of the natural hazards facing the community. Also absent are any measures of the financial resources available to the community or of the condition of the community's infrastructure. Thus, there is no data to assist in prioritizing investments in these areas.

While the development team did not explicitly identify a decision-maker who might use the data (or a process for its use), the quote above implies that community leaders are the target as they assess projects or initiatives undertaken to improve resilience to natural disasters. To do this, decision-makers would have to look at changes in the indicators over time (the trajectory of the community). This makes it more likely that community leaders will look at a few specific indicators directly related to a given project or initiative rather than the composite indices within BRIC.

One of BRIC's most valuable uses may be to help community leaders to find peer communities. The indicators for Memphis, for example, are quite similar to those for New Orleans. Thus, Memphians might turn to those in New Orleans who have dealt with the problems of flooding for guidance on recovering from a massive flood of the Mississippi River.

Community Disaster Resilience Scorecard

The Torrens Resilience Institute (Arbon, 2014) in Australia has taken a very different approach toward natural disaster resilience. It begins with a community leader-driven decision process and then proceeds to develop indicators to support the process. As part of the Scorecard, guidance is provided in terms of who within the community should collect the data. While community-based, the process also lends itself to regional planning.

The "indicators" are the answers to 22 questions, grouped into four categories: community connectedness, available resources, risk and vulnerability, and planning and procedures. As relevant, the Scorecard blends census-type data (e.g., trends in the size of the resident population) with self-assessment questions (e.g., availability of food, water, and fuel). It is the only measurement approach that directs attention to the transient population in a community, including tourists and those who work in the community but reside elsewhere. There is a strong emphasis on assessing the state of community planning.

While the approach inquires whether risks are known, and whether the community may be isolated in a natural disaster, it does not quantify risks. It also does not consider the community's economy or finances, its natural environment or the state of its infrastructure. Rather than long-term recovery, the focus of the Scorecard is on readiness and near-term response actions.

Because it is embedded in a decision-making process, the Scorecard lends itself to identifying actions needed to achieve greater resilience. However, because of its limited scope and its emphasis on planning, it is best used to drive "public decisions" – actions by government or social service providers. Its lack of consideration of the community's economy limits its usefulness for leaders in the private sector. However, since the approach uses the community's own answers as its indicators, the data is more readily understood by the community leaders than the literature-driven indicators in BRIC.

Community Advancing Resilience Toolkit (CART)

Like the Scorecard, CART (Pfefferbaum, 2011) is designed to assist community leaders (of all types) going through a process to improve resilience. CART consists of nine tools that either generate or present data. Data are grouped into four domains: connections and caring, resources, transformative potential and disaster management. As opposed to the preceding approaches, it explicitly considers terrorism as a community risk.

CART is unique among the approaches considered in that it does not explicitly specify what data community leaders should have for the decisions they make. Rather, the CART tools are designed to assist Community Leaders in collecting and interpreting the data they need. For example, the Assessment Survey within CART consists of a core group of questions aimed at determining a community's perception of itself and its resilience and optional sets of questions that delve more deeply into aspects of the community such as community communications and informants' relationship to the community. The Data Collection Framework identifies data that might be useful in making decisions but leaves it to the decision-makers to decide what data they need. Similar to BRIC and the Torrens Scorecard, the natural environment and community finances are not considered. While communities can map the infrastructural elements within neighborhoods using the Neighborhood Infrastructure Maps tool, there seems to be little attention to analysis of these data by decision-makers.

CART is a flexible and powerful tool; that is both its strength and its weakness. It is easily customized; many of the tools even include suggestions for doing so. However, customization and making use of its power requires a level of sophistication that many community leaders may not have. Further, because assessing perceptions is so much at the core of the approach, it may be difficult for community leaders to gain a clear picture if there are widely divergent views within the community.

Coastal Community Resilience Index

The US National Oceanic and Atmospheric Administration (Sempier, et al.,

2010) has sponsored development of a Community Resilience Index for coastal communities in the United States. Similar to the Torrens Scorecard, it is a self-assessment aimed at leaders of coastal communities facing storms and flooding. It, too, is embedded in a process aimed at enhancing resilience. The community's assessment team starts by identifying a severe past storm as a benchmark and then an even more severe future storm (50% greater intensity is suggested) to provide the context for the assessment.

The assessment is broken into six modules: critical infrastructure and facilities, transportation, community plans and agreements, mitigation measures, business plans and social systems. For critical infrastructure and facilities the assessment team determines whether critical infrastructure or facilities are in areas that are either flood-prone or would be impacted by either the past or postulated future storm. The team then determines whether the infrastructure or facility would still be functional after a disaster. The other five modules contain simple "Yes-No" questions; e.g., will road transportation would be back in service within one week; how prepared is local government to respond to a disaster; have both the public and private sectors taken adequate steps to mitigate disaster (including protecting the natural environment); are large retail stores, grocery stores and fuel distributors prepared for a disaster; how strong are the social and economic ties that bind the community together.

The individual questions allow decision-makers to readily identify gaps in their resilience to severe storms, but are primarily geared toward the immediate response to a disaster and to leaders of local government. The questions that uncover gaps essentially guide the decision-maker to fill the gap, with one glaring exception. Since the intended users of the tool are "experienced local planners, engineers, floodplain managers or administrators," it is not clear what they can do to strengthen weaknesses found in the social ties that bind the community together.

DEVELOPING A RESILIENCE MEASUREMENT APPROACH

The difficulties of measuring a community's resilience discussed above, combined with the examination of four measurement approaches, lead to practical principles that can guide design of an approach to inform decisions by community leaders relating to community resilience.

Purpose. The specific purpose for which the measurements are needed – the kinds of decisions that the measurements will inform – must be clearly identified. Doing this will provide a less fuzzy definition of resilience for the decision makers. The data needed to identify areas of weakness that should be addressed are somewhat different than those needed for prioritizing investments, both of which are quite different than those needed to evaluate the progress made by a single project. And in prioritizing areas for investment, the trajectory (trend over time) as well as the current state of the community can provide useful inputs.

Decision-maker(s). It is imperative to ascertain who the intended users – the decision-makers – are before developing a measurement approach. While the decisions to be made will in part determine what data should be collected, the value of the data collected (and, in fact, whether it is used at all) will also depend on the capability and perceptions of the decision-makers: their level of understanding of community resilience; the time they can devote to analysis of data; and the amount of data they believe is necessary for decisions. While "snapshots" can be informative, community leaders may be more interested in the community's temporal trajectory. Decision-makers also can impact the selection of surrogates: if the surrogate is to be useful in decision-making, decision-makers need to readily perceive its relevance to decisions being made.

Data collection. The data collection process – who will collect data, how (and how frequently) they will collect data, in what domains – must be clearly specified. Decision-makers may easily become frustrated if the data collection process has not had this scrutiny: the wrong data may be collected, or the data may not be provided in a timely manner. Some decision-makers (e.g., a transportation department) may only be interested in data on one part of the community; inundation by irrelevant (to them) data will also cause frustration. If the data is to be collected on a continuing basis (for example to monitor the evolution of the community's resilience) the data collection process should be developed with continuity of collection in mind as well.

Understanding and Trust. If the message – data – is to inform decisions, then decision-makers must trust the messenger and understand the message. Several factors will contribute to this. The better acquainted the decision-makers are with the data providers, the more likely they will be to trust the data. If surrogates are used, the linkage between the surrogate and the property it represents must be almost intuitive to ensure its import is understood. Since none of the approaches purporting to measure resilience have been validated by actual experience, there should be evidence from actual disaster recoveries that the properties included in the measurement approach contribute to a community's resilience. Even if one selects those properties based on first principles, there should at least be evidence from case studies demonstrating their relevance.

CONCLUSIONS

In terms of informing decisions at the community level, each of the four approaches considered leaves some dark corners hidden from decision-makers. None of them examines community finance (e.g., insurance in the private sector or creditworthiness in the public sector), yet financial resources are essential for recovery. None of them gives more than a glance at the community's governance (how and how well decisions are made and implemented), yet the depth of the disaster, and the duration and ultimate success of the recovery directly depend on the community's governance. Rather surprisingly, little light is shone on the vulnerability of the natural environment, primarily because of a lack of data. For the same reason, those approaches that rely on publicly available data also provide decision-makers with little information about infrastructural resilience. Thus, none of them provide a complete picture of the community.

Resilience measurement approaches based on self-assessment appear to have advantages in terms of understanding and trust. They are not constrained by the availability of consistent publicly available data sets. They can be adjusted to collect and use the community's own data reducing the reliance on surrogates. Because the data comes directly from the community itself, the data is more likely to be trusted. Embedding a resilience measurement approach in a decision support framework also improves the usefulness of the approach.

Measurement will not make a community more resilient. However, a well-designed measurement approach can illuminate the community so that its strengths and weaknesses stand out in bold relief. The approach needs to be designed to provide the data needed by decision-makers to inform their decisions, through a well-conceived process that provides the data needed in a timely manner, in a form that decision-makers can understand and trust.

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MEASURING COMMUNITY RESILIENCE FOR COMMUNITY ACTION: WHAT WORKS, WHAT DOESN'T

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ABSTRACT

The measurement of resilience has become a major focus of effort world-wide. Starting in 2010, the Community and Regional Resilience Institute (CARRI) developed and refined an assessment approach for community resilience. The goal of the approach is to assist community leaders in taking action to improve their community's resilience. The assessment used four tools: a simple risk assessment worksheet; a compilation of statistical information; a survey to provide a subjective "profile" of the community; and an in-depth multi-hazard resilience assessment of the "Whole Community" (Plodinec, et al., 2014).

This assessment regimen was used as part of a larger program in nine communities across the United States. Several important conclusions have been drawn which are guiding CARRI's continuing efforts.

Since all of the communities had already completed detailed risk assessments for emergency management purposes, the risk assessment worksheet was useful only by helping community leaders consider economic and mass contagion risks. Community leaders used neither the statistical compilation nor the community "profile" survey in decision-making. The statistical compilation was at too coarse a scale (county instead of neighborhoods) to drive action. The community "profile" survey was not administered by any of the communities, primarily because of a lack of resources and a lack of understanding of the information developed. Conversely, the multi-hazard resilience assessments proved to be very helpful for community leaders: each assessment pointed directly to potential actions. The assessment itself was trusted because it was carried out by the community's own experts.

This paper discusses these lessons learned in terms of the usefulness of each part of the assessment for decision-making. Methods to improve each part of the assessment are discussed. It is hoped that these lessons learned may prove useful to others developing resilience measurement regimens.

Key words: Community resilience measurement; community systems

INTRODUCTION

The Community and Regional Resilience Institute (CARRI) has developed a unique "Whole Community" approach to help communities improve their resilience (Plodinec, et al., 2014). CARRI defines a *community* to be a group of individuals and organizations bound together by geography and perceived self-interest to efficiently carry out common functions and provide essential services. *Community resilience* is thus simply the ability of the community to positively adapt to change.

CARRI's approach is embodied in a simple process designated the Community Resilience System (CRS). The CRS has four parts: organizing the community's leadership; assessing the resilience of each part of the community; formulating plans to improve resilience, based on the assessment; and then implementation of the plans and monitoring of their effectiveness. The CRS was the first resilience-building approach to operationalize the "Whole Community" concept in the United States. CARRI identified a set of eighteen systems each of which provides an essential service to the community; for example, finance, energy, and education (as detailed in Plodinec, et al., 2014). In this paper, the initial assessment process used in the CRS is presented. Lessons learned from its use in nine communities in the United States are discussed in terms of their usefulness to community leaders in making resilience-building decisions. Improvements for each part of the assessment process are then examined.

COMMUNITY RESILIENCE SYSTEM BASICS

Assessment of a community's resilience, while necessary, is not sufficient: unless community leaders take action based on the assessment it will be a resource-intensive but only mildly interesting exercise. Thus, the usefulness of the CRS resilience assessment approach must be judged in terms of how useful it proved to be to community leaders in making decisions for improvement of their community's resilience.

As described by Plodinec (2014), CARRI's Whole Community approach is predicated on the concept that all communities provide the same set of essential services, but that the systems that provide these services vary widely. Taken together, these systems – one for each service area –provide a consistent framework for evaluating a community's resilience.

The set of service areas used by CARRI are: Arts, Entertainment and Recreation; Communications; Community Records; Economy; Education; Energy; Finance; Food; Housing; Individuals and Families; Local Government; Natural Environment; Public Health; Public Safety and Security; Solid Waste; Transportation; Water and Wastewater; and Workforce.

Parsing the community as is done in the CRS offers significant advantages for assessments of community resilienc. First, some community systems recover more rapidly or more completely than others from the same severe disruptive event, i.e., each community system has its own resilience. For example, New York City's economy recovered relatively quickly after the 9/11 atrocities, but it took much longer for its transportation infrastructure – with its hub at the World Trade Center – to fully recover. Thus, the CRS "Whole Community" approach provides a convenient method to assess and define needed actions for each community "service area."

Second, the CRS approach facilitates community leaders' understanding of the interdependencies within and among the systems that provide its essential services. This is important because these interdependencies determine the distinctive impacts that each type of severe event will have on specific systems and on the community as a whole (Plodinec, 2015). Natural disasters directly impact a community's physical and natural environment with a cascade of concatenated consequences on other parts of the community. Conversely, a pandemic will not directly impact a community's infrastructure at all, but may severely impact a community's social capital and its economy. As Plodinec (2015a) has noted, "disasters have direction."

RESILIENCE ASSESSMENT PROCESS

The CRS resilience assessment process is led by the community's collective leadership. This Leadership Team includes senior leaders from each service area thus representing all of the community's significant stakeholders.

CARRI's community resilience assessment process discussed in this paper consisted of four parts:

Identification of the most significant risks facing the community as determined by the Leadership Team;
Use of a "Community Snapshot" – a collection of publicly available statistical data (compiled by CARRI) each reflecting one or more aspects of the community's resilience;
Development of a community identity profile based on a survey of community members; and
Assessment of the resilience of each community service area toward all of the significant risks identified by the Leadership Team.

Identification of Most Significant Risks

Each community's Leadership Team collectively determined which of the threats facing their community was significant. The Team was provided with a worksheet that listed a variety of natural hazards, technological hazards, human-caused hazards, mass contagion (pandemic), and economic threats. The worksheet was an expansion of FEMA's Threat and Hazard Identification and Risk Assessment worksheet (FEMA, 2013). The leadership group were instructed to rate each threat in two categories – frequency of occurrence (High, Medium, Low, Never) and level of severity (High, Medium, Low). All threats that rated "High" in either category and any that were rated "Medium" in both categories were to be considered "Significant." This set of hazards and threats was used as input to the multi-hazard resilience assessment as described below.

Community Snapshot

When a community began using the CRS process, CARRI's staff generated a Community Snapshot from publicly available statistical data, primarily from the US Census Bureau. Data were at the county level because that provides the most comprehensive span of data sets, i.e., there are more data types available for counties than for finer-grained units (e.g., census tracts or parcels). The data were organized into three categories: one set focused on the community's economic resilience, a second focused on its natural and built environment, and the third on its social resilience. For each datum, CARRI provided the community's numeric value and the state and US national averages for comparison. CARRI also provided a visual cue for the comparisons: a red-yellow-green "stoplight" for comparison to both the state and national averages. A red or a green light indicated that the community's value was more than one standard deviation away from the state or national average. A yellow light indicated that the community's value was within one standard deviation of the relevant average.

In addition, "gauge" indicators were provided for each of the three data categories that indicated the community's overall resilience in that category compared to others in its state or in the US. For each data category, the gauges indicated where the aggregate of the data in the set fell in relation to state and national averages.

In selecting variables for inclusion in the Snapshot, CARRI scouted several other compilations (e.g., Cutter, 2008; Norris, 2007; Sherrieb, 2010). The variables included in the Snapshot were selected because there was evidence that they contributed to a community's resilience. Care was taken in variable selection to avoid unduly giving extra weight to a particular aspect of the community. There is no relevant publicly available data available for some of the community systems (e.g., energy), but the 26 variables selected provided a broad view of a community's resilience.

The following variables relating to the community's economy were included in the Snapshot:

A "business profile," a pie chart showing the contributions of various sectors to the community's economy.
A profile of community annual incomes (fraction earning less than $40,000, fraction earning from $40,000 to $100,000 and fraction earning greater than $100,000. This also includes the median household income.
The net influx of workers in the 25-44 years of age cohort. This is intended

to reflect the relative economic attractiveness of the community.
A profile of the community's population by age.
A profile of the educational attainments of the community (fraction with less than a high school diploma, fraction graduated from high school, fraction who have earned a four-year college degree, and fraction with a graduate degree).
The fraction of the community's labor force who are actually employed.
The fraction of the community's housing which is vacant.
The ratio of "transfer" payments to earned income. Transfer payments include Social Security and welfare, and other distributions of funds from government to individuals. A high ratio often indicates that in case of a crisis, the community will have to rely more on external sources of funding than will more self-sufficient communities. It also is likely to be a more precise indicator of vulnerability than simply looking at the fraction of the population in groups that may require special assistance.

The following variables relating to the community's built and natural environment were included in the Snapshot:

The community's score on the Natural Amenities Index. This Index was developed by the US Department of Agriculture to indicate the desirability of a community in terms of its natural environment. It considers temperateness of the climate (both temperature and humidity), fraction of the area covered by water, and the topographic variability of the area.
The community's score on the US Environmental Protection Agency's Air Quality Index. This Index provides a relative measure of overall air quality. It aggregates the concentrations of five major pollutants in the air: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide.
The average commuting time for the community.
The fraction of the community's housing which is vacant.

The following variables relating to the community's social resilience were included in the Snapshot:

The ethnic makeup of the community. This is presented as a pie chart based on the ethnic groups residing in the community.
The fraction of the community belonging to the "creative class." The creative class is made up of those members of the community who are pursuing either artistic or professional careers.
The average life expectancy at birth is a measure of the health of the community.
The fraction of the school-aged members of the community actually enrolled in school. This was included as a leading indicator of future resilience.
The ratio of "transfer" payments to earned income. In conjunction with the population profiles this can be used to identify what groups within the community are at special risk.
The ratio of births to teen-aged mothers to total births. Since teen-aged

mothers are much more likely to be locked into a cycle of poverty and dependence and more teen births, this is a leading indicator of future weakness and reduced resilience.
Charitable giving. This is a strong indicator of the social strength of the community reflecting community members' support for each other.
FBI crime indices. These are inverse indicators of a community's social strength.
The ratio of the number of religious establishments in the community to the population. Religious establishments are great sources of strength in many communities providing both social services and social networks to community members.
Ratios of the number of civic organizations to the population. Three were provided: one for arts, entertainment and recreation organizations; one for civic betterment organizations; and one for social advocacy organizations.

Community Identity

The Community Snapshot was a collection of quantitative measures of the community's strengths and weaknesses. The Community Identity survey gathered more subjective information about the community. It consisted of two parts: a brief questionnaire about the community's self-perceptions and a rating of the perceived quality of various aspects of the community.

The first part asked questions adapted from Pfefferbaum, et al., (2013), including

How would you describe your community?

Why do people move into or away from your community?

Where do people regularly gather in your community (e.g., cultural or civic centers, parks, retail centers)?

In the last three years, has the community undertaken one or more large initiatives? If yes, why were they successful or unsuccessful?

For the second part of the survey, residents were asked to rate the following on a scale of 1 to 4, where "1" indicates a need for improvement, and "4" indicates excellence. The aspects of the community included were: public safety, the economy, employment opportunities, wages, education, the natural environment, transportation, health care, housing, shopping, recreational opportunities, art and culture, community spirit, and friendliness.

Multi-hazard resilience assessment

The multi-hazard resilience assessment (MHRA) consisted of a set of "yes-no" questions for each service area aimed at identifying strengths and weaknesses. The MHRA is specific to a given community because it only asks questions that pertained to the risks the community leaders had identified as significant (using the risk assessment worksheet). Thus, for example, if a community is not prone to natural disasters, its resilience to a natural disaster is not questioned, reducing the data-gathering burden.

Each set of questions (called threads) considered four aspects of the resilience of a particular service area (based on Plodinec, 2015b): its capacity or level of service, critical assets necessary for delivering the service, critical assets at risk to the significant hazards or threats facing the community, and the resources available for recovery.

These questions were answered by a group of subject matter experts (SMEs) for each service area. For example, for a community's energy service area, the group of SMEs might include representatives from the regional electric utility and the regional transmission organization, distributors and retailers of liquid fuels (gasoline, propane and natural gas), and suppliers of support services. For the water and wastewater service area, the group of SMEs might include representatives from the regional water authority, the local public health department, the state environmental regulator, and chemical and equipment suppliers.

Questions relating to capacity or level of service included:

Does the entire community have access to the electric grid?
Does the generator of electric power have enough generation capacity to meet the service area's needs at times of peak demand?
Is the community's electric power reliability equal to or greater than the national average of 99.96% for electric reliability?

Is there an active arts and entertainment scene in the community?

Is there a park, public open space, or other recreational area within 0.3 mi of every resident in the community?

Similar questions were asked for each service area.

The SMEs for each service area also determined which assets were critical to that service area and recorded the location of each. Examples for the water services area might include reservoirs and storage tanks, water pumping stations, water distribution lines, wastewater treatment facilities, and water treatment chemical storage areas. For the public health service area critical assets might include hospitals, clinics, medical supplies distribution centers and ambulance depots. If any of these were owned or otherwise controlled by an organization outside the community that also was recorded because it constituted a potential weakness that should be explored (Plodinec, 2015).

For each critical asset identified, the SMEs were asked to assess the asset's vulnerability to the significant threats facing the community. As an example, if the community's financial service area SMEs identified an IT hub as a critical asset, and if a pandemic was a significant threat to the community, the SMEs are asked: *Has the IT hub organization identified critical personnel and developed succession plans for them if they are unable to work?*

Similarly, if a community that is facing natural hazards and identified a community college as a critical educational asset, the SMEs were asked: *Is [the community college] at risk from natural hazards? Consider its location in relation to expected seismic zones, flood plain maps for the community, or nearness to a coastline, and whether or not the facility has been designed to withstand the natural hazard.*

Questions such as this give rise to "subthreads" of questions depending upon how they are answered. A "Yes" answer indicating that the community college was at risk would then lead to follow-on questions such as "*Is there an evacuation plan for the community college?"* and "*Has an alternate location been identified for providing the educational services normally provided by the community college?"*

The last part of each thread queried the SMEs about the resources available for recovery of service. For example, in a community prone to natural disasters, SMEs in the transportation service area were asked "*Are there sufficient financial resources available to repair or rebuild transportation assets at risk? Consider reserve or special purpose assessments or funding, taxes, catastrophic insurance, bonds, loans, and federal funds*."

For any answers that indicated a gap or shortfall, a potential action the community could take was identified and an indication of its cost provided. Relevant resources that could help community leaders shape their actions (success stories from other communities, links to web resources, tips for success) were also provided. In total, over 300 supporting resources were (and are) contained in the CRS.

WHAT WORKS, WHAT DOESN'T

Over the last five years, nine communities have used the assessment module. These have provided some significant "lessons learned" that should guide similar efforts in the future.

The identification of the risks that are significant for the community proved to be useful in two ways. It helped to focus the Leadership Team on the risks that were most important to consider and it reduced both the data-gathering burden and the number of potential actions the CRS generated.
The Community Snapshot – the compilation of publicly available data – did not prove to be very useful to community leaders in making decisions to improve resilience. When asked, community leaders felt that it did not

provide actionable information because it was at too coarse a scale. The Snapshot would have been more useful if it had provided the data in a geocoded form, facilitating actions targeted to a specific neighborhood. It would also have been more useful had it provided the data over time, enabling Community Leaders to see the trajectory of the community.

None of the communities used the community profile survey. Some of the communities did not believe they had the expertise to administer the survey and interpret its results. Others simply did not have the resources for the effort. This did not reflect a flaw in the survey but rather an opportunity to improve the CRS. None of the communities that have used the CRS have been closely aligned with a college or university. Going forward, communities will be encouraged to include one as a partner to handle data gathering tasks such as administering the survey.

As Plodinec (2014) noted, the results of pilot testing led to a change in the CRS from a web-enabled to a facilitated model. While not useful for decision-making by community leaders, the Snapshot provided a valuable context and better understanding of the community for facilitators from outside the community.

The decision to have SMEs carry out the multi-hazard resilience assessments was validated by experience. For example, when one local government tried to carry out the assessment it was later found to be extremely inaccurate and of no use. Community leaders opined that the community's own SMEs lent the assessment more credibility and a more nuanced understanding of what was needed and what actions would be successful in their community.

SMEs indicated that geocoding asset locations would have helped them to make better decisions about which assets were at risk.

Conversely, when SMEs carried out the assessment they often found new insights particularly related to dependencies and interdependencies. However, SMEs often did not know who should be involved in the assessment of their service area. As has been described elsewhere, CARRI developed additional tools to help with this process, including moving to a partially facilitated process (Plodinec, 2014; Plodinec, 2015a).

CONCLUSION

Assessment of a community's strengths and weaknesses should be the signpost for community actions to toward greater resilience. CARRI's rather unique approach – combining both statistical and subjective measures with detailed assessments of each community service area – was developed to provide that direction. In practice, the multi-hazard resilience assessments of each service area have proved to be the most useful in pointing to meaningful actions. CARRI is using the results reported here to further improve the CRS process.

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IMPLEMENTATION OF TRANSPORTATION RESILIENCE ASSESSMENT TOOL: NORTHLAND FLOOD CASE STUDY

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INTRODUCTION

Resilience refers to a system's ability to accommodate variable and unexpected conditions without catastrophic failure, or "the capacity to absorb shocks gracefully" (Foster 1993). As everyday local, regional, national, and international dependence on transportation facilities grows around the world, resilient transportation systems are needed to secure the highest possible level of service during various disruptive events. Reports from recent events around the globe, including Hurricane Katrina and significant seismic events in Haiti, Chile, and Japan, have increased the awareness and the importance of resilience demands on transportation systems. Indeed, analysis of the transportation network's resilience before a disruptive event will help decision makers identify specific weaknesses within the network so that investment is prioritized appropriately (Freckleton et al. 2012).

In recent years, many researchers have focused on the concept of resilience for infrastructure systems and their evaluation. A number of frameworks and measurement tools have been proposed, intending to integrate resilience into the transportation system's asset management process. Among these, the New Zealand Transport Agency (NZTA) engaged AECOM to develop a framework to measure the resilience of the New Zealand transport network. The research has been published as Research Report 546 - Measuring the resilience of transport infrastructure (Hughes and Healy 2014).

One of the recommendations from this work was to 'undertake a real-scenario testing of the framework with key operational staff'. Consequently, the purpose of this research is to test the resilience framework and assessment tool developed by Hughes and Healy (2014) in a pilot study to determine its potential usefulness to NZTA.

OVERVIEW OF THE NZTA TRANSPORTATION RESILIENCE TOOL

This section provides a summary of the transportation resilience measurement tool drawing heavily from the original research.

Technical Resilience Framework

Referring to Figure 1, the technical resilience assessment tool by Hughes and Healy (2014) has been divided into three main principles (i.e. robustness, redundancy and safe-to-fail). Each principle is in turn a weighted average of a number of categories below each Principle (e.g. structural, procedural and interdependencies under robustness). Finally, a number of measures (or questions) exist under each Category.

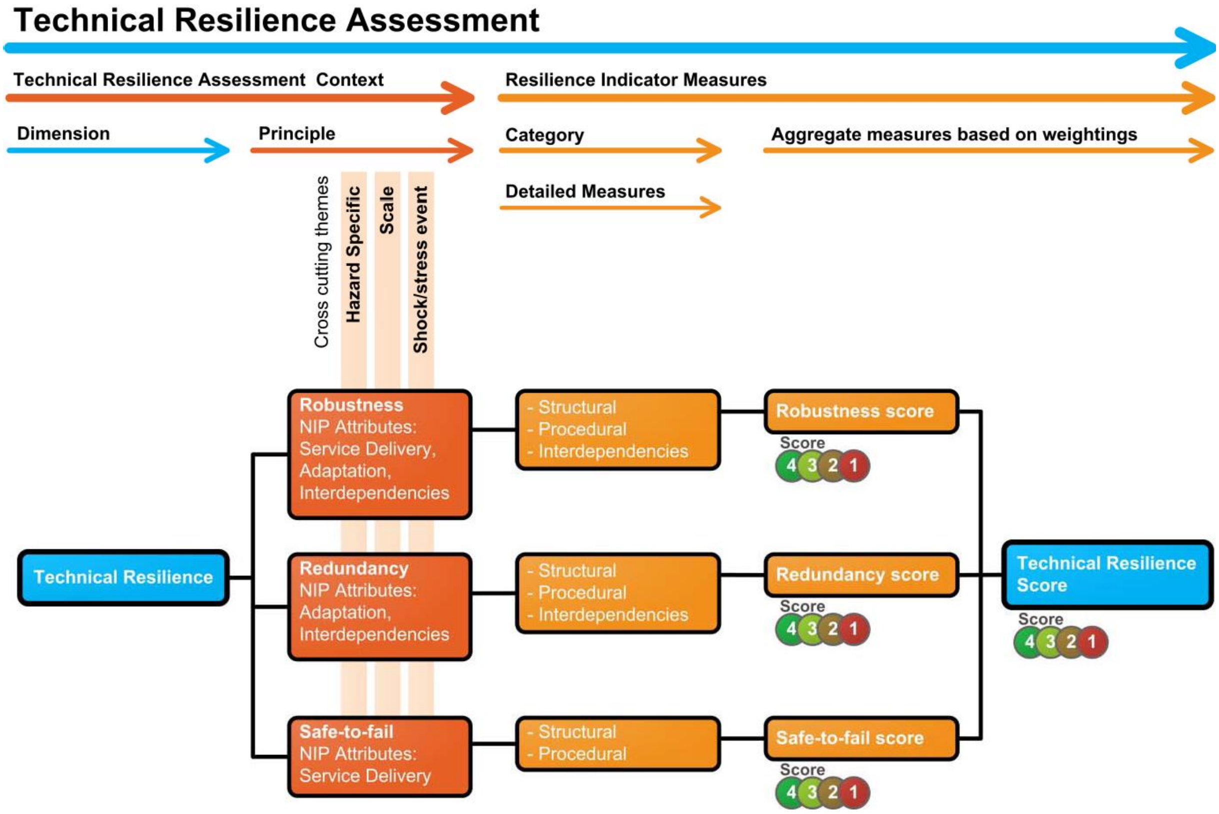

Figure 1: Technical Resilience Framework Overview, Source: Hughes and Healy (2014)

Resilience Assessment Tool

A resilience assessment tool – in spreadsheet format - was developed which describes each measure and their measurement process. The tool captures scores on a scale of 4 (very high level of resilience) to 1 (low resilience). Table 1 shows a sample of identified measures for robustness indicators within the structural category.

Referring to Table 1, it is noted that the tool consists of a range of questions across the categories. Once the relevant questions have been answered, weightings can be applied at the category, principle or dimension level. It is important to note that the weightings are subjective and will be based on user preference.

Table 1: Example of the Resilience Assessment Tool (for the 'robustness' principle)

ROBUSTNESS			Total Robustness score:		2.3
Category	**Context**	**Measurement Indicators**	**Measurement scale**	**Individual score**	**Category average**
Structural	Maintenance	Processes exist to maintain critical infrastructure and ensure integrity and operability – as per documented standards, policies & asset management plans (e.g. roads maintained, flood banks maintained, stormwater systems are not blocked. Should prioritise critical assets as identified.	4 – Audited annual inspection process for critical assets and corrective maintenance completed when required. 3 – Non-audited annual inspection process for critical assets and corrective maintenance completed when required. 2 – Ad hoc inspections or corrective maintenance completed, but with delays/backlog. 1 – No inspections or corrective maintenance not completed.	3.0	2.8
	Renewal	Evidence that planning for asset renewal and upgrades to improve resilience into system networks exist and are implemented.	4 – Renewal and upgrade plans exist for critical assets, are linked to resilience, and are reviewed, updated and implemented. 3 – Renewal and upgrade plans exist for critical assets and are linked to resilience, however no evidence that they are followed. 2 – Plan is not linked to resilience and an ad hoc approach is undertaken. 1 – No plan exists and no proactive renewal or upgrades of assets.	4.0	
	Design	Percentage of assets that are at or below current codes	4 – 80% are at or above current codes 3 – 50-80% are at or above current codes 2 – 20-50% are at or above current codes 1 – Nearly all are below current codes	3.0	
		Assessment of general condition of critical assets across region	4 – 80% are considered good condition 3 – 50-80% are considered good condition 2 – 20-50% are considered good condition 1 – Nearly all poor condition	3.0	
		Percentage of assets that are in zones/areas known to have exposure to hazards	4 – <20% have some exposure to known hazards 3 – 20-50% are highly exposed, or >50% are moderately exposed 2 – 50-80% are highly exposed 1 – 80% are highly exposed to a hazard	2.0	
		Percentage of critical assets with additional capacity over and above normal demand capacity	4 – 80%+ of critical assets have >50% spare capacity available 3 – 50-80% of critical assets have >50% available 2 – 20-50% of critical assets have >50% spare capacity 1 – 0-20% have spare capacity.	2.0	

IMPLEMENTATION METHODOLOGY

The methodology adopted follows the "Action Research" training methodology (Stringer 2013). The pilot study site chosen was a high profile and high-impact case study (refer to Site Selection section below) to enable the research to focus on probable issues and lessons learned (Creswell 2012; Patton 2014). The case study methodology used in this research seeks to explain the present situation, to address "how" things happen and "how" technical resilience measures should be assessed and carried out to enhance the resilience of the state highway network (Yin 2013).

Purposeful Sampling: Identification of Key Participants and Data Sources

Purposeful sampling was conducted, where key individuals were initially proposed by NZTA to help collect an *"information-rich"* data sample (Patton 2014). Identifying other *"opinion leader"* or *"gatekeeper"* respondents was later extended using the so called *"snowballing"* process followed by Stringer (2013).

A number of face to face workshops and interviews were undertaken in the case study to provide an environment through which stakeholder groups and individual experts could collectively contribute during implementation. These were supplemented by telephone and email communication as required. The use of other sources of data (e.g. documentation, observation, archival documents and audio-visual materials) allowed the research team to investigate a broader range of technical and historical issues.

Site Selection

The pilot study route proposed by the Northland Regional office is state highway one (SH1) at Kawakawa. Specifically, the study route starts at the SH1/10 junction at Pakaraka to the SH1/SH11 junction at Kawakawa, and from that point along SH11 to 427 Paihia Road. An aerial photo of the selected site is included in Figure 2. The region's transportation network in 2015 included 6,530 kilometres of road, a freight rail link from Auckland via Whangarei to Otiria, a deepwater port at Marsden Point and commercial airports at Whangarei, Kerikeri and Kaitaia (Northland CDEM 2016).

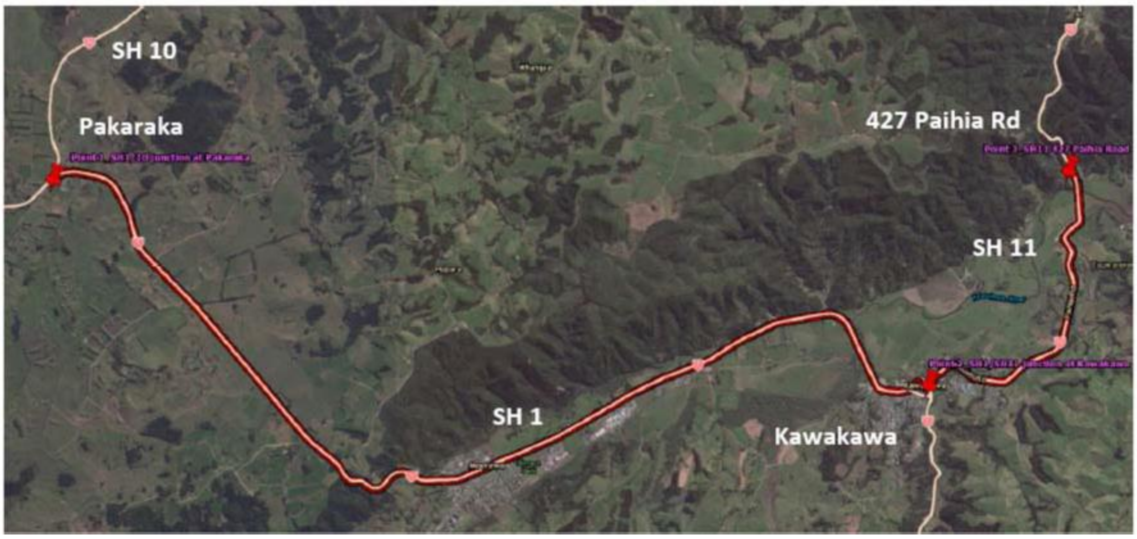

Figure 2: Pilot Site for Assessment

Hazard Selection

The individual hazard to be assessed as part of this trial was chosen as flooding; pre-selected in the wake of the major 2011 and 2014 Northland floods.

Northland was significantly hit by three sequential flooding events from 8th to 20th July 2014, consequently State Highway 1 (SH1), SH10, SH11 and SH12 completely closed and SH14 became single lane. In addition, more than 100 local roads closed and more than 430 landslips happened in the area. In January 2011, cyclone Wilma caused damage to the road network in the region at a cost of approximately $6 million. In July and March 2007 the region faced similar flooding events which caused approximately $3 million and $6.2 million damage to the road transport network, respectively.

According to the Northland CDEM (2016) "Flooding has, and will continue to be a high priority hazard for the Northland region". However, the area is also vulnerable to other hazards including: tsunami; volcano; pandemic; and electricity or fuel failure

Resilience assessment process

The assessment process developed by Hughes and Healy (2014) is summarised in Figure 3 below. This includes an initial criticality assessment, followed by a hazard-specific risk assessment to determine a 'desired' level of resilience. The resilience assessment of an asset is then undertaken and compared against the 'desired' level, from which any improvements or interventions can be then developed.

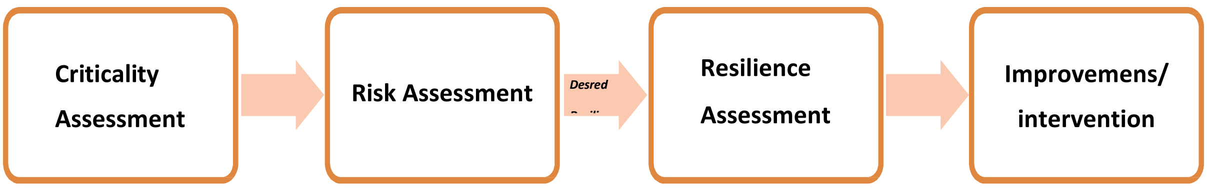

Figure 3 Resilience assessment process, Source: Hughes and Healy (2014)

For this pilot study, a critical route within the study area (see Figure 2) has been chosen in conjunction with NZTA, as discussed in the Site Selection section above.

Subsequently, in preparation for the resilience assessment process, the highly exposed sites within the study area which were prone to flooding were identified. The 2012 Flood Study (URS Ltd) has been reviewed, along with interviews with relevant stakeholders to determine the likelihood of flooding at different sites. Consequently, four flood prone sections have been identified, as shown in Figure 4.

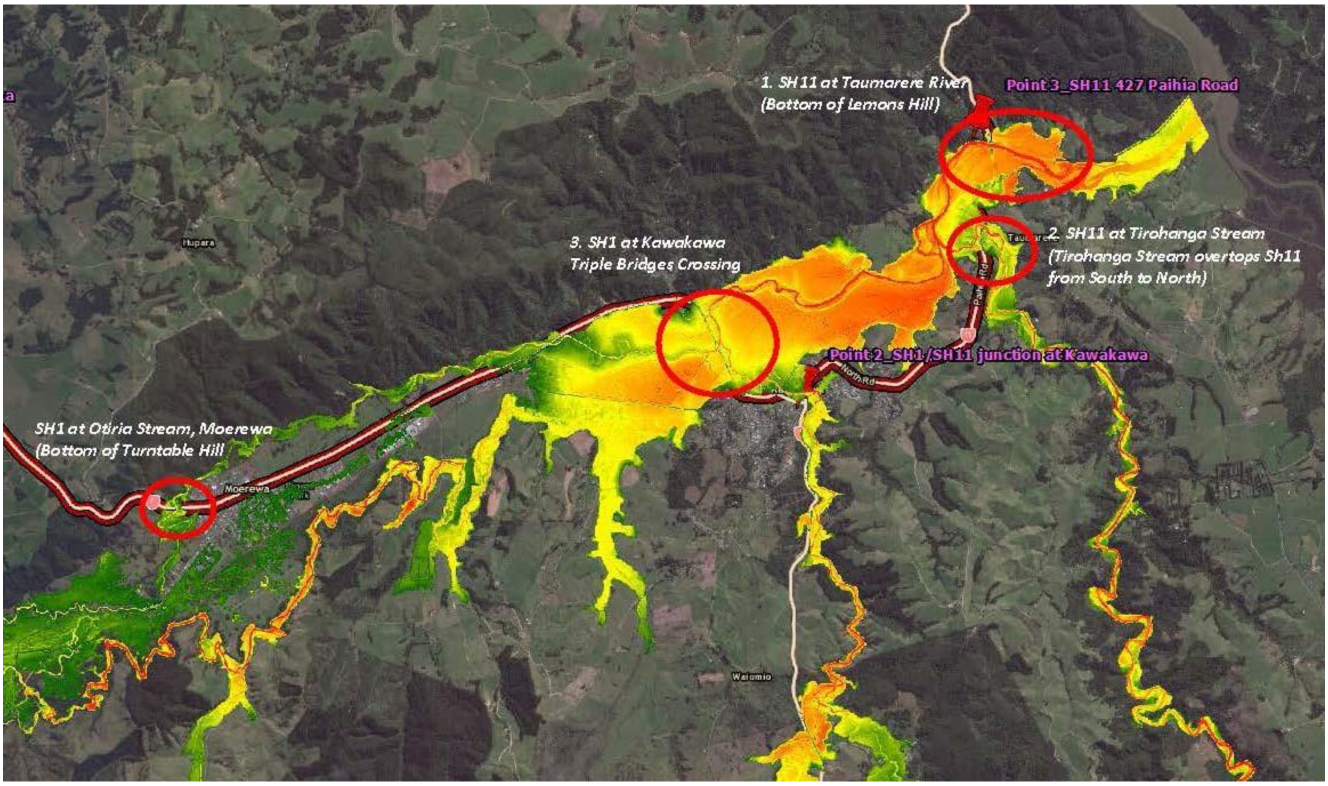

Figure 4 Flood Information for ARI=100 years

The risk ratings for each site indicated in Table 2 below, along with the resulting 'desired' resilience level, were then determined. This is on a four-tier scale from 'low' resilience (corresponding to a low 'risk' score) to 'very high' resilience (corresponding to an 'extreme' risk score).

Table 2 Risk scores and 'desired' resilience scores for highly exposed sites

	Site 1: Taumarere	**Site 2: Tirohanga**	**Site 3: Three bridges**	**Site 4: Otiria Stm**
Likelihood rating	Possible	Highly unlikely	Possible	Likely
Consequence	Major	Major	Major	Major
Risk*	High risk: Risk requires close attention	Moderate risk: Risk requires attention	High risk: Risk requires close attention	High risk: Risk requires close attention
'Desired' resilience level*	High	Moderate	High	High

**From NZTA Risk Assessment Tool*
***From Hughes and Healy (2014)*

As shown in Table 2, three of the four sites require 'high' resilience, and the fourth (Tirohanga bridge) merits a 'moderate' resilience score. Figure 5 shows a photo of one of the high risk sites (i.e. three bridges) in July 2014 during a flooding event.

Figure 5: Flooding at Kawakawa Triple Bridges in July 2014 (looking north)

RESILIENCE ASSESSMENT

This section includes the technical resilience assessment for the selected network. The default weightings were applied, as the determination of weightings was outside the project scope. As the pilot study progressed, it became clear that a particular Average Recurrence Interval (ARI) also needed to be defined. For example, some of the resilience assessment questions refer to the 'percentage of critical assets affected' or the 'likely impact on system performance'. In the case of flooding, the response to the question is dependent on the particular ARI. Consequently, for the purpose of this pilot study, an ARI of 100 years was chosen.

The resilience scoring matrix is summarised below, along with the associated colour scheme in the resilience assessment tool (see Figure 6).

Score 4: Very high resilience – meets all requirements
Score 3: High resilience – acceptable performance in relation to a measure(s), some improvements could be made
Score 2: Moderate resilience – less than desirable performance and specific improvements should be prioritised
Score 1: Low resilience – poor performance and improvements required.

Score	4	3	2	1

Figure 6: Resilience colour scheme

The summary dashboard detailing the technical resilience of the study route is shown in Table 3 below.

Table 3: Summary of Technical Resilience Assessment for Northland Study Route

		Category Score		Principle Score		Dimension Score	
Dimension	Principle	Category	Average Score	Principle	Average Score	Dimensions	Average Score
Technical Resilience	Robustness	*Structural*	2.29	Robustness	1.8	Technical Resilience	1.95
		Procedural	1.00				
		Interdependencies	2.25				
	Redundancy	*Structural*	1.67	Redundancy	3.0		
		Procedural	4.00				
		Interdependencies	2.25				
	Safe to fail	*Structural*	1.00	Safe to fail	1.0		
		Procedural	1.00				

As a standalone route assessment, the resulting resilience scores provide the following insights:

Overall, the pilot study route has a *moderate* technical resilience level. This is achieved via a poor safe-to-fail principle score (score of 1.0), a high redundancy score and a moderate robustness score.
Within the categories, all scores were moderate or poor, with the exception of redundancy-procedural, which scored very high.
The robustness-procedural score was low due to the absence of resilience-specific design codes being available, and enacted.
The safe-to-fail scores were low as this is a new concept and therefore not part of historical design codes or practices.

DISCUSSION, LESSONS LEARNED AND RECOMMENDATIONS

Getting 'the right person in the room'

The importance of getting 'the right person in the room' should be highlighted. In addition, they need to come prepared with the right information. While the study team eventually found 'the right person' to answer each question, this was arrived at following interviews with one or two others who had an opinion on the score but recommended that we speak to 'the right person' to obtain confidence in the scoring. Consequently, the final score adopted was taken to be that from the "right person" and this was, where possible, backed up by evidence.

Consistency of Scoring

Maintaining consistency was not an issue in this trial, as the same people were being quizzed on each critical asset. However, should the tool be used nationally to assess the resilience of assets or corridors in different NZTA regions, with a view to funding resilience projects, ensuring consistency of interpretation and scoring potentially becomes an issue. One solution may be the establishment of a dedicated resilience team within NZTA, tasked with travelling to the regions to manage/facilitate the resilience assessment process, thereby ensuring consistency.

Consistency of Events

As the pilot study progressed, and as previously mentioned, it became clear that a particular Average Recurrence Interval (ARI) needed to be defined – chosen as 100 years for this study. For example, some of the resilience assessment questions refer to the 'percentage of critical assets affected' or the 'likely impact on system performance'. In the case of flooding, the response to the question is dependent on the particular ARI. Should the tool be used nationally to assess the resilience of assets or corridors in different NZTA regions, with a view to funding resilience projects, then pre-defining the events against which the assessment is to be carried out is critical to ensuring consistency and comparability.

Broader Trial of the Resilience Tool

To date the tool has been trialled only for a single hazard – flooding. While it is envisaged that the tool can equally be applied to an alternate single hazard or multiple hazards, the ease with which it can be applied depends on availability of data. Consequently, it is recommended that the resilience assessment tool is trialled for all specific hazards requiring consideration in the New Zealand environment. This will help determine data requirements for each hazard and, indeed, availability of such data.

CONCLUSION

The Transport Agency has indicated that they would like this tool to be used to gauge resilience levels on various parts of the State highway network. These levels could then be compared across the country, to assist in decisions on where to invest money in order to achieve the greatest overall network resilience. The Transport Agency have also indicated that they would like the tool to be used as a network wide filter to identify these problem areas before drilling down and doing a more detailed assessment of the problem areas identified. This approach would feed in well to the business case process where more detail is required as each case progress.

The trial of the resilience tool suggests that, with the recommended modifications, it would be able to assist the Transport Agency with the above. However, the tool itself needs to be more user friendly, such as providing a clearer user interface and integrated instructions. An integrated tool would also need to be able to draw in reports from different parts of the network to provide the evidence for scores.

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HOW DO WE MEASURE CRITICAL INFRASTRUCTURE RESILIENCE?

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ABSTRACT

Measuring resilience is not an easy task. Even though amount of research on resilience has been increasing in the past decade, according to the UNDP, finding a consensus on how to measure it is impossible. This can be explained by the fact that the concept of resilience has been developed in different fields and using diverse set of dimensions for analysing phenomenon.

Modern societies are highly dependent on the uninterrupted functioning of critical infrastructures (CIs) and therefore, any disruption will have a negative impact on the security and well-being of citizens. Consequently, several initiatives have been created, such as the European Programme for Critical Infrastructure Protection (EPCIP), the Centre for Critical Infrastructure Protection (CCIP) in New Zealand or the Presidential Policy Directive: "Critical Infrastructure Security and Resilience", in the USA.

For this paper, we performed an extensive literature review on the concept of critical infrastructure resilience (CIR) to determine what types of measurement of the phenomenon are available and how they are used. We also consulted CI operators through workshops we conducted under the EU project IMPROVER.

We found that available models for assessing CIR focus mainly on technical and rarely include social dimension of resilience. We also found that the CI operators are not able to agree on a definition of CIR.

Keywords: critical infrastructure resilience, resilience assessment

INTRODUCTION

Economic losses from disasters are now reaching an average of US$250 billion to US$300 billion each year. It is estimated that future losses will be at US$314 billion in the built environment alone (UNISDR, 2015). Built environments including CI form the backbone of modern societies. Therefore building resilience into CI systems is essential for increasing the overall resilience of communities.

The concept of CI can be traced back to the US in the mid-1990s, when some infrastructures began to be seen as critical for the functioning of the society. The concept of CIR started to appear in CI related documents, most notably in the US, in the late 2000s. It gathered speed after the hurricane Katrina in 2005 and policy debates regarding the US government's policy being too focused on protecting assets from terrorist attacks rather than improving the resilience of those assets against a variety of threats (Moteff, 2012). The change from CI protection to resilience enabled an all hazard approach (Australian Government, 2010). Due to the adverse and changing landscape of hazards and threats to CIs, it is not possible to foresee, prevent, prepare for and mitigate all these events.

Despite the fact that there has been increasing interest in building and measuring CIR, the efforts tend to focus on technical aspects of infrastructures and they fail to grasp antecedent social factors. While the technical features are essential for the infrastructure to function, the main purpose of CI is to provide services to the public. Separation of social and the technical environment that are highly interconnected is arbitrary and therefore there is a need for more holistic approaches to measuring CIR.

METHODOLOGY

This article is built on the information collected by the EU project IMPROVER by using several methods. First of all, we conducted an extensive literature review analysing all types of material relevant to the topic, including books, scientific articles, conference proceedings, etc. In order to collect information on existing country-level definitions, implementation and assessment of resilience concepts, the IMPROVER consortium conducted an extensive international survey covering Europe, Africa, Asia, Oceania, North and South America. Information was collected by reviewing region specific documents, scientific papers, and conducting interviews with resilience experts in a specific region or country.

Secondly, we interviewed identified CI operators and other experts from different European countries. We gathered information in the IMPROVER workshop that took place in Copenhagen in September, 2015, as well as CI operator workshop that was held at the premises of the European Commission Joint Research Centre in Ispra in April, 2016. The pool of CI experts was primarily composed of the IMPROVER associate partners who committed themselves to support the project. Other experts were involved using personal contacts of the IMPROVER consortium members. We were compelled not to disclose the names of the organisations and experts referenced in this article due to non-disclosure agreements; therefore, we are allowed to mention only the business area of the interviewed experts.

CONCEPT OF CRITICAL INFRASTRUCTURE RESILIENCE

The concept of CIR is rather ambiguous and no commonly accepted definition exists in scientific literature. Despite the difficulties, different countries are making progress in this direction. For example, the US National Infrastructure Advisory Council (NIAC) defines infrastructure resilience as "the ability to reduce the magnitude and/or duration of the disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event" (National Infrastructure Advisory Council, 2009). In Japan, resilient infrastructure is defined using four qualities: resistance, reliability, redundancy, response and recovery (Dewit, 2015). In New Zealand, infrastructure resilience has been defined in relation to risk reduction, readiness, response and recovery (Ministry of Civil Defence and Emergency Management, 2015). Therefore, these CIR definitions are closely related to the theory of engineering resilience and primarily focus on the technical dimension of resilience for improving CIR (Bruneau et al., 2003; Tierney & Bruneau, 2007). Technical dimension of resilience refers to the physical properties of a CI facility, including its ability to resist damage and loss of function and "to fail gracefully".

However CI is a socio-technical system and a part of a complex community system. No matter how much physical science and technology are involved in a complex system; no system is ever solely physical (Bea et al., 2009). Therefore, there have been some recent attempts to link CIR with other dimensions of resilience, such as social and organisational, this way urging for the resilience concepts that are applicable and relate to both the CI itself and the community where it functions within. For example, Labaka et al. suggest that CIR should be defined as: (a) the resilience level of the CI where triggering event occurs (internal resilience composed of technical, organisational and economic resilience); (b) the resilience level of the rest of the external involved agents (external resilience composed of technical, organisational, economic and social resilience) (Labaka et al., 2015). Jackson also recognises that the people and organisational infrastructure surrounding the technological systems are also involved in ensuring system resilience (Jackson, 2007). In the context of CIR, social resilience aims to increase resilience of people living around and depending upon CI services in times of disruptions. Organisational dimension of resilience is concerned about organisations owning and operating CI facilities and ways to increase their resilience in the case of an emergency.

The Australian Critical Infrastructure Resilience Strategy is an important development in relation to the aforementioned discussion as Australian Government has chosen to focus on organisational and not technical resilience in order to achieve CIR. CIR is seen as "coordinated planning across sectors and networks, responsive, flexible and timely recovery measures, and development of an organisational culture that has the ability to provide a minimum level of service during interruptions, emergencies and disasters, and return to full operations quickly" (Australian Government, 2010).

IMPROVER RESULTS

Our interviews with CI operators and other resilience experts revealed that the concept of CIR is at a rather early stage of implementation in Europe. There is neither commonly accepted definition nor methodology for measuring CIR. "Different CI sectors require different indicators to measure resilience. Even within one sector several functions might exist with various indicators of each functional performance. Therefore the indicators of resilience will be different across different sectors and functions. A major challenge is how to compare and/or combine them." (IMPROVER workshop in Copenhagen, group discussions with CI operators and resilience experts, September 25, 2015).

IMPROVER results from interviews with CI operators indicate that the operators across European countries do not use direct measures to assess CIR. A representative of the company working in oil sector in Norway noted that instead of measuring resilience, the company measures infrastructure redundancy (representative from a major supplier of fuel to the Norwegian market, personal communication, April 22, 2016). Norwegian power grid operator argued that "downtime is the most descriptive way to measure CIR. One could also measure lifetime, condition, maintenance and criticality" (representative of electrical power production and distribution company, Norway, personal communication, April 22, 2016). Similar opinion was expressed by the former employee of an organisation operating Öresund fixed link who informed that resilience should be measured in terms of the downtime of a facility (former employee of an organisation operating Öresund bridge and tunnel, Sweden, personal communication, May 17, 2016).

The representative from water sector in Norway informed that in their company "resilience is measured indirectly with parameters such as deliverance certainty, resistance against unwanted events, surveillance, condition monitoring, number of unwanted events, downtime, analysis of previous events, redundancy in the systems, etc." (local suppler of potable and waste water management, Norway, personal communication, April 22, 2016).

Group discussion during the IMPROVER operator workshop revealed that European CI operators consider already existing risk management or business continuity tools to be useful. They stressed that as long as resilience concepts do not appear significantly different, it is hard to motivate and justify the usage of resilience concepts and measures. Therefore in that sense it could be argued that resilience is already part of the company, and it is difficult for the operators to see the need for something else. The group stressed the need for clearly described indicators, and a framework that can be used together with already existing business continuity plans and risk management tools (IMPROVER operator workshop in Ispra, group discussion, April 28, 2016).

These results indicate that CI operating organisations mainly focus on internal resilience by assessing technical factors (such as robustness and reliability of the physical infrastructure, downtime, post-event functionality, etc.) of infrastructure with some recent efforts to include organisational resilience indicators (such as training and education of staff). However, they tend to fail to include social dimension of resilience (e.g. training and education of the public, local understanding of risk, information sharing with the public, etc.). Nevertheless, during the operator workshop, CI operators agreed that in order to achieve overall community resilience, there is an urge to involve society. The resilience of societies in the context of CIs can be increased through improved population engagement and the utilisation of the concept of shared responsibility.

EXISTING ATTEMPTS TO MEASURE CI RESILIENCE

Compared to the European countries, the US is rather advanced in the area of CIR measurement. The US Department of Homeland Security (DHS) has developed the Enhanced Critical Infrastructure (ECIP) Initiative which serves as a cornerstone of the voluntary outreach effort by the Government to help to increase resilience of CIs across the country. The Resilience Measurement Index (RMI) used as part of the programme was developed to characterise the resilience of CI. The RMI involves technical as well as organisational resilience indicators. It is developed using a hierarchical process (three levels of indicators), placing the generic characteristics of resilience at the upper 'Level 1': preparedness, mitigation measures, response capabilities, and recovery mechanisms (Figure 2) (Petit et al., 2013).

In reality, indicators are measured and applied using a set of specific questions. The RMI is an aggregation of information from questions answered during a facility visit to create an overall index. A list of 'Yes/No' questions each having its weight is divided into functional groups. For each group an index is calculated by using a weighted sum method. Each group itself has its weight value. The final CIR index is calculated as a weighted sum of all calculated group values. Each 'Yes' answer is worth 100 points and each 'No' question is worth 0 points. Consequently, RMI can have values from 0 to 100 reflecting relative resilience level of a particular CI facility. Consider business continuity management exercises group. It contains seven questions, such as if an organisations includes external responders in its exercises.

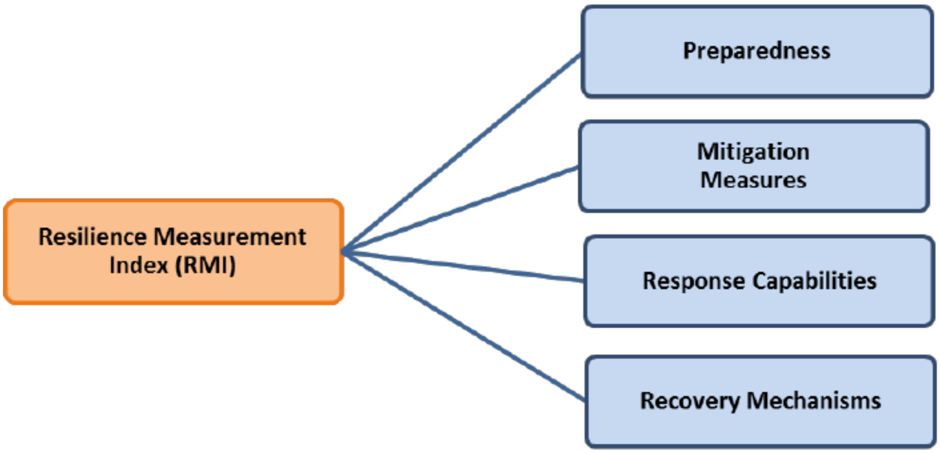

Figure 2. Resilience Measurement Index. Reprinted from "Resilience Measurement Index: An Indicator of Critical Infrastructure Resilience", by Petit et al., Argonne National Laboratory, ANL/DIS-13-01, 2013. Retrieved from: https://www.researchgate.net/publication/299528136_Resilience_Measurement_Index_An_Indicator_of_Critical_Infrastructure_Resilience. Accessed: July 3, 2016.

As it was already mentioned, the Australian government has focused on organisational resilience in order to achieve CIR. CIR is achieved by undertaking traditional risk management/business continuity and organisational resilience initiatives. For example, the Australian Government offers an online tool called 'Organisational Resilience HealthCheck' which asks to rate an organisation according to a set of low and high level descriptors for 13 resilience indicators (see Figure 3).[1] The indicators are grouped under three resilience attributes, namely leadership and culture, networks and partnerships, change readiness (Australian Government, n.d.). Each indicator is qualitatively assessed in a four-item scale (from low to high). Consider leadership and culture group. It consists of seven questions, such as leaders are reactive and act under stress, or if leaders are oblivious to the needs of people working below them.

The index can have values from 0 to 100 and offers a set of treatment options to improve organisational resilience. For example, to improve leadership, it is suggested to develop a culture of managing problems locally and supporting the teams centrally, etc. However, putting an emphasis on organisational resilience assessment, this model does not take into consideration neither technical nor social resilience aspects.

[1] HealthCheck is based on an organisational resilience assessment tool developed by Lee et al. from the research group Resilient Organisations in New Zealand (Lee et al., 2013). Lee et al. developed the tool by reviewing and adapting organisational resilience benchmarking tool developed by Stephenson (2010).

Figure 3. Resilience Indicators. Reprinted from Resilient Organisations, 2012. Retrieved from: http://resorgs.org.nz/what-is-resilience. Accessed: July 5, 2016.

As a part of Critical Infrastructure Resilience Strategy, the Australian Government also initiated the Critical Infrastructure Modelling and Analysis (CIPMA) program, which is intended to improve the security of the country's CI (Australian Government, 2008). Although resilience is not among the main targets of the program, it is implicitly included though the investment to mitigation strategies. The CIPMA program aims to improve an insight into the effects, in terms of service disruption, of natural or human-sourced disasters (Buxton, 2013). The outcome of this program is a software tool that combines simulation models, databases, geographic information system and economic models. It is intended that CIPMA should provide guidance on helping to avoid failures, with preparedness and planning as well as aid in recovery from disasters. It should be noted that when the CIPMA team undertake a program of study, each case is treated separately and tailored to the purposes of the project (Buxton, 2013). However, only limited information about the methodology used in the tool could be accessed.

CONCLUSIONS

There is existing, but fragmented efforts to measure CIR. This paper showed how CIR assessment models focus on the technical and organisational aspects of the infrastructure failing to take a more holistic approach and include social resilience measurements. While the technical features are essential for the infrastructure to function, the main purpose of CI is to provide services to the public. Indeed, since the goal of these models is to increase resilience of CIs, why not to include indicators which the CI operators can control in order to enhance social resilience? For example, one of the key factors of social resilience is communication between all the actors involved in the disaster, including the public, CI operators, emergency management personnel, etc. Thus by sharing timely and accurate information not only with emergency management personnel but also with the public, CI operators would be increasing social resilience. Social resilience can also be improver through improvements in risk awareness and preparedness.

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EVALUATING WASTEWATER SYSTEM FUNCTIONALITY AND RECOVERY PERFORMANCE FOLLOWING MAJOR DISRUPTIONS

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ABSTRACT

Following major disruptions, the restoration of infrastructures back to pre-event service levels can be tracked to aid recovery decisions. For wastewater systems, damage assessment in the immediate response to a disruptive event can prove difficult due to being a largely buried system, the relatively slower response to realising a loss of connectivity due to storage capacities, and overflows to land or co-located stormwater networks. Due to these inherent complexities, using single performance metrics to define system operability, such as network connectivity alone, cannot sufficiently represent all aspects of system functionality. A previous study has defined a range of functionality indicators conducive to data collection both in the immediate response and in posterior analyses of wastewater system recovery. Further separating these indicators into distinctive levels of service; full, restricted, or no service, the technical recovery of the system can be quantified. This paper builds on the literature by incorporating a metric to assess the performance of the technical recovery based on restoration targets or user expectations of recovery. The proposed approach is applied in a post-disaster analysis of wastewater recovery following the Christchurch Earthquake (22 February, 2011) and quantitatively concludes that the wider system recovery was largely effective. The complete framework can be applied in both the immediate response to disruptions and in the simulation of different redundancy and recovery strategies to compare the impacts on overall system functionality and the perceived performance of recovery decisions.

Key Words: Wastewater, Christchurch earthquake, disaster recovery, lifeline infrastructure

INTRODUCTION

The restoration of an infrastructure system following a major damage causing event is commonly represented graphically by plotting the functionality of the system over time (Dueñas-Osorio & Kwasinski, 2012; Cimellaro et al., 2014; Zorn & Shamseldin, 2016a; amongst others). The definition of functionality is not always consistent between infrastructures or events, however, variations on network connectivity are frequently the most widely reported (i.e. the population without service, number of connections without service, or the percentage of operable nodes and links in the network). With spatial variability in population densities and the representation of networks at different resolutions, such indicators are not necessarily analogous and may not be representative of the wider system as a whole. The importance of considering system functionality beyond connectivity is highlighted by Davis et al. (2012) in the analysis of the potable water system recovery following the 1994 Northridge Earthquake. By separating the water system functionality into a range of properties (connectivity, quality, quantity, and fire protection) insights into the recovery process were made that were not otherwise evident when considering connectivity in isolation.

With this in mind, wastewater system recovery has recently been separated into different categories (Davis, 2014; Preston, 2015; Zorn & Shamseldin, 2016b). While somewhat related in definition and purpose, only those proposed by Zorn and Shamseldin (2016b) are applied to an observed disruptive event – a posterior analysis of the wastewater system recovery following the February 22, 2012 Christchurch earthquake. With a focus on simplicity and being conducive to data collection in both the short-term immediate response to a disruptive event, overall system functionality was broken down into three service categories; network connectivity, the volume of wastewater produced, and the treatment qualities. Furthermore, each was separated into three distinct classes of normal service (N), restricted/alternate service (A), and no service (X). In taking this approach, it was observed that considering wastewater connectivity in isolation leads to a significant overestimate of the complete system functionality.

While the framework presented by Zorn and Shamseldin (2016b) provides an indication of technical functionality in the immediate response phase, the priorities and perceptions of recovery progress can differ across user groups (Quarantelli, 1999; Brown et al., 2008). Although asset operators generally prefer to minimise the number of adversely affected users (Bruneau & Reinhorn, 2007), user groups may have a different priorities as evinced in the Christchurch Earthquake recovery (Potangaroa et al., 2011; Lambert et al., 2012; Law, 2015; amongst others). To further assess recovery, the acceptance of users to provided level of service can be examined (Kameda, 2000) based on the premise that although an aspect of system functionality may be provided using an alternative measure, the community may be less acceptant of such provisions for extended lengths of time. Gauging such perceptions of users proves difficult in the Christchurch application due to the control placed on social science research following the event (Beaven et al., 2015) and the time delay for this analysis. As a compromise, wastewater recovery targets are assumed representative of public expectations for the assessment of recovery performance. This will allow comparison to the conclusions of an independent review of the emergency management response (McLean et al., 2012) who commend the wastewater recovery efforts given the damage state.

The main contribution of this paper lies in the provision of a framework to investigate and quantify the restoration performance in the immediate response to a major disruption based on the perceived acceptability of each level of service classification.

METHODOLOGY TO QUANTIFY RECOVERY PERFORMANCE

Zorn and Shamseldin (2016b) define wastewater system functionality based on three separate categories which each comprise three distinct level of service classes (Table 1). This breakdown allows for the straightforward population of categories and classes in the immediate response to a disaster event or in a posterior analysis with reduced information.

Table 1. Service categories and classifications for wastewater network recovery simplified from Zorn and Shamseldin (2016b).

Service Category		Case Study Definition
Collection Service	N	Wastewater producing appliances can be used with the downstream collection network able to convey flow – regardless of lateral connection status.
	A	External collection of wastewater is in place through the use of portable or chemical toilets.
	X	No wastewater collection service is provided on behalf of the Christchurch City Council.
Volume	N	No restriction in producing normal wastewater volumes whether through a normal connection or sufficiently sized redundant storage tanks.
	A	Volume is restricted due to alternative collection services or downstream damage requiring users to restrict the wastewater volume produced due to overflows to the environment or repairs.
	X	No wastewater produced is connected to the network at any stage of conveyance or treatment
Treatment Quality	N	Pre-event removal efficiencies are maintained at the wastewater treatment plant (WWTP).
	A	Treatment plant is operational but at a reduced capacity and/or efficiency.
	X	Wastewater is discharged directly to the environment without any treatment.

For an individual sub catchment (or a complete system as a whole), the fraction with normal operation in the j^{th} service category over time t is denoted $n_{j,t}$. Similarly, alternative/reduced and no service classifications are $a_{j,t}$ and $x_{j,t}$, respectively. Each of these are normalised by the maximum attainable level of service such that they summate to one across all t. For a total of J service categories to a maximum time T, normal service levels can be represented through;

$$\mathbf{N}=\begin{bmatrix} n_{1,1} & n_{1,2} & \cdots & n_{1,T\text{-}1} & n_{1,T} \\ n_{2,1} & n_{2,2} & \cdots & n_{2,T\text{-}1} & n_{2,T} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ n_{J\text{-}1,1} & n_{J\text{-}1,2} & \cdots & n_{J\text{-}1,T\text{-}1} & n_{J\text{-}1,T} \\ n_{J,1} & n_{J,2} & \cdots & n_{J,T\text{-}1} & n_{J,T} \end{bmatrix} \quad (1)$$

and similarly for alternative service **A** and no service **X** with elements $a_{j,t}$ and $x_{j,t}$, respectively. This allows for the addition of any number of service categories (such as if additional wastewater re-use options are in place) and/or for the combining of multiple sub-catchments based on a weighting assumption (e.g. populations served, pipe lengths, or otherwise). To track the progress of system recovery from the user's point of view, a restoration performance metric is introduced to consider both the importance of the service category over time and the level of service provided. The approval of normal service $\hat{n}_{j,t}$ for the j^{th} service categories over time t can be represented through;

$$\mathbf{W_N}=\begin{bmatrix} \hat{n}_{1,1} & \hat{n}_{1,2} & \cdots & \hat{n}_{1,T\text{-}1} & \hat{n}_{1,T} \\ \hat{n}_{2,1} & \hat{n}_{2,2} & \cdots & \hat{n}_{2,T\text{-}1} & \hat{n}_{2,T} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \hat{n}_{J\text{-}1,1} & \hat{n}_{J\text{-}1,2} & \cdots & \hat{n}_{J\text{-}1,T\text{-}1} & \hat{n}_{J\text{-}1,T} \\ \hat{n}_{J,1} & \hat{n}_{J,2} & \cdots & \hat{n}_{J,T\text{-}1} & \hat{n}_{J,T} \end{bmatrix} \quad (2)$$

where $\hat{n}_{j,t}\in[0,1]$ with the limits representing complete unacceptance and acceptance, respectively. Following a single disruptive event, $\hat{n}_{j,t}\leq\hat{n}_{j,t-1}$ such that acceptance is constant or decreasing over time. While $\mathbf{W_N}$ is expected equal to unity under normal circumstances, similar matrices for alternative and no service provisions denoted $\mathbf{W_A}$ and $\mathbf{W_X}$ (with elements $\hat{a}_{j,t}$ and $\hat{x}_{j,t}$) are expected to differ and need to conform to $0\leq\hat{x}_{j,t}\leq\hat{a}_{j,t}\leq\hat{n}_{j,t}\leq1$ to ensure a preferential order of service levels.

From Equations 1 and 2, the combined system restoration performance **P** over time is;

$$\mathbf{P} = \mathbf{W_S} \cdot [\, \mathbf{N} \cdot \mathbf{W_N} + \mathbf{A} \cdot \mathbf{W_A} + \mathbf{X} \cdot \mathbf{W_X} \,] + \mathbf{E} \quad (3)$$

where elements of **P** are denoted $p_{j,t}$, **E** is a J by T combination error term, and the importance of j^{th} service category over time are represented in $\mathbf{W_S}$ with elements $s_{j,t}$ such that for a given t, $\sum_j s_{j,t}=1$. Such interpretations are evident in the literature where a wastewater service connection is a priority over wastewater treatment quality through the discharging of raw wastewater to the environment without normal treatment procedures (Strand & Masek, 2008; Tang & Johansson, 2010; Wang & Fu, 2011; Wareham & Bourke, 2012). Amongst other examples, Davis (2014) suggests the protection of human life and property is of most concern following a disaster, which could be inferred as the avoidance of spills and surface flooding is of greater concern initially when compared to other categories. Weightings can therefore be likened to the proportion of effort or resources that should be going into restoring and maintaining each of the service categories. For a given t, the overall system restoration performance P_t is $\sum_j p_{j,t}$ with $P_t \leq 1$ for all t. While P_t provides an expression of recovery performance, assumptions and variability in public opinion provide greater uncertainties when compared to technical functionality. As a result, distribution of this metric should be always be coupled with comment on the source and/or derivation of weightings.

APPLICATION TO THE CHRISTCHURCH EARTHQUAKE

The February 22, 2011, Christchurch Earthquake and Canterbury Earthquake Sequence is well reported and discussed throughout the literature. Similarly, discussions regarding wastewater system response and recovery are widely reported, such that the reader is directed towards the literature cited within this paper for further discussion.

System Functionality

Based on the nine recovery curved delineated by Zorn and Shamseldin (2016b), Figure 1 presents the recovery of the Christchurch City wastewater network across all service categories ($s_{j,t}=0.3\dot{3}$) for normal, alternative, and no service classes. While the cited study provides discussion regarding these curves, it should be noted herein that the sharp changes at 13 June are due to a significant aftershock and is hence taken as the temporal extent of analysis in this paper.

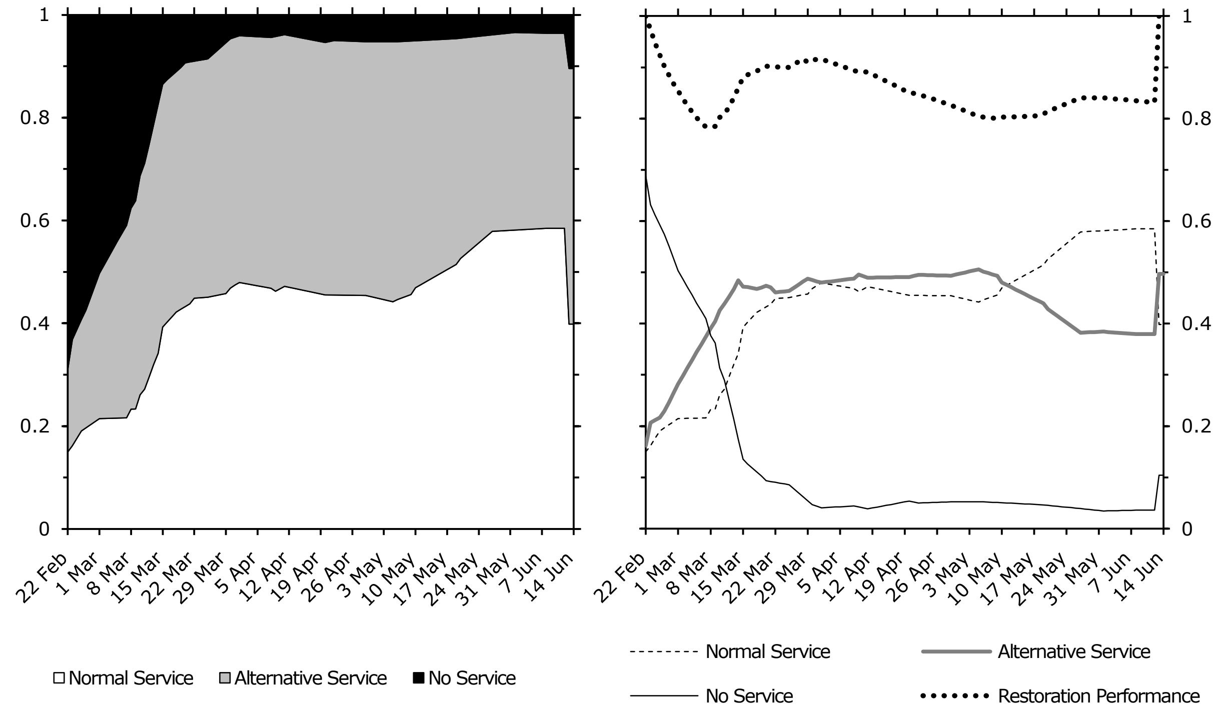

Figure 1. Overall wastewater system functionality following the February 22, 2011 Christchurch Earthquake as stacked areas (left) and as separate curves with recovery performance (right).

Defining Acceptability

To quantify the weighting matrices ($\mathbf{W_N}$, $\mathbf{W_A}$, and $\mathbf{W_X}$), recovery targets are used to assess restoration performance under the assumption that these are representative of the general public view. For each service category, normal service is assumed to be expected from all connections (i.e. $\hat{n}_{j,t}$=1). This ensures that recovery is relative to an earlier pre-Christchurch Earthquake user survey which noted 88% satisfaction in safety, convenience, and collection efficiency (CCC, 2010). The remaining $\mathbf{W_A}$ and $\mathbf{W_X}$ are populated based on pre-event target recovery times for Christchurch City wastewater recovery as discussed below and presented in Figure 2.

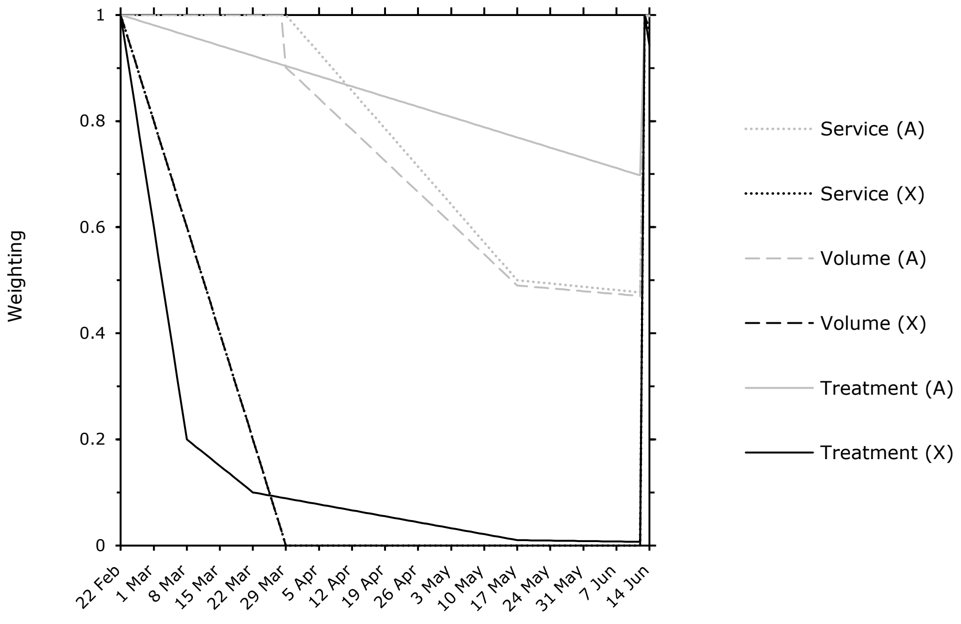

Figure 2. Assumed weightings for alternative/restricted service and no service provision across relevant categories.

The provision of service to standard connections (i.e. residential) are expected within two to eight weeks (Ladbrook, 2013). Figure 2 assumes the midpoint (five weeks) is where all available connections are expected to have some form of connectivity whether normal or alternate by this time. At 12 weeks (17 May), 50% connectivity is targeted (CELG, 1997) with this being extrapolated across the remaining time period due to the expectation of full recovery after two years (CELG, 1997; Ladbrook, 2013).

For wastewater volumes, the acceptance of no service provision is analogous to no wastewater volumes being collected (Service (X) = Volume (X) in Figure 2). However, as a restriction on wastewater volume production can occur with both normal and alternate connection types, the acceptance of alternate wastewater connections is assumed greater than or equal to restrictions on volumes. In addition, it can be assumed that reduced volumes are expected when alternate connections in place. Over time, as alternate services are no longer deemed acceptable, overflow target volumes can be subtracted from this value to provide the estimate of suitable volume conveyance. This is based on the premise that those with normal connections to the network will not necessarily accept their wastewater flowing to the environment (Rai, 2011). The target overflows modelled here equate to 80% of wastewater piped to the WWTP after two weeks, 90% after four weeks, 99% after three months, and full compliance between six and twelve months (Henderson, 2011).

The acceptability of no treatment is similarly relatable to the decreasing target overflow volumes with an expectation that overflows will occur at the time of the event with no acceptance after six months. For reduced treatment, a linear reduction is assumed between full acceptance of this service at the time of the event until twelve months where full compliance is targeted.

Recovery Performance

Figure 1 presents the resulting restoration performance curve modelled using the weightings of Figure 2. Due to the assumption that users will expect a reduced level of service immediately following a major disruption, the restoration performance curve does not exhibit a sudden reduction over the first 2-3 time steps (days) when compared to the fraction of the system showing no service. Although restoration performance continues with a negative slope over the first two weeks to a minimum (~78%), the rate of change slows due to the ongoing provisions of alternative measures and the regaining of normal service across the wider system. The decrease in restoration performance in the early recovery period can be attributed to the significant damage at the single centralised WWTP (Wareham & Bourke, 2012), however, additional issues have been raised regarding the apparent inconsistent distribution and delay in the provision of portable and chemical toilets as an alternative waste collection method (Potangaroa et al., 2011; Heather, 2011b; McLean et al., 2012).

With further increases in normal and alternate service across the system, restoration performance increases to a maximum (~92%) after approximately 5 weeks (1 April). Beyond this, the little change in system functionality leads to a steady decline in restoration performance due to the decreasing perceived acceptability of temporary alternatives still being in place. While progress in restoration performance begins with increases in normal system functionality, the 13 June aftershock event provides a re-initialization of weightings. While in reality the expectation in service levels following an aftershock so close to the event may not be equivalent to the initial expectations, determining the effects of ongoing earthquakes on lifeline service acceptance is beyond the scope of this paper.

FUTURE DEVELOPMENT AND APPLICATIONS

While the framework for determining technical functionality is effective for the immediate response to disruptions, further consideration is required in quantifying weightings. This is in terms of both sub-catchment recovery priorities (i.e. focus on minimising overflows) and the scalability of weightings across different disruptions. Although representative sub-catchment priorities are difficult to quantify, scalable weightings can be achieved if recovery targets are based on the time to restore to a certain percentage of initial damage, as recognised by Zorn and Shamseldin

(2015) who present dimensionless recovery curves for various infrastructures to restore the system back to 90% of the initial damage.

Although solely calibrated to the Christchurch Earthquake recovery, the impacts of different redundancy and recovery options in the immediate recovery phase of a disruption can also be simulated using this framework. The advantage in using this framework lies in the rapid overview of system response compared to a more technical wastewater recovery scheduling and optimization model.

CONCLUSIONS

This paper presents a framework for tracking wastewater system recovery following major disruptions. Wastewater functionality is shown that it can be effectively broken up into different categories of service each comprising three distinct levels of service – while all being conducive to data collection. This is in both in the immediate response to a disruption and in a posterior analysis of recovery. Pre-determined recovery targets are shown to provide an effective indication of how recovery is progressing. In application to the Christchurch Earthquake, this quantitative approach suggests a minimum recovery performance of ~78%. Given extent of system damage, recovery is considered largely effective – in line with the views of the independent report from McLean et al. (2012) into the emergency response. It is suggested that the overall calibrated model is further tested in the simulation of added network redundancies and recovery options.

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WHAT GETS MEASURED GETS DONE: RESILIENCE BENCHMARKING AND MONITORING

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ABSTRACT

Resilience across all sectors of society is imperative for global efforts to reduce the adverse effects of disasters and to build a society that is change-ready and seeking opportunities for future wellbeing. In 2015, the New Zealand government launched the Resilience to Nature's Challenges (RNC) research programme to address the country's significant disaster-related challenges. This paper examines aspects of the initiating work on RNC approaches to resilience measurement and connects it to the next phase of resilience research and action in New Zealand. The paper begins by introducing a general theory of change for resilience improvement, followed by an overview of analyses on the many approaches to resilience assessment. We argue that actively improving resilience begins with assessing the current position of the system's resilience and monitoring progress over time. To this end, we introduce a maturity model for evaluating the ability of existing resilience assessment tools to operationalise resilience. The final section concludes by moving from theory to meaningful action, discussing how New Zealand can become more resilient to disasters.

Keywords: Maturity model; Resilience measurement; Resilience to Nature's Challenges; Sendai Framework for Disaster Risk Reduction

INTRODUCTION

In 2015, as part of a new funding approach to investigate the country's biggest challenges, the New Zealand government launched the Resilience to Nature's Challenges Kia manawaroa Ngā Ākina o Te Ao Tūroa – National Science Challenge 10. The Resilience to Nature's Challenges (RNC) programme aims to combine, "hazard knowledge with innovation to enable New Zealanders to better anticipate, adapt and thrive in the face of nature's challenges," (Joyce, 2015).

Resilience refers to a system's ability to anticipate, resist, absorb, adapt, respond effectively to, and recover from a hazard in an efficient manner and in a way that allows for the restoration of basic services and improvement going forward (Paton & Johnston, 2006; UNISDR, 2009;

Stevenson et al., 2015). This understanding of resilience describes a system's ability to respond in various ways to the shocks and stresses to which it is exposed.

There are a number of underlying factors that make systems more or less resilient. Much of the research undertaken as part of the RNC will seek to identify and understand such resilience factors. Project outputs will ultimately aim to influence these factors in ways that improve resilience.

As illustrated in the general Theory of Change model (in Figure 1), we argue that improved resilience is located at the intersection of project outcomes and the broader societal impact (Brooks et al., 2014). The impact is assessed as the wellbeing of New Zealanders despite shocks, a motive for action and investment articulated by many, including The New Zealand Treasury.[2]

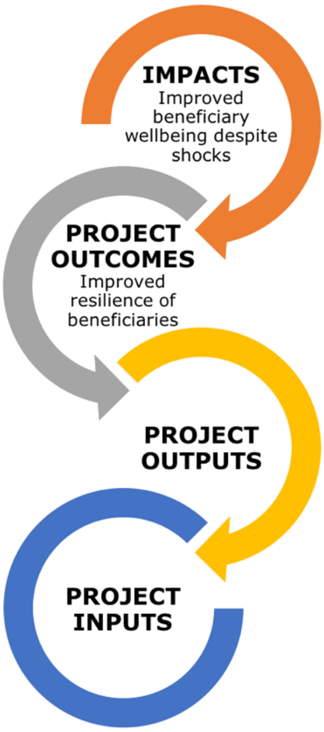

Figure 3: General Theory of Change for Resilience to Nature's Challenges

A Theory of Change is a way of thinking about how to promote social change, beginning by defining the desired impacts on society and working 'backward' to programme design and required inputs.

The decisive measure of a project's resilience outcomes will be the extent to which it can be associated with reductions in the negative effects of shocks and stresses (Brooks et al, 2014). In most cases, however, we will need to evaluate changes to resilience in the absence of shocks.

Resilience, however, is not directly observable. As a result, research on resilience measurement has focused on identifying and defining resilience indicators – quantifiable variables that represent a characteristic of a system or phenomena. In the case of the RNC, indicators will allow us to evaluate the efficacy of research programmes at the *outcome* (and impact in the event of a shock) rather than just the *output* level.

THE STATE OF RESILIENCE MEASUREMENT

Measurements of complex social phenomenon, such as disaster resilience can serve as tools for objective assessments and as value-laden decision

[2] The Treasury is developing the Higher Living Standards Framework (HLSF) to assess their policy choices. The HLSF uses "subjective measures of wellbeing…as a useful cross-check of what is important," (Karacaoglu, 2012).

making tools. They provide a way to consistently measure, interpret and compare resilience, but they also influence the type of disaster risk reduction activities that are pursued, where resources are focused, and how success is gauged. Therefore, resilience measurements both monitor the progress and efficacy of programmes like the RNC and serve as targets at which policy makers and practitioners can aim their efforts.

Building resilience begins with understanding where a system is, the desired future state for that system, and through repeated trials and evaluation, building pathways to get there. There will not be a single best tool. Those seeking to measure resilience will need a suite of data collection and analysis tools including indicators and indexes that use secondary data, primary data collections tools to fill information gaps, and models and scenario tools to map paths forward.

Resilience Benchmarking and Monitoring Tool Review
Measuring resilience is currently approached from many theoretical, epistemological, and methodological perspectives. In a thorough meta-review of disaster resilience metrics Winderl (2014) classified the different approaches based on the elements included (see Figure 4), the number of dimensions evaluated, the unit of analysis, and the levels at which resilience was measured (i.e., input, output, outcome, impact).

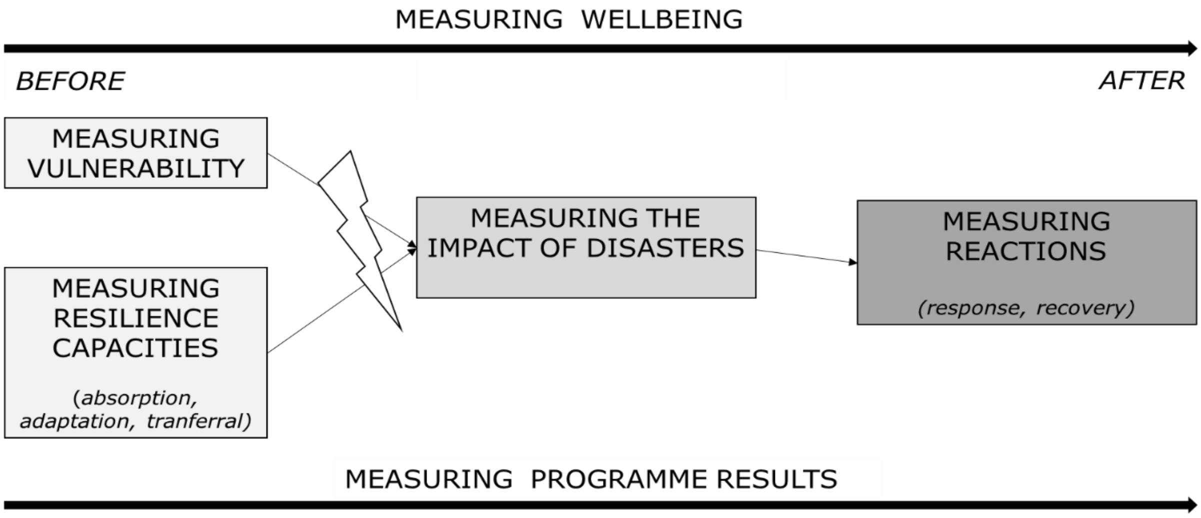

Figure 4: Elements of measuring disaster resilience (adapted from Winderl, 2014)

For example, in the classification system in Figure 2, tools that measure "resilience capacities" capture a system's *potential* ability to absorb impact, adapt, and transform, but because it is not yet manifested through behaviour change, it is considered an output rather than an outcome. Tools that measure reactions, on the other hand, evaluate outcomes.

Additionally, in a systematic evaluation of 27 disaster resilience assessment tools, Cutter (2016, p.742) found that the most common elements in all of the approaches could be divided into "attributes and assets (economic, social, environmental, infrastructure) and capacities (social capital, community functions, connectivity, and planning)." As a result of this analysis, Cutter (2016) proposes a measurement core for community disaster resilience (Table 2). This measurement core provides a useful point to begin assessing baselines for resilience, benchmarking systems against relevant references, and monitoring the progress of assets and capacities in these systems.

Table 2: Measurement core for community disaster resilience (Cutter, 2016)

Attributes/ Capacities	Most often used proxy variable
Economic	Income (median household)
Social	Educational attainment/ equality, health care access (number of doctors)
Social capital	Civic organisations (number), religious organisations/ adherents (number)
Institutional	Mitigation plans (% population covered), mitigation activities (number), or mitigation spending (per capita)
Community assets and functions	Community services (number)
Infrastructure	Buildings of various types (emergency management, government, power, bridges, commercial)
Connectivity	Feeling of belonging to the community, proximity to urban areas
Emergency management	Shelters, evacuation routes
Environmental	Impervious surfaces

Categories & scales of assessment

Researchers and practitioners use a wide range of tools to assess hazards resilience. Here we provide a summary of three tools: indexes, scorecards (including surveys and compliance monitoring tools), and computational modelling (Box 1). The tools adopted depend on the assessors' desired outcomes, requirements, capabilities, as well the characteristics of the system.

Indices and composite indicators tend to use secondary data provided through government bodies (e.g., census data). They facilitate standardized comparisons across time and are useful for tracking dynamic trends for various indicators. Indices often require large inputs of data, often aggregated from a number of sources with varying degrees of quality and completeness. This can lead to compounding uncertainties that undermine the validity of the results (Barnett et al., 2008).

Box 1: Resilience Assessment Tool Categories
Indices: Indicators are combined to construct an index or composite indicator in order to capture the multidimensional nature of a system, while distilling it into a single metric. *Examples*: Baseline Resilience Indicators Model for Communities (BRIC) (Cutter et al., 2010), Community Disaster Resilience Index (CDRI) (Peacock et al. 2010) **Scorecards:** Consist of a number of questions or assessment criteria, often with a set of scaled answers from which to select. The result can be a single 'score' or a collection of scores within a number of target areas. *Examples:* Risk and Resilience Scorecard (Ahorn, Burton, & Khazi 2014) **Computational Models:** Rendering of a system designed to help an observer to understand how it works and to predict its behaviour. Relationships are captured using a set of formulas or matrices. *Examples:* Community Resilience Modelling Environment (NIST 2015), Measuring the Economics of Resilient Infrastructure Tool (MERIT) (GNS 2014)

Scorecards can be deployed at any time (i.e., researchers do not have to wait for official sources to gather new data). They also offer flexible applications at different scales, that may be more difficult for a secondary data. The down side, is that primary data collection is time consuming and costly; self-assessed questionnaires are often subject to misinterpretation, and the number of items evaluated is often limited to ease the burden on the respondent.

Computational models can offer the potential for forecasting using the integration of hazard scenarios and testing the efficacy of interventions. These tools can be expensive to develop, however, and end-users require training in the software systems. Additionally, higher powered models can be very data intensive, and robust empirical data on resilience factors is often limited (Stevenson et al., 2015).

Resilience assessments can be standardised to facilitate comparisons between communities or other systems. They can be context-specific – tailored to a particular system; or they can be a blend of both with a core set of standard indicators supplemented by locally tailored measurements (Winderl, 2014).

Resilience assessment maturity model
Resilience assessment is a field 'under development'. There are new conceptual, empirical, and mechanistic assessment frameworks emerging regularly across a number of scales and systems. Those developing resilience assessment tools may choose to build on existing frameworks or to 'translate' tools developed in other contexts to their specific system of interest. Winderl (2014, p.19) identified six phases of maturity for disaster resilience measurements: 1) theoretic framework, 2) identification of potential indicators, 3) development of a clear indicator framework, 4) some data collected for indicators or data for a limited geographic area, 5) data collection institutionalised and collected regularly, and 6) measurement empirically verified.

In order to assist with the process of tool evaluation, we have developed a prototype Resilience Assessment (RA) Maturity Model (Figure 3) to evaluate existing frameworks and provide pathways for further development in the Resilience to Nature's Challenges Context. While Winderl's (2014) phases of maturity focus on data and empirical development, the RA Maturity Model includes assessment criteria for the operationalisation of resilience assessments.

A maturity model is a staged structure, indicating levels to which specific processes, goals, or quality measures are assigned (Stevenson et al., 2015). The evaluation criteria within the RA Maturity Model were derived from interviews with RNC stakeholders in 2015 and a systematic survey of the resilience literature. The evaluation criteria include:

The theoretical foundation of the measure (i.e. resilience is clearly defined and distinct from other concepts)
Whether the conceptual work on resilience has actually led to the development of an assessment tool
Whether that tool has been tested with empirical data and refined
Whether the assessments are operationalized to influence policy inform decision-making, or prompt and guide resilience building interventions
Whether the model has been validated.
The maturity model (presented in Figure 3) enables users to evaluate the degree of fit that frameworks and resilience assessment tools have with a number of proposed optimal criteria. The assessment of a tool's maturity using the preliminary model is not intended to be a critique. Rather, assessing a tool's maturity level (ML) provides some degree of guidance about the practicality of using these tools to realise the users' goals for

resilience benchmarking, monitoring, and guiding policy and interventions.

This maturity model can help researchers make systematic comparisons between tools that are currently in use in New Zealand and elsewhere. For example, the Rockefeller City Resilience Framework (CRF) is currently informing policy and resilience interventions in New Zealand through the 100 Resilient Cities programme. The CRF will eventually serve as the basis of a City Resilience Index (CRI) with specified sub-indicators and metrics, but the CRF is not currently mature enough to be considered a high-quality resilience assessment tool.

Conversely, the Adaptive Capacity/ Resilience Model developed by Duglas Paton and colleagues draws on over a decade of empirical research on social-cognitive disaster preparedness, vulnerability, and resilience. Researchers have also started validating the model, in part using data collected during the response and recovery to the 2011 Canterbury earthquakes. The validation confirms that the model’s factors actually enhance post-disaster outcomes for individuals or communities (Paton et al., 2015). As a result of these different levels of development maturity, the CRF is assigned an ML of 2.5 and the Adaptive Capcity/ Resilience Model is assigned an ML of 4.5 (Table 3). The scores generated using the maturity model reflect the relative suitability of these tools as systematic and comparable resilience benchmarking and monitoring tools.

Table 3: Maturity Level (ML) evaluation results for two models of resilience

	Definition Develop-ment	Tool Refine-ment	Policy & Operational-isation	Validity	Maturity level (Avg.)
City Resilience Framework	ML 5	ML 2	ML 2	ML 1	ML 2.5
Adaptive Capacity/ Resilience Model	ML 5	ML 5	ML3	ML5	ML4.5

There is no single best tool for resilience assessment, and not all models or frameworks of resilience are intended to facilitate systematic benchmarking and monitoring. New Zealand will need a suite of robust assessment tools to benchmark resilience, monitor progress, and evaluate interventions.

CONCLUSION: OPERATIONALISING RESILIENCE MEASUREMENT

Going forward a number of steps are important to operationalise resilience measurement, to move from theory to meaningful action that enhances the disaster resilience of communities. Making this move requires systematic and coordinated efforts among researchers, practicioners, policy makers, and ultimately (and most importantly) with affected communities. Such efforts will require a process through which elements of a common vision of resilience can be formed, assessed, monitored, and refined over time. Some proposed steps include:

Clearly define resilience for the system of interest

Establish a vision for the desired *impact* of resilience on the system of interest (i.e., develop an operational definition and set of criteria for the desired impact)

These two steps may be facilitated by official policy tools including the National Disaster Resilience Strategy being developed by the Ministry of Civil Defence and the Treasury's Higher Living Standards Framework. They will also be informed by the Sendai Framework for Disaster Risk Reduction (2015-2030) – the United Nation's international agreement intended to provide guidance and enhanced international cooperation to prevent the creation of risk, reduce existing risk, and strengthen resilience to natural disasters – which New Zealand will begin to report against in the coming years.

Identify important system drivers (people, resources, processes) and how they contribute to resilience.

Identify observable components and behaviours to benchmark resilience and monitor the efficacy of interventions.

For these two steps, researchers and practitioners will build on work already conducted nationally and internationally.

	Maturity Level 1 *Theoretical or Ad Hoc*	Maturity Level 2 *Repeatable*	Maturity Level 3 *Systematic*	Maturity Level 4 *Validated*	Maturity Level 5 *Optimized & Adaptive*
About	Untested conceptual frameworks and ad hoc interventions.	Resilience assessment tools developed or some evidence of repeatable interventions	Tools, policies, and/or interventions that have been tested or systematically integrated into practice.	Well-developed assessment tools, policies, and operationalized interventions.	Well-developed assessment tools, policies, and operationalized interventions are adaptable to optimize assessments and interventions.
Definitions	Unclear or ambiguous definition of resilience and desired resilience outcomes.	Resilience and desired resilience outcomes defined.	Resilience and desired resilience outcomes defined. May include specific operational definition of resilience.	Resilience and desired resilience outcomes defined. May include specific operational definition of resilience.	Resilience and desired resilience outcomes defined. May include specific operational definition of resilience.
Resilience Assessment Frameworks/ Measurement Tools	-	Developed, possibly demonstrated using empirical data or case studies.	Developed, tested & refined using empirical data.	Developed, tested & refined using empirical data	Developed, tested & refined using empirical data
Policy & Operationalization	Not systematically operationalized through policy.	Interventions occurring on a repeatable basis. Policy or standard may be in place, but no clear pathway for implementation.	Linked to polices or standards with clear pathways for implementation.	Established policy with clear pathways for implementation and enforcement or quality assessment	Established policy with clear pathways for implementation and enforcement or quality assessment
Validation	-	-	-	Evaluation to ensure that interventions are leading to desired resilience outcomes.	Evaluation to ensure that interventions are leading to desired resilience outcomes.

MATURITY

LONG-TERM EFFICACY

Figure 5: Prototype Resilience Assessment Maturity Model

For example, the United Nations Office for Disaster Risk Reduction (UNISDR), established an Open-ended Intergovernmental Expert Working Group on Indicators and Terminology tasked with developing terminological definitions related to Disaster Risk Reduction and identifying indicators that can monitor progress toward achievement of the Sendai Framework's global targets.

Consider the context-specific features of the environment in which you will be operating.

Consider the approaches to assessment that might be most appropriate in that context

Again, researchers and practitioners will work collaboratively with communities across New Zealand to ensure that the approaches developed are context appropriate. Going forward, the next big challenge for resilience assessment will be to integrate possible future trends and incorporate models of potential changes (gradual or acute) into resilience assessments to better guide decision making to optimal short- and long-term resilience outcomes.

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SOCIAL, ECONOMIC AND POLITICAL FACTORS THAT INFLUENCE AND DEFINE PROJECT SUCCESS IN THE AUSTRALIAN STATE LEVEL EMERGENCY MANAGEMENT SECTOR.

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ABSTRACT

Australian Governments (local, state and federal) have spent large sums on projects initiated after major emergency and natural disasters. The public expects this. But 'too often, too much money is spent on the wrong projects in the wrong place' (Terrill et al., 2016 p2).

Even in the wake of a major emergency, politics often 'comes ahead of the public interest' (ibid.,). Large sums of public money get spent on projects that do not contribute to the sector mandate to protect life and property but are easy to sell to the public. The political pressures of election campaigns and industrial relations negotiations often drive decisions on project selection and the funnelling of taxpayer money into marginal electorates. Decisions made on 'weak or undisclosed business cases' result in projects that 'provide no more benefits . . . but cost twice as much' (ibid.,) as existing services.

This study explores projects in the state level emergency management sector (EMS) in Victoria, Australia with a particular interest in projects initiated after major emergencies or natural disasters. The research investigates why the success of projects in the EMS is determined by the delivery of outcomes of the project management process (products delivered on time and in budget) rather than on outcomes delivered to meet strategic objectives. Objectives that support the sector mandate to 'protect life and property' and the stated social, economic and political standards of public service delivery. The aim of the research is to understand if social, economic and political factors influence and define the success of projects in the EMS.

The study examines the 'lived experience' (van der Hoorn, 2015) of emergency management practitioners in the EMS in Victoria, Australia. Underpinned by an interpretivist philosophy, the research utilises

qualitative methods to build on the author's own experience and, due to the 'complex, multiple and unpredictable nature of what is perceived as reality' (Hudson and Ozanne, 1988), the unique experiences of a range of qualified individuals from across the sector.

Findings are based on analysis of literature (both academic and government reports and papers available in the public domain), observation of 4 EMS project management Community of Practice (CoP) meetings and 25 semi-structured interviews conducted between 2014 and 2015. Analysis to date indicates that a large number of projects initiated after a major emergency or natural disaster are politically motivated rather than strategically driven. These projects move straight to project implementation without progressing through the concept or front-end planning phase. The projects tend to have poorly defined scope, outcomes that don't align with the stated sector mandate or strategies, and are defined by 'traditional' concepts of project success – the delivery of a product on time and in budget – *doing things right*, rather than the delivery of an outcome that contributes to the protection of life and property – *doing the right thing* (Rochet, 2008).

This research aims to identify if social, economic and political factors influence and define project success in the state-based emergency management sector. This will support the future development of treatments that ensure project outcomes are aligned to the sector mandate to protect life and property.

Key Words: Emergency Management; front-end project management; project success; rethinking project management; social, economic and political factors;

INTRODUCTION

Despite the depth of discussion on projects and the discipline of project management, the range of research undertaken on projects delivered in the EMS is limited. Of the 291 academic articles, reports and documents reviewed in this research to date, only 12 discuss projects delivered in the EMS (Hougham, 1996; Fitzgerald & Russo, 2005; Moe & Pathranarakul, 2006; Simpson, 2006; Steinfort & Walker, 2007, 2008, 2011; Curlee & Stirling, 2008; Steinfort, 2010; Crawford et al, 2013; Kim & Choi, 2013; McLennan & Handmer, 2014). This includes four pieces by the same author on Aid Relief Projects (Steinfort & Walker, 2007, 2008, 2011; Steinfort, 2010). It has been equally difficult to identify research on factors that influence and define the success, or otherwise, of projects in the EMS, and particularly projects initiated after a major emergency or natural disaster.

The aim of this research is to understand if social, economic and political factors influence and define project success in the EMS. This will inform the future development of treatments that ensure project outcomes are aligned to the sector's mandate to protect life and property.

Understanding these factors is important as they inform how these forces 'enable, constrain and define project outcomes in ways that cannot be apprehended within existing research' (Sage et al, 2014, p545). Examining the 'social contextualisation of project management' (ibid., with reference to Cicmil et al, 2009) will aid understanding of 'how and why those outcomes are being defined and legitimated' (Sage et al, 2014, p545);

Social - the role of the EMS is to deliver services considered essential for the protection of life and property and the universal provision of these services should be guaranteed. In 1999, the United Nations Secretary-General, Kofi Annan stated 'Above all let us not forget that disaster prevention is a moral imperative, no less than reducing the risks of war' (Emery, 2005). Kapucu & Van Wart (2006) identified that 'people increasingly expect the public sector to do a better and better job in the management and reduction of risk of all types, with emergency management being key among them. The larger the emergency or potential for crisis, the more the expectation has grown for public sector involvement' (p282). In July 2016, Victoria's Emergency Management Commissioner (EMC) announced the Victorian Preparedness Goal. This work responds to the community demand for EMS reform after the 2009 Victorian Black Saturday fires. Developed in collaboration with the Federal Emergency Management Agency (FEMA) in the United States, the goal is about 'building safer more resilient communities' and meets the 'obligation to contribute to improving the preparedness, capability and resilience of all communities to prepare for, respond to and recover from emergencies' (EMV, 2016 p3). This indicates that the outcomes of projects should always contribute to the 'all communities, all emergencies approach [that] underpins Victoria's emergency management system' (ibid.,).

Economic - most projects initiated after a major emergency or natural disaster are funded by public money. There is an expectation that public value will be gained when public money is expended. As the government 'uses the power of the state to divert the resources and options of private individuals to achieve public value' (Moore, 1995 p29), the public expects that public money will be spent wisely and efficiently for the benefit of the public as a whole. The obligation is to deliver services that provide economic use of financial and material resources. 'Once a public authority is engaged, issues of fairness are always present. And public authority is *always* engaged when tax dollars are being spent' (ibid., p48, italics in original). As noted by Steve Sedgwick (2010) during his term as Australian Public Service Commissioner, the Australian community has a perfectly proper expectation that the Australian Public Service (APS) will act ethically in the administration of programs funded by the public purse (p9). As global trends show that Victoria is going to experience an increase in the frequency and intensity of emergency incidents (EMV, 2016, p4), the EMC has committed to public accountability and transparency to 'drive improved public value' and to 'maximise utilisation of capability and capacity' (Ibid., p6). In an environment of increasing demand, ensuring projects deliver outcomes of public value is vital.

Political - in Australia, politics plays a key role in the delivery of emergency management projects at local, state and federal government levels. This is particularly evident in projects initiated after a major emergency or natural disaster. As evidenced by the political activity following Victoria's devastating fire season of 2009, major incidents often become the fodder of election campaigns. These campaigns generate political promises and stimulate funding that result in project mania. Flyvbjerg (2012) noted that these pressures lead to flawed planning and decision making where promised projects are 'strategically misrepresented' (p328) in terms of overestimated benefits and underestimated costs to increase the likelihood of public approval. In an environment where future governments are not legally bound by the financial promises of the past projects can be abandoned as funds are redirected. Political election cycles create environments where emergency management organisations cannot count on ongoing commitment to project outcomes or leave unsustainable and obsolete legacies that make no contribution to the protection of life and property (Wirick, 2009, p6).

Analysis of research data to date indicates that projects initiated after a major emergency or natural disaster are highly influenced by these social, economic and political factors. Interviewees describe these projects as 'knee jerk' and focused on short-term outputs rather than long term outcomes that contribute to the sector mandate to protect life and property. According to the interviewees, projects often fail to deliver value in terms of the public purse and more often than not are the fodder of political point scoring and 'pork-barrelling' (Terrill et al., 2016). The challenge is to manage these factors to ensure project outcomes deliver on the mandate to protect life and property.

RESEARCH CATALYSTS AND RESPONSES

The researcher's interest in investigating these factors germinated from experience in the VEMS. Over the past 16 years, the author has sought to understand why project success was determined by the delivery of 'government initiatives' (on time and on budget) rather than on the delivery of the sector identified strategic outcomes that contributed to the protection of life and property.

This interested was enhanced by a number of highly critical reports on projects in both the federal Australian and Victorian Public Sectors. The reports included admissions that governments, departments and agencies were not able to demonstrate that they deliver on stated outputs, or operate and manage projects effectively, efficiently or economically (Terrill et al., 2016; Victorian Ombudsman, 2011; VAGO, 2012). The reports identified that despite the extensive guidance, expertise and literature available, the mistakes in planning, governance and project management that have been observed and reported for some years are consistently repeated. They also reported a lack of accountability of those responsible for ensuring project outcomes linked to organisational strategy. The interesting thing about these reports was the focus on a product being delivered on time and in budget rather that on whether the project delivered the planned benefit or outcome.

Whilst these reports did not directly address the emergency management sector, these findings reflect the 2009 Victorian Bushfires Royal Commission's *Delivery Report* (2010) and the Bushfires Royal Commission Implementation Monitor's *Progress* and *Final Reports* (July 2011 & July 2012). These reports describe failures to deliver within project timeframes, lack of adequate resource allocation, the imposts and limitations of legal barriers, policy and procedures, and a need for coordinated strategic direction and leadership within the entire emergency management sector. Again, the interest to the researcher was that these reported failures reflect a perspective that relies on the 'enduring traditional approach' (Brady & Hobday, 2012), where the 'function of projects and their management is the accomplishment of some finite piece of work in a specified period of time, within a certain budget and to an agreed specification' (Hodgson & Cicmil, 2006, p2).

The experience of the author and the interviewees in the EMS, includes (but is not limited to) projects generated as a result of the 1998 Linton Fires, the 2004/05 Victorian Alpine Campaign fires, Victoria's 2009 'Black

Saturday' bushfires and the 2010 Victorian floods. Examples of the projects managed include those generated by the more than $900 million of state and federal taxpayer funding committed in direct response to Victoria's 2009 Black Saturday fires and the 67 recommendations of the 2009 Victorian Bushfires Royal Commission (VBRC). This, by any standard, is a significant commitment of public monies to the promise of improved future protection of life and property.

THEORETICAL FRAMEWORK

The research seeks to move discussion from one focused on the delivery of successful project management outcomes, the '*doing things right'*, to a discussion that considers the delivery of a successful strategic outcome, the '*doing the right thing'* (Rochet, 2008). It pursues Hodgson & Cicmil's (2006) idea that the success of projects requires something other than a heavy reliance on the mainstream functionalist, instrumental view where the function of projects and their management is the 'accomplishment of some finite piece of work in a specified period of time, within a certain budget and to an agreed specification' (p2).

Project management has, according to Bredillet (2004), 'evolved from a conceptual approach based on a positivist paradigm' (p1), an approach that forms a 'barrier to effective understanding and communication of the true nature of project management' (ibid., p 1-2). According to Cicmil and Hodgson (2006) 'mainstream research into projects and project management continues to rely heavily on the prescriptive and the instrumental (p6) and, as Söderlund (2011) argues, an analysis that is orientated around 'descriptive statistics on the criteria and factors of project success and failure' (p158). This supports Brady & Hobday's (2012) argument that perhaps 'the very high project failure rates observed are partly a consequence of the enduring traditional approach' (p289).

Using a qualitative research approach, this research seeks to explore how the perspective of the 'lived experience' can bring 'new insights to fundamental project concepts' (van der Hoorn, 2015, p1). This approach supports the development of a theory to assist the understanding of the phenomenon and further contribute to the research discussion in this field. The exploration requires a systematic methodological approach that captures the 'unique experiences' of participating individuals and ensures a 'more personal, concrete description of the perceived experience' (van der Hoorn, 2015, p4). For this reason, an interpretivist philosophy has been adopted. Underpinned by a qualitative research approach grounded theory research methods are utilised to avoid 'the research participants providing generic, instructed, or indoctrinated responses that are based on a theory of what projects *should be* like or taught definitions (ibid.,). The research approach is useful because little is known about the phenomena or 'contextual conditions' (Yin, 2011, p8) of the social, economic and political factors that impact on emergency management projects.

The grounded theory research methods used include participant observation, semi-structured interviews, and the analysis of secondary data (sector artifacts and documents published in the public domain). As a participant observer, the researcher's immersion and long-term engagement in the VEMS has assisted in the identification and collection of primary research data. The preliminary analysis of the data collected provides an account of key elements of a state level emergency management environment. This supports the investigation of how social, economic and political factors 'enable, constrain and define' (Sage et al, 2014, p545) project outcomes delivered in the sector.

RESEARCH GAPS

The research to date has identified that, despite the level and depth of discussion on projects and project management, and the continued professionalism of the discipline of project management;

the literature and reports fail to account for what Moe and Pathranarakul (2006), Gauld (2007), Wirick (2009), Flyvbjerg (2012) and Terrill et al., (2016) describe as the dynamics of the social, economic and political elements that surround public sector and emergency management projects.

the range of research undertaken to understand if social, economic and political factors influence and define the success project outcomes within the Australian federal and state public sector is limited.

the research undertaken on the nature and extent of the challenges to the delivery of projects within state level emergency management sector specifically is also limited. This limited discussion focuses on the delivery of successful project management outcomes, the '*doing things right*', rather than the delivery of successful strategic outcomes, the '*doing the right thing*' (Rochet, 2008). The discussion has yet to address the 'more substantive question of how and why those outcomes are being defined and legitimated' (Sage et al, 2014, p545)

the literature available on the management of emergency management projects is limited and lacks understanding of the 'peculiarities' of the emergency management sector and the social, economic and political context in which it operates. The emergency management sector is a highly complex environment, 'more complex than most traditional project managers are very likely to face' (Steinfort & Walker, 2011, p8). As a result, there are few sources from which project managers and emergency management organisations can obtain guidance on developing well-founded project delivery strategies and actions to address the challenges they face.

This research aims to address these gaps by identifying if social, economic and political factors influence and define project success in the state-based emergency management sector. This will support the future development of treatments that ensure project outcomes are aligned to sector mandate to protect life and property.

FINDINGS

As planned, the researcher conducted a total of 25 semi-structured interviews and observed 4 VEMS project management Community of Practice (CoP) meetings between 2014 and 2015. These project-based activities were part of a sustained relationship with EMS project practitioners that included interviews, informal conversations, site visits and meetings with senior sector personnel including Inspector-Generals, Chief Officers, Regional Commanders, Directors, Divisional Operations Managers, Senior Program and Project Managers and Project Coordinators. A 'purposive sampling' (Rudestam & Newton, 2007, p106) approach was utilised to increase the scope and range of data and to 'uncover the full array of multiple perspectives' (Lincoln & Guba, 1985, p40). Participants were identified through sector networks as 'experiential experts on the phenomenon being studied' (Rudestam & Newton, 2007, p107).

The findings to date indicate that despite the growing adoption of project management as a standard business practice, there is a limited amount of empirical research that 'takes seriously the practitioners lived experience of projects' (Cicmil & Hodgson, 2006, p675; see also Morris et al 2012a; Söderlund, 2012; van der Hoorn, 2015). This is particularly relevant to projects in the VEMS and supports the dynamics identified by Steinfort and Walker (2011), and Crawford et al (2012 & 2013) relating to the challenges of delivering projects within the emergency management and disaster recovery context.

In an environment where issues of urgency and the objective to 'improve' and cope with similar catastrophes in the future add a complexity that 'most traditional project managers are ever likely to face' (Steinfort and Walker, 2011, p8), the use of standard project management tools and techniques have been criticised by researchers and interviewees as 'foolish or even harmful' (ibid., see also Crawford et al., 2012 & 2013) in terms of their wider applicability to chaotic disaster related environments.

The research so far supports findings into why failures of public sector projects continue to be so common despite the research, reports and investigations conducted both domestically and internationally (Young, 2006; Flyvbjerg & Budzier, 2011; VO, 2011; VAGO, 2012 & 2014, Terrill et al., 2016). Preliminary research findings indicate that the majority of projects initiated after a major emergency or natural disaster move immediately to project implementation without progressing though the concept or business case phase. Projects have poorly defined scope, are 'output' rather than 'outcome' focused, are defined by 'traditional' concepts of project success and the implementation of the 'government initiatives' rather than the delivery of a net benefit contribution to the public good.

Interestingly, preliminary analysis of interview data correlates with the findings of a recent report released by the Grattan Institute on transport infrastructure projects in Australia (Terrill et al., 2016). This relates as transport infrastructure is a core capability identified in Victoria's Preparedness Goal (2016; www.emv.vic.gov.au/capacity). Whilst all EMS participants were interviewed well before the Grattan Report release, the initial research data indicates that;

whilst governments fund many worthwhile projects, overall investment is poorly directed
decisions on particular projects are made of the basis of weak or undisclosed business cases
too much money is spent on the wrong projects in the wrong places
too often politics comes ahead of the public interest
an 'ad hoc' approach misses key opportunities and results in a high level of waste
many projects provide no more benefits to service delivery capability but cost more than twice as much

there is little that can be done to stop politicians committing to projects before they are properly evaluated – particularly during election campaigns

the public don't understand the sector and therefore don't understand if the funds are being spent wisely

(Terrill et al., 2016, 'Roads to riches: better transport investment', p2)

Although the detailed, data analysis is yet to be completed, the consistency of these preliminary findings across the participant interviews suggests that social, economic and political factors do influence and define the success of projects within the EMS.

LIMITATIONS AND CONSTRAINTS

The focus of this study is limited to the EMS in the State of Victoria, Australia and the social, economic and political factors that impact at the state level. As such, it may not be deemed 'universally-applicable' (van der Hoorn, 2015). However, as the VEMS is a robust example of a state level EMS it is likely that the factors identified may be applicable to other state level EMS within Australia and the commonwealth. A larger sample of the sector in other states and federally in future research would increase the validity of the findings.

Other limitations include the potential bias of the author who has been employed in the VEMS for over 16 years. As the sole facilitator and analyst of all interviews, bias may influence interpretation of the data presented. Equally, the validity of the understanding of the 'lived experience' as grounded in the conception of the memory – experience gap may be a limitation to the findings. Kahneman (2007) and Kahneman and Riis (2005) argue that the 'experienced' and the 'remembered' are two different measures that will have different results. This is noted to highlight that whilst the findings of this research 'cannot be assumed to reflect the 'living' experience (i.e. the experience in the moment) . . . they can be categorised as the 'lived' experience (i.e. a recollection of the past, a memory)' (van der Hoorn, 2015 p12).

CONCLUSION

This research provides an overview of the preliminary findings of the research to identify if social, economic and political factors influence and define the success of projects in the EMS. This research has identified that discussion of projects, particularly those initiated after a major emergency or natural disaster, is limited in the literature. The research to date indicates that the social, economic and political factors influence and define project outcomes in ways that 'cannot be apprehended within existing research' (Sage et al, 2014 p545). It identifies that current definitions of project success are not sufficient to ensure outcomes that support the sector mandate to protect life and property. The aim of this research is to enhance the theoretical understanding of the management of projects in the state based EMS. This research will contribute to the future development of treatments that ensure project outcomes are aligned to the sector mandate to protect life and property.

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PSYCHOMETRIC EVALUATION OF DISASTER IMPACT

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ABSTRACT

Disaster response is primarily concerned with allocating limited resources efficiently and quickly to those most in need of them. Accurately identifying which people to target with relief, as well as what types of aid to provide, is crucial to an effective disaster response. This is unfortunately often difficult to accomplish when assessments examine tangible factors in isolation to determine needs. Psychometric evaluation of individual quality of life allows for rapid, sector-agnostic assessment of disaster impact and community resilience. This information can be used in both research and operational contexts to identify at-risk subgroups for targeted interventions, monitor the effectiveness of specific aid interventions over time, determine the appropriate phase of disaster response or recovery relative for recipients, and identify the current needs of disaster victims. This paper develops the theory underlying the psychometric assessment approach, and examines the methodology and results of applying this approach to post-disaster communities in villages in Afghanistan after severe flooding and Vanuatu after a Category 5 tropical cyclone. The studies demonstrate that quality of life indicators are robust, operationally viable, culturally agnostic, and imminently useful for targeting aid, determining needs, and measuring the effectiveness of programs.

Keywords: assessment, disaster, Afghanistan, Vanuatu, resilience

INTRODUCTION

The disaster response/relief sector faces several key challenges due to the nature of the post-disaster operating context: limited resources, limited information visibility, and limited time. Because of these limitations and the primary mandate of disaster relief—reducing human suffering and saving lives—sub-optimal action on the part of humanitarian actors is damaging, whether in the form of poorly targeted or poorly implemented interventions, or redundant interventions from several different actors. Poor programming in a humanitarian context consumes limited resources out of the total available to the entire response pool (funding, logistical capacity, etc.), wastes time, and ultimately leads to more loss of life or suffering than if proper action had been taken. Unfortunately, the very same limitations that make missteps so damaging also make error more likely, as humanitarian actors struggle to meet victims' needs with restricted resources while making decisions with partial information under time pressure.

Given the trend of increasing disaster frequency, size, and complexity, effective humanitarian action is of dire importance (Dilley 2005). The core question for effective relief is who to allocate limited resources to (target population), how (programming), and how to do so quickly (timely response). The traditional solution is to use technical assessment techniques to identify needs by measuring tangible, easily counted deficiencies, such the loss of a home. At-risk or marginalised groups are identified by these tangible factors and/or commonly accepted demographic factors, such as household size or gender (Jones et al. 2013; OCHA 2013).

Unfortunately, physical measures are inherently flawed when used as a complete measure of need for determining resource allocation in disaster relief. Technical factors alone do not capture the net human impact of disasters, which is determined by the complex interaction of multiple physical and psychological dimensions, as well as victims' tangible and intangible resources (Couch & Kroll-Smith 1985; Gist et al. 1998). Measuring all of these factors in the field would be impractical, even before trying to combine them.

However, human factors assessments—measuring the present quality of life of disaster-stricken populations—offer a promising solution to these issues. Examining overall disaster effects through proxy measurements, such as clinically proven quality of life tools. Using semi-quantitative psychological measures (psychometrics) as the primary assessment method yields many benefits, including (a) measuring the real outcome of the interaction of all factors that could amplify or ameliorate the cumulative effect of a disaster, (b) identifying individuals and communities capable of self-driven recovery, (c) clearly showing differentiated impacts, (d) measuring need in a sector-agnostic manner, and (e) providing a comprehensive metric for measuring the effectiveness of relief programs over time. Quality of life surveys also do not create the expectation of specific aid.

By combining psychometrics with demographic factors, high-need groups can be quickly identified and helped, without the opacity of using technical assessments or assumptions of relying on predetermined demographic risk factors. A psychometric approach generates unified indicators that account for the nexus of factors that determine disaster impact and resilience, including factors that are not readily apparent or measurable. Psychometrics account for the disaster's affect after considering factors such as culture, personal savings and income security, and community-mediated resources accessible through family and social networks.

Psychometric assessments can also easily extend to include simple ways for individuals to self-indicate needs. This gives aid recipients a voice in the process, and when paired with the psychometric indicators, quickly shows which people are most affected and what types of programming to investigate to meet their most pressing needs. Assessing populations using psychometric tools is also a useful proxy measure of community resilience (or vulnerability) before or after a disaster.

The objective of this research is to further demonstrate the operational viability of using a psychometric assessment approach in disaster relief. Studies were conducted in several villages in Afghanistan following a UNHCR shelter response to flooding in 2014, and in the developing island nation of Vanuatu after Tropical Cyclone Pam in 2015.

METHOD

Assessment data was collected using the Depression, Anxiety, and Stress Scale 42-Item (DASS-42) psychometric survey, extended with demographic data and a self-ranked hierarchy of current needs for respondents. The DASS-42 indirectly measures depression (sad, "empty" affect, accompanied by somatic and cognitive changes leading to loss of function), anxiety (apprehension, worries about loss of control or ability), and stress (over-arousal, characterised by touchiness, irritability, or jumpiness), via the frequency with which respondents experience physical and psychological phenomena. The DASS was utilised because it has been used to measure psychological well-being in a variety of contexts, including past disasters as a resilience indicator (American Psychiatric Association 2013; Antony et al. 1998; Aslam & Kamal 2016; Mujeeb & Zabair 2012; Potangaroa et al. 2015; Santosa et al. 2014).

Potangaroa and Wilkinson (2015) in particular have made use of the DASS in a disaster context in Pakistan, China, Haiti, Christchurch, the Philippines, and Indonesia. They successfully focused on utilizing the DASS-42 as a tool for identifying which demographics were most affected by disasters and evaluating the outcome of aid programmes. When considering the case studies performed previously, as well as those outlined in this paper, it is clear that psychometric tools, and the DASS-42 specifically, can be flexibly applied to assessment for almost any cultural context, hazard type, or scale of event.

The survey's phenomenological nature makes it largely trans-cultural, and suitable for most contexts if properly translated (Oei et al. 2013). It is robust and designed to be administrable by nonprofessional staff (Lovibond & Lovibond 1996). It can be effectively conducted in approximately 15 minutes by a practiced administrator (Potangaroa et al. 2015).

The DASS severity index for interpreting scores is effective for indicating the relative seriousness of the measured psychological states, regardless of cultural context and, critically for post-disaster assessment, without the need for baseline data.

RESULTS AND DISCUSSION

Afghanistan

The objective of administering the DASS-42 in Afghanistan was to demonstrate the psychometric method's ability to measure the effectiveness of the UNHCR housing programme in meeting the affected population's needs, uncover the local patterns of disparately affected groups, and to identify those need of further assistance.

After the shelter programme's completion, the extended DASS-42 was used to gather quality of life information. The extended DASS-42 survey forms were translated into Dari and Pashto as appropriate and validated. UNHCR partnered with local Afghan officials to collect data from 444 aid recipients in the Gardiz, Herat, Mazar, and Kabul regions by interviewing aid recipients with the questionnaire. Data was collected in November and December 2014, following the April flash floods.

Table 4. Median DASS scores by region.

	Region					
Dimension	**Gardiz**	**Herat**	**Karbul**	**Mazar**	**Overall**	**Severity**
Depression	9	7	17	13	12	Mild
Anxiety	10	5	16	13	12	Moderate
Stress	17	8	17	17	17	Mild

Table 5. Frequency of DASS severity indicators

Severity	Depression	Anxiety	Stress
Normal	174	122	180
Mild	106	51	74
Moderate	113	107	97
Severe	35	79	57
Extremely Severe	16	85	36

The data shows that while a majority of the studied population had recovered to normal levels of quality of life (Table 1), a significant portion were still strongly affected, experiencing severe or extremely severe psychological symptoms (Table 2). This indicates that while shelter response was effective in restoring quality of life for the community at large, critical gaps remain, leaving many families still in a state of crisis. This kind of post-intervention evaluation is not easily obtained using technical assessments, but is incredibly important for ‘completing’ a response. This data also enables agencies to become more effective with immediate follow-ups in the field for those still in crisis, as well as enabling an improved response in future disasters.

Quality of life data can also be used to identify marginalised groups and local risk factors effectively. One of the most notable disparities in quality of life was geographic (Table 1). The Karbul and Mazar regions demonstrated disproportionately high indicators of depression and anxiety, while Herat appears to have been most-recovered province. The disproportionate impact on Karbul may be related to a high number of young children in Karbul households (Table 3). Indeed, for the surveyed population, there was a highly positive relationship (significant even at $p < 0.005$) between the number of young children in a house and all of the DASS dimensions, as well as with household size.

Table 6. Number of children per respondent household, by region.

Region	Avg. no. children 5 or under	Median no. children 5 or under
Gardiz	1.88	2
Herat	0.80	0
Karbul	3.14	3
Mazar	1.51	2

Normally, this type of risk information is assumed—for example, the preferential targeting of female-headed households or the elderly for aid. However, many of these factors are locally specific, as demonstrated by the difference between the relatively high quality of life for women in Gardiz (where they were significantly less affected than men, and less than women in Karbul and Mazar), compared to the impact on women elsewhere (significantly more so than men) (Table 4). These regional differences in demographic differentiation would be more difficult to quantify using standard assessments.

Table 7. DASS scores by gender and region.

		Region					
Gender	**Dimension**	**Gardiz**	**Herat**	**Karbul**	**Mazar**	**Overall**	**Overall Severity**
M	Depression	15	6	16	13	12	Mild
	Anxiety	16	4	13	13	12	Moderate
	Stress	18	7	16	17	15	Mild
F	Depression	8	10	18	16	12	Mild
	Anxiety	9	9	18	13	11	Moderate
	Stress	17	17	18	18	17	Mild
Overall	Depression	9	7	17	13	12	Mild
	Anxiety	10	5	16	13	12	Moderate

Stress	17	8	17	17	16	Mild

Foregoing standardized assumptions about marginalised demographics in favour of quality of life information also prevents wasteful mis-targeting of aid. For example, the Afghanistan data reveals no consistent relationship between age and quality of life after the disaster. Contrary to the findings of past research on other communities, older respondents did not report consistently higher levels of depression, anxiety, or stress, with the exception of a single outlier in the Herat region (Phifer 1990; Phifer & Norris 1989; Potangaroa et al. 2015). Even though Afghanistan has been regularly censured by international organisations as one of the least hospitable countries in the world for the elderly, age was a poor predictor of the quality of life impact of the flooding (HelpAge International 2015). Neither was the number of people with disabilities in a respondent's household, which did not show a statistically significant correlation to any quality of life indicators.

Vanuatu

The objective of the research in Vanuatu was to again demonstrate the operational efficacy of psychometric assessment for identifying both relative disaster impact (who to help), as well as how the method can be extended to capture the primary needs of the community (how to help). The DASS-42 was extended with not only demographic factors, but a list of potential needs—food, water, housing, debt, income, clothing, and health—which respondents ranked for their top three concerns.

The DASS was translated to Bislama and validated. It was administered to all of the adults (n=14) in the village of Laonkarai on the island of Efate in June 2015, following the devastation of Tropical Cyclone Pam in March. Although the standard format for administering the DASS is a private interview with individuals, constraints led to the survey being self-filled by respondents. Administration is a key determinant of DASS outcomes, and should be kept consistent across the population to keep relative results valid. There are several problems inherent to self-filling: the presence of family members or other observers may distort responses for some respondents but not others, and the necessity of assistance for those without the literacy required for self-filling the survey will skew answers through both the observer effect and by priming the respondent with a failure. Due to the variation of literacy capabilities in most populations, even in developed countries, as well as the potential for confusion on the scale or instructions, ensuring a consistent environment (one or two interviewers with privacy from the community) is preferred to self-filling. Fortunately, the main concern of the DASS in an operational environment is generation of data valid for relative comparisons between groups and over time, and not measurement precision on an absolute scale, and thus the assessment is adaptable to several methods.

The demographic context of the village was non-traditional, because most of the working-age men had left the region or even country to find employment. Only four of the 14 adult villagers were male, only one of whom was younger than 54. However, a large number of children were still present, with a median household size of 5.

The psychometric method's utility in validating or disproving the traditional assumptions regarding vulnerable groups have the potential to be a powerful tool in increasing the efficiency and efficacy of disaster response. In this case, the data shows that women were more affected by Cyclone Pam—each indicator of psychological distress is one to two scales of severity higher for women when compared to scores for men (Table 5), which indicates an unusually disparate effect across genders. This may be due to cultural factors, as witnessed by Vanuatu's chronic record of gender inequality, with 60% of ni-Vanuatu women experiencing physical or sexual violence, one of the highest prevalence rates in the world (CARE 2015).

Table 8. DASS results by gender.

	Depression	**Anxiety**	**Stress**	**n**
Male	5.5 Normal	7.5 Normal	8 Normal	4
Female	11.5 Mild	13.5 Moderate	22.5 Moderate	10
Total	9 Normal	13 Moderate	18.5 Mild	14

Surprisingly, younger respondents were more affected than older villagers, especially two of the young women who were functioning as heads of household. Older members of the community, however, were not as affected (see Table 6).

Table 9. DASS results by age.

	Depression	Anxiety	Stress	n
Under 30	17 Moderate	20 Extremely Severe	31 Severe	3
30-39	21 Severe	13 Moderate	17 Mild	3
40-49	6 Normal	10.5 Moderate	10 Normal	2

50+	7.5 Normal	10.5 Moderate	15 Mild	6

The only other demographic factors correlated with lower quality of life were households with female heads and households with higher numbers of young children.

The extended quality of life assessment format allows disaster victims to participate in the initial aid process by indicating their primary needs themselves, which also enables a more-efficient pull-style aid supply chain. Respondents reported a significant increase in needs and concerns after the cyclone, especially regarding food security (Figures 1 and 2). Housing was previously a top concern for aspirational reasons; before the cyclone, villagers wanted to update their current traditional shelters to Western designs and methods.

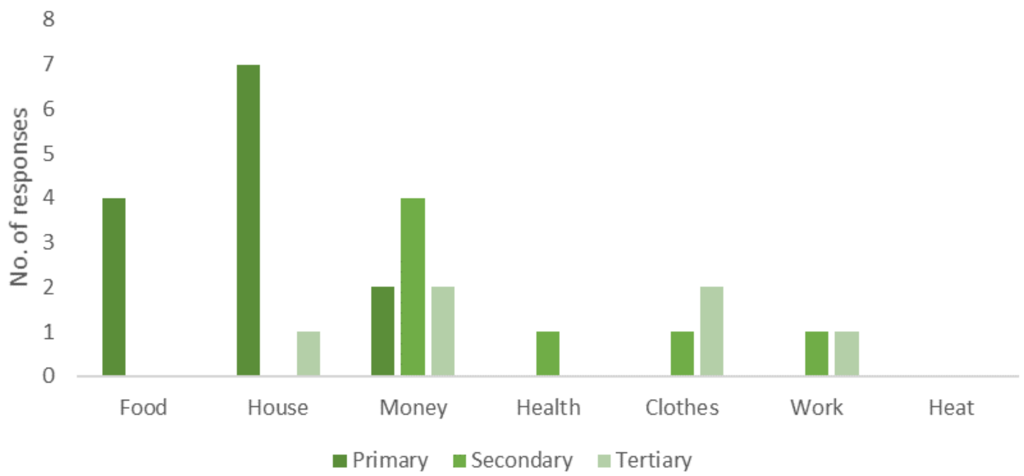

Figure 6. Self-indicated needs and concerns of villagers before Cyclone Pam. Some villagers reported no concerns before the cyclone.

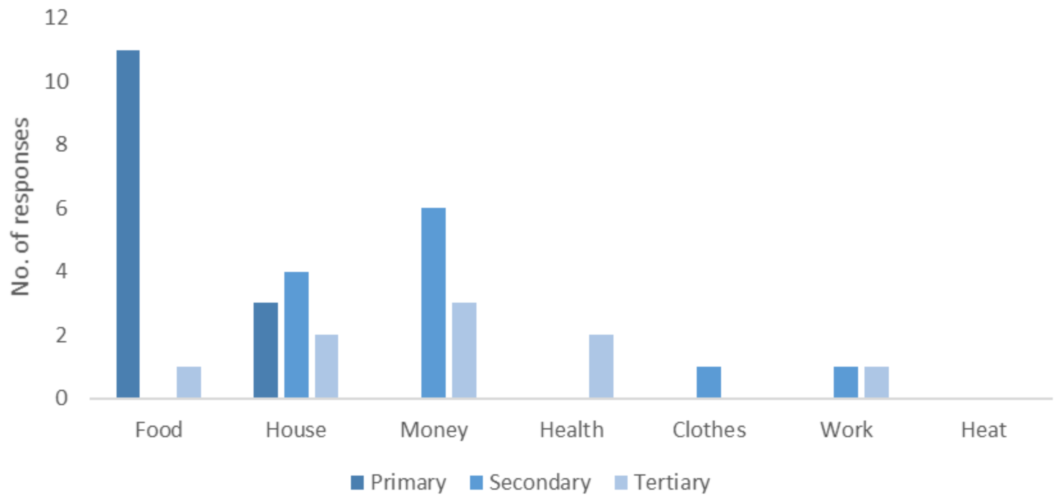

Figure 7. Self-indicated needs and concerns of villagers after Cyclone Pam.

Despite their central location, the villagers are concerned about food supplies in the future. Financial concerns were also largely fuelled by the perception of food insecurity. The destruction of local traditional fruit crops by the cyclone, combined with country-wide agricultural devastation due to Pam and an oncoming dry season, will only increase pressure on the villagers' ability to procure food at reasonable prices. Agricultural capacity is not predicted to fully recover for at least 3 years (based on historical regrowth patterns for leaf-stripped crop trees), even given optimal conditions (no dry seasons or cyclones).

It is notable that while aggregate measurements of psychological wellbeing for the village at large were below expected for a community in the response and early recovery phases following a disaster, 28% of the villagers were still experiencing severe quality of life effects. Additionally, although Laonkarai village was not as severely affected by Cyclone Pam as it could have been (with intact homes and no deaths), they are now highly vulnerable to a secondary-onset disaster, such as an extended drought or another cyclone. Without intervention, food security concerns will only grow over the following years.

CONCLUSION

Using quality of life assessments such as the DASS-42, offers demonstrated advantages over using only technical assessments. As shown by the study in Afghanistan, the DASS can be implemented efficiently on a large scale, and provides a culturally agnostic, comprehensive measure of which groups or individuals are most in need. Psychometrics are shown to be robust indicators because they account for hidden factors, as well as interactions between factors, and thus show the net state of an individual or community, rather than only measuring a small piece of the overall context. Because of this, psychometric assessments are also more useful and accurate for program targeting than assuming that traditional risk factors for marginalized groups are valid in every situation.

The study in Vanuatu also demonstrated that extending this assessment format with self-reported needs is an effective way to inform programming that will have the greatest impact on quality of life, and to identify the greatest needs for specific communities and subgroups. Quality of life assessments can also provide a much more relevant tool for measuring the effectiveness of technical interventions for improving the lives of aid recipients. Given these operational advantages, the authors recommend that disaster response efforts at all levels incorporate quality of life assessment techniques for primary assessment following disasters and when monitoring the effectiveness of programs.

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BUSINESS RECOVERY FROM DISASTER: THE ROLE OF INSURANCE

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The Canterbury earthquakes present a significant opportunity to observe business disruption and recovery in a well-insured and relatively high-income country. This paper examines the business disruption effects of the Canterbury earthquakes to identify which businesses were most impacted and why. Using data collected in business surveys at various stages of the recovery process, we analyse the extent to which insurance helped, and sometimes hindered, business recovery, providing insight to the role of insurance in both the short- and longer-term recovery contexts.

Insurance was a significant part of the recovery journey for many organisations in Canterbury. In some cases it gave organisations the financial 'space' to respond and adapt to the dynamic post-disaster environment. In other instances however, insurance created roadblocks in their recovery process. The second half of this paper draws lessons for the insurance industry on the role that they can and do have on business resilience and recovery.

Key words: insurance, business disruption, disaster recovery, economic impacts, organisational resilience

DISASTER RISK REDUCTION AS A PROFESSIONAL COMPETENCY: A REVIEW OF RELATED TRAINING AND EDUCATION PROVISION FOR BUILT ENVIRONMENT PRACTITIONERS IN THE UK AND AUSTRALIA

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ABSTRACT

The UN's Sendai Framework for Disaster Risk Reduction 2015-2030 highlights the importance of engaging multiple stakeholders in Disaster Risk Reduction (DRR). However, questions remain about whether the increasingly broad range of people who are required to make more informed decisions about risk reduction actually have the professional competencies to do so. DRR in the UK is a part of the resilience agenda, which implies a proactive approach to managing disasters and reducing the risks. In Australia, DRR is integrated within national disaster management policy, shifting responsibility away from government towards a proactive private sector, community and individual. When analysed closely it becomes apparent that despite the presence of legislation that encourages integrating such considerations into built environment processes, many built environment practitioners have not received the training required for dealing with DRR. In addition, proactively dealing with disaster risk in both countries is primarily implemented by emergency managers that typically have not been trained to deal with the required range of DRR approaches. These observations suggest that if DRR considerations are going to become better integrated into the (re)development of increasingly urbanised world, then there is a need to better integrate DRR principles into the core professional training (or at least continued professional development) of some of these key built environment practitioners. Therefore with the aim of assessing the extent to which DRR is (or can be) a core professional competency, this paper a) presents a critical review of the current core competency requirements for members of professional institutions, and b) provides an overview of the training of built environment practitioners in the UK and Australia.

Keywords: Disaster Risk Reduction; built environment; professional competencies

INTRODUCTION

The last century has witnessed mass urbanisation that has occurred in the context of neo-liberal 'free-market' policies, with the role of the state as an urban custodian gradually being diluted (Johnson et al. 2013). This has resulted in a reduction in regulatory control and a perspective that the role of the state is primarily to enable 'free' markets to work. For the construction sector this has enabled investments in construction through the provision of infrastructure, financial mechanisms and making land available for development. However, reduced (or ineffectively applied) regulatory controls have meant that disaster risks, and other environmental concerns, are often poorly considered in urban development decisions (UNISDR 2011; Johnson et al. 2013). This has been further exacerbated by the lack of appropriate training among built environment practitioners.

The UN's Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015) highlights the importance of engaging multiple stakeholders in Disaster Risk Reduction (DRR), with the specific role of built environment practitioners highlighted in literature (e.g. Bosher et al. 2007; Chmutina et al., 2014). However, questions remain about whether the increasingly broad range of people who are required to make more informed decisions about risk reduction actually have the competencies to do so.

A number of authors argues (e.g. Bosher et al., 2015; Siriwardena et al., 2013) that despite the presence of legislation that encourages DRR and resilience agendas to be integrated into built environment processes (i.e. design, construction and operation of the built environment), it becomes apparent that many built environment practitioners have not received the training required for dealing with DRR. In addition, proactively dealing with disaster risk is primarily implemented by emergency managers that typically have not been trained to deal with the required range of DRR approaches. These observations suggest that if DRR considerations are going to become better integrated into the (re)development of increasingly urbanised world, then there is a need to better integrate DRR principles into the core training (or at least continued professional development) of some of these key built environment practitioners (i.e. civil engineers, architects, surveyors and facilities managers).

Therefore with the aim of assessing the extent to which DRR is (or can be) a core professional competency, this paper a) presents a critical review of the current core competency requirements for members of professional institutions (e.g. the Institute of Civil Engineers (ICE), Institute of Structural Engineers (IStructE), Chartered Institute of Building (CIOB), Royal Institution of Chartered Surveyors (RICS), Royal Institute of British Architects (RIBA), Institute of Engineers Australia (EA), Australian Institute of Architects (AIA)) and, b) provides an overview of the professional training of built environment practitioners in the UK and Australia.

DRR COMPETENCIES AND PROFESSIONAL TRAINING

Why are DRR competencies important?

There is a potential for the private sector to play a critical role in proactively addressing DRR. However the realities of free-market economics (that often places a value on hazard prone land and a competitive market for insurers to provide insurance as standard) and the lack of incentives for the private (and even the public-private) sector to proactively consider DRR have resulted in a legacy of inappropriately considered developments. These developmental practices have occurred to promote economic development, but not necessarily to enable appropriate sustainable development.

Nonetheless, Bosher (2014) believes that there is scope for utilising an approach to DRR that is less dependent on governmental regulation. For instance, possibly through forward thinking private sector developers that can grasp the business opportunity (even if it is just driven by free-market fundamentalism). For some 'new build' developments, particular developers are recognising that it could actually be a good idea to become a market leader in incorporating DRR into commercial developments, with the hope that it will give them the cutting edge over competitors in the short term (i.e. under risk-blind legislative conditions) and the long term. This has already happened in the area of sustainability, which is becoming more and more mainstreamed into the construction sector's activities; many developers charge premium rates for the project that have a potential to receive outstanding environmental ratings (e.g. LEED or BREEAM). The greater engagement of built environment practitioners with DRR activities provides a similar opportunity not just to increase revenue and profitability, but also to contribute towards the betterment of sustainability, and community, environmental and other social outcomes (Bosher and Dainty, 2011).

The involvement of built environment practitioners in DRR has in the past largely been associated with a range of critical activities such as temporary shelter before and after the disaster, restoration of public services (e.g. hospitals, schools power lines) etc. (World Bank, 2001). In reality, however, built environment practitioners have a much broader role to anticipate, assess, prevent, prepare, respond and recover (Keraminiyage et al. 2007). Figure 1 illustrates that for DRR ideologies to be made more influential, they need to be considered in the 'project concept' and maybe even made a core component of 'Company Policy' (Bosher and Chmutina, 2017). The approach to how cities, infrastructure and buildings are developed needs to be change, by not merely mainstreaming DRR into practice but by making DRR part of the 'developmental DNA' (UNISDR, 2015). If DRR is only considered in the planning and detailed design stages then there is hope that DRR measures will be included but they may not be highly effective. If DRR is not considered or only considered once construction or reconstruction has started then the creation of disaster risk is much more likely.

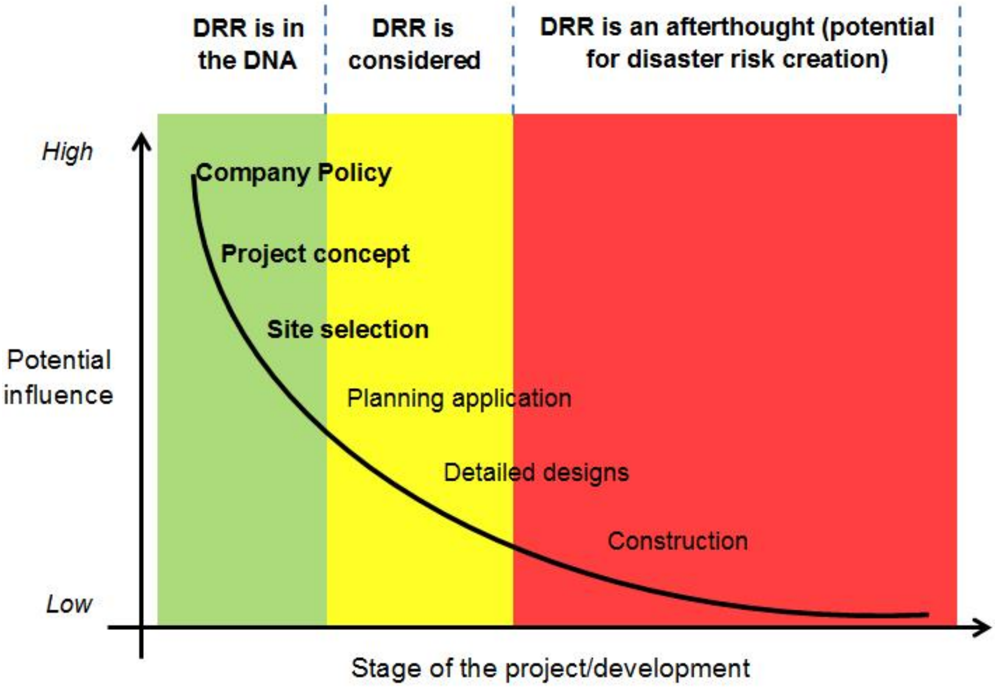

Figure 1: The 'Project influence curve' (Bosher and Chmutina, 2017)

This vision will need to be supported by many other non-structural activities, and in particular by incorporating DRR into the professional training (formal and informal) of built environment practitioners and raising awareness of proactive risk reduction to deal with the current and longer-term impacts of climate change.

As advocated by Russell (2013) and Janda and Pareg (2013) new skills are required as core competencies to enable a better understanding of the societal aspects of built environment practices and improved engagement /empowerment with stakeholders (such as clients and local communities). Bosher et al. (2015) take this idea further stating that the professional institutions that provide education to, and accredit courses for, built environment practitioners should take the lead in educating current and future built environment practitioner about their roles in DRR. While admittedly this is not a panacea it would definitely be a move in the right direction.

DRR competencies and professional development in the UK[3][4]

[3] This section is largely based on the research conducted by Mark Mayers as a part of his final year dissertation project for the School of Civil and Building Engineering, Loughborough University and supervised by Dr Lee Bosher and Dr Ksenia Chmutina.

[4] Data collection for this and the following section involved the exploratory analysis of the online information in order to identify what DRR-related courses are currently available as a part of civil

Whilst there is an opportunity for the introduction of DRR as a part of professional competencies, current situation in the UK demonstrates that this opportunity has not yet been fully realised.

The role of Higher Education Institutions in enhancing DRR-related knowledge and skills through the development of relevant curricular and modules is recognised (Malalgoda et al., 2015). Currently, a number of engineering courses in the UK provide DRR-related modules, however a predominant number of these modules are optional (see Table 1). These modules mainly cover flood management, seismic hazards and tectonics. The majority of the DRR-related programmes are largely offered at a post-graduate level, with the main focus being on emergency management (i.e. reactive rather than proactive approach to DRR).

Table 1: Overview of the DRR-related modules

Subject area	**Number of Universities offering the subject area**	**Number of compulsory DRR-related modules**	**Number of optional DRR-Related modules**
Civil and Building Engineering	52	1	19
Town and Country Planning	26	0	2

Siriwardena et al. (2013) point out that due to the complexity of DRR, relevant competencies have to be developed continuously. The underpinning principles of the professional institutes that accredit built environment courses provide an excellent opportunity for the integration of DRR into the professional competencies, as their Codes of Conduct already emphasise the importance of welfare, health and safety, and sufficient professional knowledge (e.g. ICE, 2014; CIOB, 2015).

Whilst none of the engineering chartered institutes see DRR as a core competency, in recent years a number of the Continuing Professional Development (CDP) events focused on DRR (particularly natural hazards) (e.g. flood management, resilience, risk assessment) has increased. For instance, in 2016 RIBA ran a 'Disaster Day' workshop aimed at developing preparedness and built in resilience approaches for the cities located in disaster prone areas (RIBA, 2016).

engineering programmes, and whether DRR competencies are covered by the professional development offered by various professional bodies.

The IStructE has a dedicated Earthquake Engineering Field Team (EEFIT) that collects and analyses data on geology and seismology, and make technical evaluations. EEFIT offers an opportunity to the members of the IStructE to join the team to expand their personal competence and development their understanding of DRR measures and the perceived importance of resilience in the built environment (IStructE, 2016).

DRR competencies and professional development in Australia

Australian society has extensive lived experience of disaster. However, in recent years, it has become apparent that risk has been often misunderstood by communities, industries and various government bodies (Forino et al. 2015). This is sometimes attributed to the highly professional nature of emergency response and a resulting complacency displayed by those at risk. There is a pervasive technocratic mind-set that asserts that more development and innovation will solve all of our concerns. In this context, built environment professionals are being trained overwhelmingly to prioritise economic rationale over all other factors and students are generally positioning themselves for a competitive neo-liberal job market.

Of the 37 universities training civil engineers in Australia, none explicitly require students to focus on DRR, but around half include DRR-related content, similar to the UK situation. Several of these have DRR-focused electives, with the standout being James Cook University. EA integrates many of the core skills and behaviours associated with DRR into its competency standards and while ‘disaster’ is not included explicitly, ‘risk’ is a critical term that is embedded strongly.

With regards to Construction Management degrees, the University of Newcastle offers an elective module on Disaster Resilience in its undergraduate programme. However among the 12 universities awarding CM degrees (which is a highly commercially focussed discipline), DRR is clearly not a priority. The Australian Institute of Building, which accredits all of these programmes, does not make any reference to ‘disaster’, ‘risk’ or ‘resilience’ in their competency standards (AIB, 2015). There is a related focus on environmental standards and health & safety more broadly.

The 18 Schools of Architecture in Australia boast numerous social good initiatives, and while this can lead graduates into DRR-related pathways, within the curriculum students are generally expected to develop their own interests and DRR is not prescribed as a core area of competence. The AIA provides various CPD opportunities in related areas and features ‘disaster relief’ as an example of the relevant application of the profession (AIA, 2016). A $10 million endowment was made to UNSW in 2015 to fund research in disasters within the architectural field and will surely raise the national profile significantly (Cheng, 2015).

Urban Planning undergraduate degrees are offered by 26 universities and deal more broadly with disaster risk management, but stop short of targeting risk reduction specifically in curricula. Planning Australia has a long standing relationship with the Australian Emergency Management Institute and seems the most active discipline in terms of shaping policy with an appreciation for DRR (Kelly, 2013). More specifically targeted DRR modules are indeed taught in Australia, across Environmental Science, Human Geography, Emergency Management, Public Policy and Development Studies but built environment disciplines do appear to be slow on the uptake with regards to graduate competency profiles.

CONCLUSIONS

This paper emphasises that for the built environment to become resilient, DRR competencies of the built environment practitioners should be improved. During the last few decades a paradigmatic shift has contributed towards an increased focus on disaster preparedness, hazard mitigation and vulnerability reduction rather than the often reactive focus on disaster management and relief. Despite this new emphasis, the construction industry at various scales is arguably poorly positioned to embrace the tenets of DRR. The construction industry's structural fragmentation sustained by ingrained practices which have emerged from the temporal nature of projects arguably present a problematic arena within which to enact the joined-up thinking necessary to mainstream DRR (Bosher and Dainty 2011), let alone the more ambitious aim of DRR becoming part of the 'developmental DNA'.

It is apparent that the broad range of built environment practitioners need to do a better job at transferring existing knowledge; many of the problems being encountered in hazard prone developments are not about knowledge/information not existing (i.e. technical information on how to build flood resistant structures), it is primarily about the knowledge not being applied (for instance due to poor knowledge transfer, poor training, commercial self-interests or poor regulation). Thus there is a need for broadening the core skills base (the breadth of multi-hazard DRR considerations, rather than just specialising in specifics such as earthquake or wind engineering) so that non-structural approaches to DRR can be given as much credence as some of the more technical structural considerations.

It is thus argued by Bosher et al. (2015), and reiterated in this paper, that proactively dealing with disaster risk should not merely be a 'bolt on' consideration, otherwise it tends to be more expensive, poorly integrated and less effective than if incorporated into earlier designs. This raises implications for the core education and continued professional training of the built environment practitioners that are involved in the design, planning, construction, operation and maintenance of our increasingly urbanised world. Consequently, it is increasingly being argued that the institutions that provide built environment related education/training programmes should take the lead in educating students about their roles in DRR. This would need the support of key professional institutions (such as the ICE, EA, RIBA, AIA, CIOB, AIB and RICS) including an open dialogue about the feasibility of including DRR as a professional competency though core undergraduate training, on-the-job practical training and/or Continued Professional Development courses.

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ANALYSING COMMUNITY HAZARD IN URBAN INFRASTRUCTURE SYSTEM

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ABSTRACT

The reliable serviceability of urban infrastructure system is crucial for supporting modern society needs. Yet, the inherent hazard events within the respective urban infrastructure system exert significant risks on the dependent community. A number of conventional risk assessment methods are unable to assess the risks in the context of its ripple effect and impact within the community as various stakeholders associated and impacted dissimilar to the existing hazard events. This study intends to fill the risk assessment knowledge gap by applying a social network theory and analysis which can capture, model and simulate the relationship between the inherent urban infrastructure hazard events and the community. A bipartite network analysis, called Bi-NA, utilized to analyze the complex risk problem in a two-mode affiliated social network. The method is applied using the real case study of urban water supply infrastructure in Indonesia context. As many as 30 hazard events identified from both literature review and expert comments in the field, including the fulfilled design-based questionnaire by 126 individual which grouped within 8 stakeholder groups of Surabaya city water supply infrastructure system used as a main input data. The core capability and advantages of the Bi-NA includes; characterizing, portraying, modelling and expressing the association between each individual (stakeholder) with the hazard events. The result, discussion and findings of this study will contributes to the risk management field and as practical tools for the urban communities in order to develop better urban infrastructure system and community resilience.

Keywords: Risk assessment; social network; bipartite analysis; infrastructure system.

INTRODUCTION

The urban infrastructure systems, within our built environment play a crucial role for, not only as the backbone of socio-economic development but also community wellbeing. As the urban infrastructure systems play a significant part to the entire community wellbeing, thus the discussion towards disturbances affecting urban infrastructure serviceability is a great crucial matter. In urban infrastructure sectors, the hazardous events can potentially exert significant failure on the functionality of one infrastructure and another, which ultimately affecting community wellbeing.

The urban infrastructure system is a complex and crucial assets which regulated, controlled and supported as well as exploited by various stakeholders (who dependent and affected by the infrastructure system). Departing from the understanding of the social amplification of risk framework (Kasperson et al., 1988), both different individual and, or groups within the urban community circumstances will be associated and affected to risk event differently. Thus, understanding the interaction between different stakeholder and risk events, in terms of different social-cultural experiences is a crucial towards building the urban infrastructure risk assessment and policy building.

In light with vast development of risk analysis and assessment method in previous studies, nonetheless, the discussion towards stakeholder-associated risk in the context of urban infrastructure is still missing. In the light of literature gap, this study proposed and applied a network-based risk analysis build upon various stakeholder perceptions towards each risk associated with them (individually) in order to analyze the nature of risk giving ripple effect affecting community.

LITERATURE REVIEW

Urban infrastructure system, faces a range of potentially serious threats, despite this formidable array of threats confronting the respective infrastructures, many problems will occur simply due to the complexity of these systems (Little, 2009). Therefore, a single disruption can be automatically devastated and affecting its serviceability which yields on disruption on urban flow. Assessing risk especially in urban infrastructure context can be daunting as urban infrastructures, which usually seen in a traditional view, cannot be solely observed in a single technical matter rather than the urban infrastructure systems create a social value downstream by serving a wide variety of end-users (as an individual or group) who rely on access to the system.

The urban infrastructure system is a complex and crucial assets which regulated, controlled, supported and exploited by various stakeholders (who dependent and affected by the infrastructure system as well). Consider the complexity characteristic of urban infrastructure system, thus the discussion towards a disturbance on, and resilience of urban infrastructure serviceability may lead to the investigation of significant issues, which is; the association between risk and urban community.

A discussion related to the urban infrastructure risk and its impact on community has received a large number of attentions in risk management studies, for instance; (Little, 2009; Mei, Chuanfeng, & Liang, 2010).

Repose to the concept of social amplification of risk (SAR) framework, developed and proposed by Kasperson et al (1988e) (Kasperson et al., 1988), different individual or groups within the urban community will be associated and affected to risk event differently in which (direct or indirect experience, and knowledge) influenced by their social and cultural environment. Understanding this interaction for different risks, for different social experiences and for different cultural groups is an important research need towards developing better urban infrastructure system risk management.

A number of conventional quantitative risk analysis method has been developed well in previous studies, for instances; Failure Mode Effect and Criticality Analysis, domino effect analysis, event tree, risk matrices, aggregate exposure metrics, risk priority-scoring methods, and fault tree. Nonetheless, conventional risk assessment considered to view hazard events in a subjective, compartmentalized, linear and isolate manner (focusing on the numerical analysis and hazard-technical matter), which neglects the relationship between the risk events and the urban community (Cox Jr, 2009; Rausand, 2013). Thus, this issue leads to losses crucial information, issues obscurity, and cause managerial uncertainty towards building the comprehensive risk mitigation plan and strategy**Error! Bookmark not defined.**.

To fill the gaps in previous risk management field of study, this study developed a novel risk assessment method in such a way be able to capture and model the divergent relationship between the hazard events and the community by objectively accommodate stakeholder perceptions towards risk.

The Bipartite Network-based Risk Analysis

The proposed methodology, named as Bipartite Network-based Risk Analysis (Bi-NA). The proposed Bi-NA is based on gathering and assembling the exchanging perception-based information towards (or experts-associated risk event. To explore the risk-stakeholder interactions-based properties, the proposed method flowchart (figure 1) and a 'step-by-step' process explained below.

Identify and determined both the hazard events and the stakeholder in the respective urban infrastructure sector.

The design-based questionnaire built in order to obtain the perception of risk from the participant. Participant need to specify what hazard events are associated with them.

The next step involves defining the links within the network, which present the relation between two nodes.

Building the stakeholder-associated risk matrix (SRM, which represents relations among objects) in order to further develop the network structure (Danilovic & Browning, 2007; Fang, Marle, Zio, & Bocquet, 2012). Risk-stakeholder interaction is considered as the existence of a possible precedence relationship between two nodes S_i and R_n. (Fig. 2)

Direct assessment is made for each potential interaction by one or more experts according to their experience and/or expertise. A qualitative scale (either 0 or 1, as aforementioned) issued for assessing the interactions.

Apply the fixed SRM as the main matrix towards 2-mode SNA simulation in order to reveal the network topology.

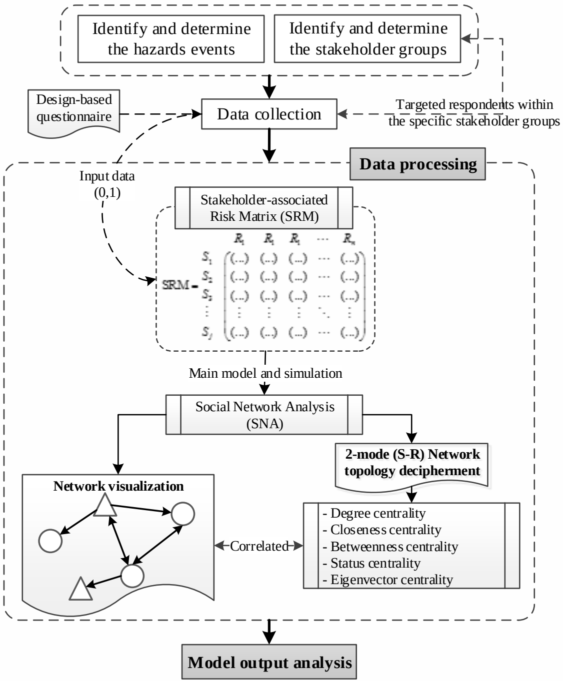

Figure 1. Proposed method flowchart.

a

	R_1	R_2	R_3	R_4	R_5	R_n
S_1		1			1	1
S_2			1	1		
S_3	1			1		
S_4	1	1			1	
S_5		1	1			1
S_i	1			1	1	1

b

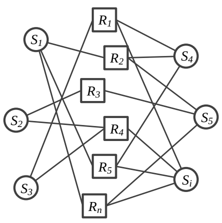

Figure 2. (a) SRM and, (b) Stakeholder-associated risk network.

The SRM matrix, which is a 2-mode (or bipartite) network, is used to form a main network. The networks can be represented by a network graph, in which the identified risks and stakeholders are mapped into N and I nodes respectively connected by non-weighted arrows (Fang et al., 2012). Further, a number of network topology representations (such as; degree, degree centrality, betweenness centrality, closeness centrality and eigenvector centrality) will be utilized to decipher the structural configurations of the node relations by calculating a number of SNA indicators in a normalize form (Lienert, Schnetzer, & Ingold, 2013; Malisiovas & Song, 2014; Marin & Wellman, 2011; Prell, Hubacek, & Reed, 2009; Zhang et al., 2008). Thus, the higher the normalized value the higher the ranking is.

Application to Urban Water Supply Infrastructure System

This study applies and validates the proposed Bi-NA method in the case of in Surabaya city water supply infrastructure system as a 2nd largest city in Indonesia who has the best ranked urban water supply system among the nation. A number of past studies explored and discussed the problem and challenge that Surabaya water supply system faced either in environmental, technical, economic and social aspects (Ostojic, Bose, Krambeck, Lim, & Zhang, 2013; Setiono, 2013; W.Dick, 2002). As many as 30 hazard events identified based on the vast literature review (including interviewing the experts) based on the studies published in the mainstream risks and resilience literatures (Grafton, Pittock, Tait, & White, 2013; Roozbahani, Zahraie, & Tabesh, 2013) (Table 1).

Table 1. The identified 30 hazard events.

Hazard category	Hazard events
Nature	R1. Climate change, R2. Natural disasters, R3. Water scarcity (shortage), R4. Idle land exploitation, R5. Pollution and contamination.
Social	R6. Uncertain water demands (and trends) R7. Water misuse, R8. Limited access to clean water, R9. Payment problem, R10. Community rejection, R11. Population growth and urbanization problem, R12. Sabotage to physical infrastructure.
Political	R13. Uncertain political behavior, R14. Limited public participation, R15. Changes in government policy, R16. Obscurity on government legal and regulatory.
Technical and Operational	R17. Insufficient non-technical service provision, R18. Water quality defective, R19. Trouble in water transmission and distribution network, R20. Mechanical (physical) component failure, R21. Under rate maintenance, R22. Physical infrastructure decay (aging), R23. Lack of technical service provision, R24. Water loss (NRW), R25. Disturbance from another supporting infrastructure.
Economic	R26. Interest rate instability, R27. Foreign exchange rates instability, R28. Poor infrastructure investment, R29. Inflation hazard, R30. Uncertain water price.

As many as 126 respondents from eight different stakeholder groups (i.e., national river basin management agency; state government public works department; public corporation (PJT-I); Surabaya city government; regional water supply company; industry; commercial and, or public facilities; domestic end user (household/individual)) participated into this study by filling the design-based questionnaire and willing to share the information which used as the preliminary input data within the proposed method.

DATA ANALYSIS, OUTPUT AND DISCUSSIONS

The raw data has been initially input, modelled and simulated using Spreadsheet and NetMiner 4.0. The SRM is a big matrix which consists of 30 x 126 matrix size (i.e., based on the 30 hazard events and 126 participant). Once the SRM developed, both the network visualization and topology decipherment can be obtained and analyzed by following the network topology measurement. This study, focus on the bipartite (2-mode) network analysis and output discussion in the risk events node side only in terms of affecting to various stakeholders. Figure 2 clearly depicts the interrelationship between stakeholder and the risk event based on divergent perceptions towards risk.

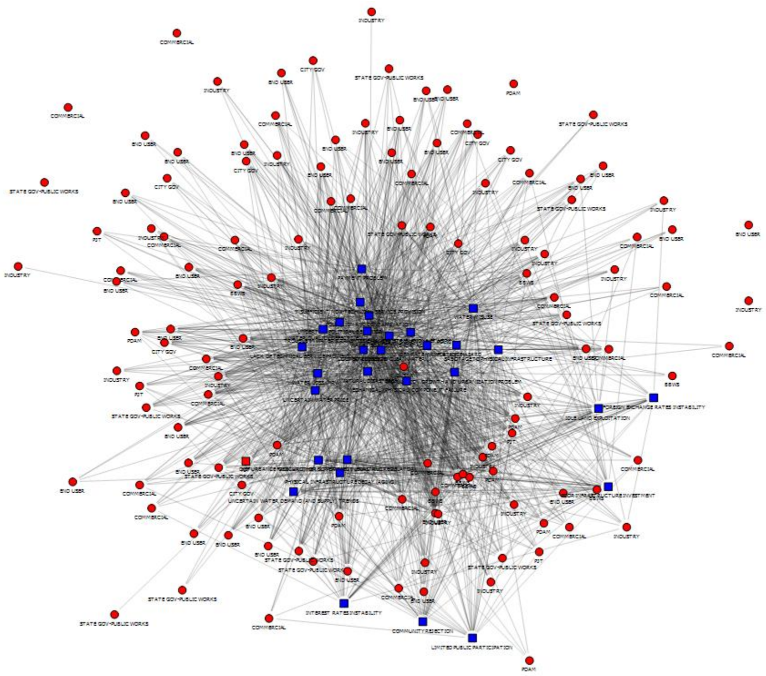

Figure 2. The 2-mode network visualization from the determined SRM.

Table 2 shows the output analysis for the network topology decipherment and figure 3 depicts the degree, betweenness, closeness and eigenvector centrality concentric map completed with the value. Referring to the concentric map, the more centralized the respective nodes the more important/significant the risk event is (following the network topology decipherment type).

Table 2. 2-Mode network topology analysis.

Risk ID	Degree	Degree Centrality			Betweenness Centrality			Closeness Centrality			Eigenvector Centrality		
		Value	Norm	Rank	Value	Norm	Rank	Value	Norm	Rank	Value	Norm	Rank
R1	70	0.556	0.753	6	0.047	0.425	6	0.640	0.835	6	0.219	0.837	6

R2	**73**	**0.579**	**0.785**	**5**	**0.061**	**0.549**	**4**	**0.654**	**0.853**	**5**	**0.230**	**0.877**	**5**
R3	**76**	**0.603**	**0.817**	**3**	**0.063**	**0.562**	**3**	**0.669**	**0.872**	**3**	**0.232**	**0.884**	**4**
R4	33	0.262	0.355	25	0.007	0.065	24	0.506	0.659	25	0.125	0.478	25
R5	**93**	**0.738**	**1.000**	**1**	**0.112**	**1.000**	**1**	**0.767**	**1.000**	**1**	**0.262**	**1.000**	**1**
R6	36	0.286	0.387	24	0.006	0.053	25	0.514	0.671	24	0.147	0.561	23
R7	51	0.405	0.548	14	0.020	0.179	14	0.563	0.734	14	0.181	0.690	15
R8	63	0.500	0.677	8	0.036	0.327	8	0.610	0.795	8	0.204	0.777	8
R9	46	0.365	0.495	18	0.016	0.146	17	0.546	0.712	18	0.162	0.619	19
R10	*28*	0.222	0.301	*27*	0.003	0.025	*30*	0.492	0.641	*27*	0.123	0.469	*27*
R11	44	0.349	0.473	21	0.014	0.123	20	0.539	0.703	21	0.159	0.608	21
R12	48	0.381	0.516	16	0.014	0.124	19	0.553	0.720	16	0.179	0.681	16
R13	*26*	0.206	0.280	*29*	0.004	0.037	*27*	0.486	0.634	*29*	0.108	0.411	*29*
R14	*28*	0.222	0.301	*27*	0.005	0.048	*26*	0.492	0.641	*27*	0.113	0.430	*28*
R15	65	0.516	0.699	7	0.038	0.340	7	0.618	0.806	7	0.212	0.808	7
R16	45	0.357	0.484	19	0.013	0.113	21	0.543	0.707	19	0.168	0.641	18
R17	57	0.452	0.613	11	0.025	0.224	11	0.586	0.763	11	0.193	0.737	11
R18	**85**	**0.675**	**0.914**	**2**	**0.085**	**0.767**	**2**	**0.718**	**0.935**	**2**	**0.254**	**0.969**	**2**
R19	**75**	**0.595**	**0.806**	**4**	**0.053**	**0.479**	**5**	**0.664**	**0.866**	**4**	**0.237**	**0.903**	**3**
R20	60	0.476	0.645	9	0.033	0.296	9	0.597	0.779	9	0.203	0.775	9
R21	58	0.460	0.624	10	0.025	0.228	10	0.589	0.768	10	0.202	0.770	10
R22	47	0.373	0.505	17	0.017	0.151	16	0.549	0.716	17	0.173	0.659	17
R23	51	0.405	0.548	14	0.019	0.168	15	0.563	0.734	14	0.182	0.695	14
R24	55	0.437	0.591	12	0.023	0.203	12	0.578	0.753	12	0.193	0.736	12
R25	38	0.302	0.409	22	0.008	0.068	23	0.520	0.678	22	0.153	0.583	22
R26	29	0.230	0.312	*26*	0.004	0.034	*28*	0.494	0.644	*26*	0.125	0.475	*26*
R27	*23*	0.183	0.247	*30*	0.003	0.028	*29*	0.478	0.624	*30*	0.097	0.371	*30*
R28	37	0.294	0.398	23	0.009	0.082	22	0.517	0.674	23	0.138	0.527	24
R29	45	0.357	0.484	19	0.014	0.129	18	0.543	0.707	19	0.161	0.614	20
R30	54	0.429	0.581	13	0.021	0.191	13	0.574	0.748	13	0.188	0.716	13

From the degree analysis part, R5 has the great number of connection link with the stakeholder as many as 93 link, followed by R18, R3, R19 and R2 by 85, 76, 75 and 73 links respectively among 126 stakeholders. Nonetheless, R27 received very small amount of degree value (just as many as 23) among the 126 stakeholders, which reflect that people mainly consider this risk event as not so important or crucial in terms of having affect/impact (influencing people perceptions) in the case of Surabaya water supply infrastructure system.

In all of the network topology analysis, R5 has been stated as the most critical risk, being perceived by majority of stakeholders as the Surabaya river is basically the main resource for producing clean water in Surabaya city. In the view of betweenneess centrality, R5 also has the highest capability in order to bridging/passing other risk event impact (both to community as well as other risk events) by having the highest centrality value. Both the closeness centrality (to reach and affecting stakeholders) and eigenvector centrality, R5 also bring a critical understanding towards its high connection and importance towards other risk events.

To the most, based on further interview, almost all of the participants agreed towards this issue. Importantly, the issue of pollution and contamination in Surabaya river is a multi-dimension challenges to Surabaya government city where the sources of this problem is both nature (climate change, river flow fluctuation, river sediment and dirt) and man-made error (lack of awareness such as; littering and wash in the river, unjustified law enforcement, a number of industries do not have and apply the standard waste management in which pollute the Surabaya river.

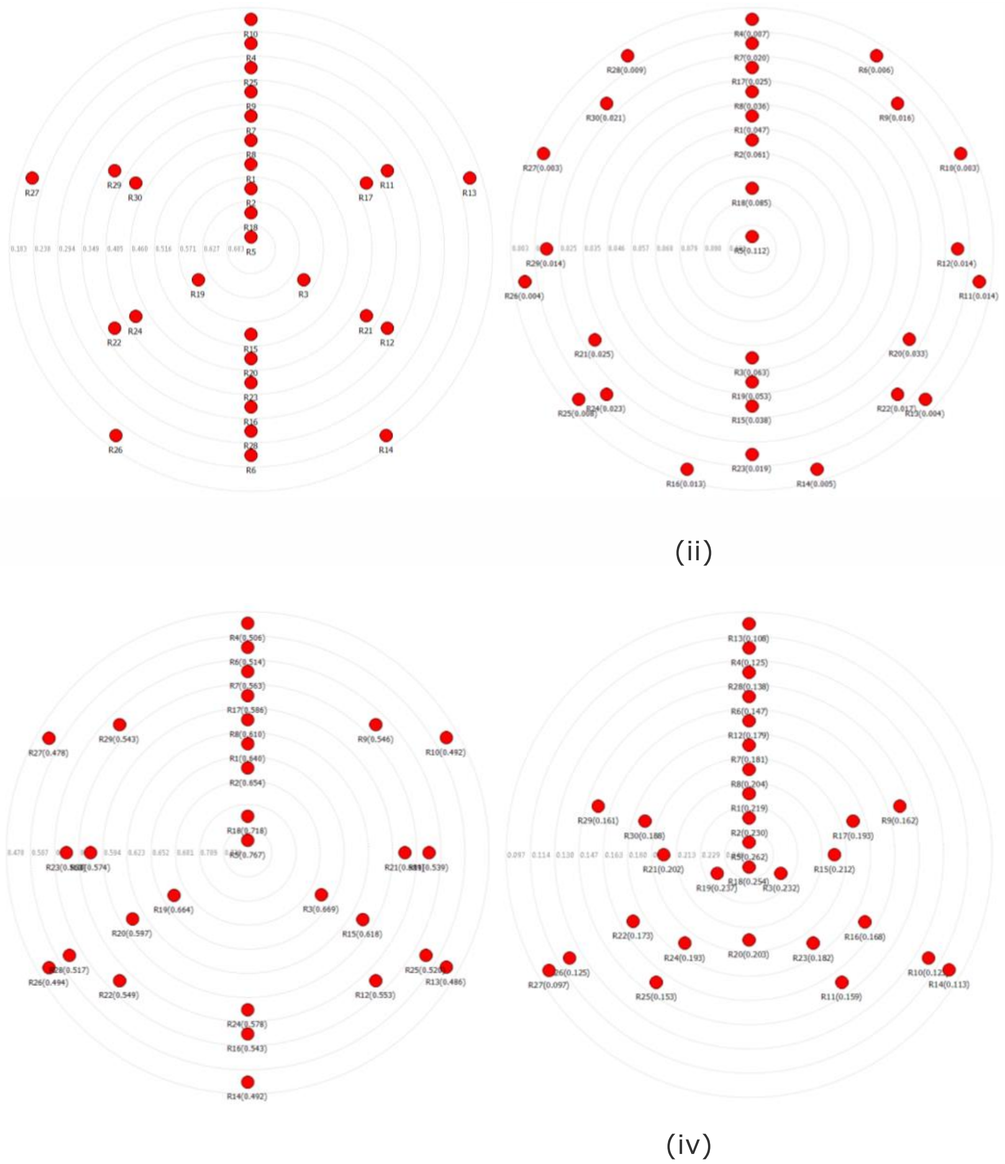

Figure 3. Risks (i) degree, (ii) betweenness, (iii) closeness and (iv) eigenvector centrality concentric maps visualization.

Another risk events which is ranked 2nd highest among the 30 risk events based on network topology decipherment analysis is. Based on the interview with the some experts (as well as lay people), this risk event correlated high with the R5. The disturbances form of this risk event is the delivery product of not-so-clean water which inevitably interfere community daily activities. Further, R2, R3 and R19 are also the risk event which has a high ranking among the other 30 risk events (ranked as 3rd, 4th and 5th). Contrary to the five risk events ranked highest discussed previously, the R10, R13, R14, R26 and R27 are another five risk issues which considered not so or unimportant in terms of affecting communities based on the low network topology score among the other one stated in table 3.

Interestingly, although the ranking from different network topology decipherment measurements is somehow dissimilar, nonetheless R_2, R_3, R_5, R_{18}, and R_{19} always ranked within the fifth best risk events, as well as the R_{10}, R_{13}, R_{14}, R_{26} and R_{27} contrary stand within the fifth lowest rank in the context of network topology analysis among the 30 risk events. This output refers to the critical and not-so-critical risk events in which, even without following the classic risk analysis, mainly direct or indirectly-negatively affecting people (either significant or not).

The discussions above further reveals another findings; people were giving their attention higher to the risks issue in which correlated high to the main product delivering by the Surabaya water supply infrastructure system (i.e., "clean water"). Moreover, people perception toward risk events is the product of individual intuition which reflects their self-vulnerability point of view both in the pre and post disturbance period. The analysis output data also clarify a significant finding which is; when direct personal experience is lacking or minimal, there's a tendency that an individual learn about risk from other persons and from the media.

CONCLUSIONS

This study attempts to propose and apply the bipartite network-based methodology to assess urban infrastructure risks in which capable to capture, model and simulate the phenomena of the complexity connection between risks and stakeholders individually. The results obtained show that the topological analysis by bipartite network theory adds further value and complements the classical risk assessment, in identifying both the important risks and the important risk interactions with respect to their role in the network behavior.

The advantages of the proposed method can be seen in the analysis and discussion shown in previous section as the risk not assessed by its impact, instead the association between individual and the hazard risks. The ability of each of the risk event giving its impact and affecting community based on multi-stakeholder perceptions toward each of risk events has been discovered and discussed deeper which is significant to support decision maker making crucial final decision for developing community resilience as well as respective urban infrastructure system in the further time. The proposed method enable for decision makers to build both preliminary and post disturbance, a combination of feasible risk mitigation actions thus can be performed and supported the building of urban infrastructure risk mitigation and planning in order to increase the urban infrastructure as well as community resilience.

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MAKING CITIES RESILIENT TO DISASTERS: “NEW” TEN ESSENTIALS

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INTRODUCTION

The growth of cities has resulted in a concentration of risk for people and assets alike. Catastrophes such as the 2004 Indian Ocean tsunami and Cyclone Nargis (which struck Myanmar just four years later) have led to the loss of hundreds of thousands of lives. These disasters also brought economic catastrophe: millions lost their homes and livelihoods; cities were reduced to rubble; economic growth and development were set back by years, or even decades in some cases. Left unchecked, the cost of climate change could account for some 20% of global GDP by the end of this century. Much of that bill will have to be paid for by cities and businesses (Axa, 2016).

Resilience planning is a complex issue that falls under the responsibility of multiple departments within governments. While some cities have set up plans that centralize the multiple aspects of resilience planning, others have integrated adaptation and resilience across departments and sectors. Cities are implementing both long-term adaptation measures as well as more immediate response activities. Given the nature of the challenges that cities will face, long term planning and adaptation to the changing environment will be crucial for surviving the worst impacts of climate change. It is, therefore, necessary to move beyond plans that simply identify the potential for disaster and to outline emergency responses.

There are also many cities and smaller urban centres where even the best-oriented disaster risk reduction policies have a limited impact due to large deficits in critical social infrastructure and in local investment capacity. Consequently, two of the key issues for building urban resilience is how to support, and learn from, the innovators, and how to leverage significant changes in city-level resilience, even where there are limited resources.

Another important trend is the extent to which cities are integrating disaster risk reduction into other local government activities, including education, livelihoods, health, environment and planning, either by incorporating risk consideration into existing activities or by initiating projects that address multiple issues simultaneously.

The United Nations Office of Disaster Risk Reduction (UNISDR) launched the Making Cities Resilient Campaign: My City is Getting Ready! (UNISDR, 2016) in 2010 in recognition of the increasing risks linked to global urbanization and to strengthen local governments' role in reducing these risks. Since its launch, the Campaign has amassed pledges from more than 3,000 cities. By signing up to the Campaign, local governments commit to implementing the "Ten Essentials" for Making Cities Resilient, a 10-point checklist that serves as a guide to good disaster risk management and reduction practice.

Within this context, this paper aims to share the Ten Essentials that have been developed by UNISDR with the aim of promoting the increased understanding of, and commitment by, local governments to disaster risk reduction and to make cities resilient to disasters caused by natural hazards.

NEED TO MAKE CITIES RESILIENT TO DISASTERS

Cities are complex in nature. They consist of a number of inter-dependent physical systems (Santos-Reyes, 2010) and human communities which are vulnerable to disasters in varying degrees. Kreimer et al. (2003) identified a city or an urban area as a "set of infrastructures, other structures, and buildings that create an environment to serve a population living within a relatively small and confined geographic area". Cities are seen as engines of economic growth where the majority of economic activity takes place (Pelling, 2003). In many cases, city centres are considered to be the preferred location for economic activities (as movement is cheap in terms of distance, time and convenience of travel as a result of good transport facilities), providing a thriving labour market and good service facilities to support business organizations (Macionis and Parrillo, 2004).

Increased global exposure to natural hazards has largely been driven by population growth and the trend for an increased proportion of that population to live in cities rather than in rural areas (Global Assessment

Report, 2015). In 1990, 43 per cent (2.3 billion) of the world's population lived in urban areas and by 2014 this was 54 percent. The urban population exceeded the rural population for the first time in 2008 and by 2050 it is predicted that urbanisation will rise to 70% (Albrito, 2012). This increase in urban population has not been evenly spread throughout the world. Different regions have seen their urban populations grow more quickly, or less quickly, although virtually no region of the world can report a decrease in urbanization. As the urban population increases, the land area occupied by cities has increased at an even higher rate. A global sample of 120 cities observed between 1990 and the year 2000, shows that while the population grew at a rate of 17 per cent on average, the built-up area grew by 28 per cent. It has been projected that, by 2030, the urban population of developing countries will double, while the area covered by cites will triple (World Urbanization Prospect, 2014).

As cities grow larger and become economically more productive, they serve as magnets for rural-urban migration. As urbanization continues, more and more people settle in cities, leading to urban sprawl and also to increasing densification. Urbanization has the potential to make cities more prosperous and countries more developed, but many cities all over the world are grossly unprepared for the multi-dimensional challenges associated with urbanization. As a result, the world's population is increasingly concentrated in large cities with poor housing and a lack of basic protective infrastructure. Cities are, therefore, characterized by high population density and a concentration of resources and infrastructure. There is thus a high risk of economic loss, damage to assets, and human casualties and injuries in disasters and extreme weather events, making cities particularly vulnerable. Many of the world's mega-cities are already situated in locations that are already prone to major earthquakes and severe droughts, or along flood-prone coastlines where the impacts of more extreme climatic events and sea level rise pose a greater risk of disaster. Urbanization taking place in relatively smaller cities is also a concern - particularly in regions where the existing infrastructure and institutions are ill equipped to cope with disasters. The vulnerability of this new generation of urbanites will become a defining theme within disaster risk in the coming decades. In contrast, cities also have a concentration of resources, skills and political power and, hence, more capacity for enabling resilience to hazards.

Cities are also characterized by much more built up areas as compared to rural regions. Because of its concentration and extent in cities, the built environment (infrastructure, facilities/installations, buildings, etc.)

represents high assets' value and is vulnerable to damage and loss due to disasters and climate change impacts. The built environment contributes significantly to resource consumption and to greenhouse gas emissions (Rosenzweig et al., 2011) and, consequently, to climate change which is a key risk element within cities. A significant proportion of urban development in cities is occurs in an ad-hoc, unplanned and unregulated pattern, characterized by large-scale informal developments that are particularly vulnerable to hazards. Urban planning and development agencies often lack the capacity and resources required to deal with the huge scale of the problem and, despite various localized coping strategies, urban communities cannot mitigate or manage disasters that stem from an urban development process beyond their control.

As a result of rapid urbanisation, cities are becoming extremely vulnerable to threats posed by natural hazards (Malalgoda et al., 2013). Increase in severe weather events and disasters have highlighted the need for cities to augment their ability to withstand the disaster risks that they may face, and to mitigate and respond to such risks in ways that minimize the impact of severe weather events and natural disasters on the social, environmental and economic infrastructure of the city. In the light of all the above, city leaders need to make significant transformative changes and investments in the resilience of their cities.

The 'resilient city' is a comparatively new term which is now widely used in disaster related literature (Malalgoda, 2014) and policy documents (UNISDR, 2012). UNISDR (2007) defines it as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of a hazard in a timely and efficient manner, including the preservation and restoration of its essential basic structures and functions. Friend et al. (2015) provide a context for considering the rapidly changing characteristics of risk at a local level and, in doing so, consider how the notion of the local level might be reframed, and the opportunities for multi-scale interventions for disaster risk reduction and how and the opportunities for multi-scale interventions for disaster risk reduction might be seized. Tyler and Moench (2012) draw on complex systems and resilience thinking to consider the implications of urbanization for an understanding of local disaster and climate risk. Furthermore, Friend et al. (2015) present urbanisation as a process of social and ecological transformation, and cities as dependent on complex systems and flows of resources beyond their physical location. These approaches emphasise the increasing influence of complex infrastructure and technology systems in shaping cities and urbanization, and the increasingly complex mobility of people across different social arenas and locations (Graham and Marvin, 2001).

Godschalk (2003) states a disaster resilient city goes beyond changing land use and physical facilities. It must also build up the capacity of the multiple involved communities to anticipate and respond to disasters. With the effects of evolving coastal hazards, this swift increase in exposure makes cities key areas in which to address evolving disaster risk.

Accordingly, what makes a city resilient to disasters can be seen as a combination of resilience accumulated through the process of urbanization and planning on the one hand, and the result of specific actions to reduce disaster risk by various actors on the other. When viewed in this light, urbanization is obliged to consider actions to reduce vulnerability beyond the physical location of cities and, in so doing, to consider what is meant by the term 'local'. In considering the local dimensions of disaster risk reduction, the focus is thus on the process of urbanization rather than on the physical location of cities, or on the administrative units of the city or municipality. This is not to reject the importance of place as a key determinant in disaster risk and vulnerability but to also argue for the growing importance of more multi-scale, systems-oriented approaches (Friend et al., 2015).

POLICY CONTEXT

The Sendai Framework for Disaster Risk Reduction: 2015-2030 (UNISDR, 2015) adopted at the Third UN World Conference for Disaster Risk Reduction, lays out the priorities of action that are necessary to be undertaken at both national and local level in order to reduce mortality and direct disaster economic losses (including damage to critical infrastructure) by increasing the number of national and local disaster risk reduction strategies by 2020.

These strategies and plans needs to be available across different timescales, with targets, indicators and time frames all aimed at preventing the creation of risk, a reducing existing risk and strengthening economic, social, health and environmental resilience.

With the adoption of the Sendai Framework and Goal 11 of the Sustainable Development Goals (make cities inclusive, safe, resilient and sustainable) local governments have become even more places at the centre of efforts to build resilience to disasters.

WHAT IS THE UNISDR "MAKING CITIES RESILIENT CAMPAIGN"?

A consideration of resilience with regard to cities has been led by the United Nations Office for Disaster Risk Reduction (UNISDR) and was adopted in their Making Cities Resilient Campaign which began in 2010 (Cassidy et al., 2014). This Campaign launched in May 2010 addresses issues of local governance and urban risk. The Campaign is led by the UNISDR but is self-motivating and partnership and city-driven with an aim to raise the profile of resilience and disaster risk reduction among local governments and urban communities worldwide. It focuses on disaster resilience – that is, the ability of a city to plan for, mitigate, respond, recover, adapt and grow after major disasters in the light of its unique physical, economic, environmental and social circumstances. The objectives of the Making Cities Resilient Campaign are (UNISDR, 2012):

Know More: Raise awareness of citizens and governments at all levels of the benefits of reducing urban risks.
Invest Wisely: Identify budget allocations within local government funding plans to invest in disaster risk reduction activities.
Build more safely: Include disaster risk reduction within participatory urban development planning processes and protect critical infrastructure.

Though all levels of government are generally expected to become involved in disaster risk reduction, the role and actions of local governments in making cities resilient are critical. Local governments can play a key role in contributing to making cities resilient in numerous ways as they are rooted at the local level where disasters strike. The Campaign developed 'ten essentials' to enable local governments to make their cities more disaster resilient (UNISDR, 2012). The rationale for this important development was to devise and implement innovative tools and techniques for disaster risk reduction which can be replicated elsewhere and/or scaled up nationwide. This rationale is also based on the hypothesis that local governments are in a better position to organise, develop and experiment with new tools and technologies for disaster risk reduction such as early warning systems etc. and to make such tools and technologies policy priorities.

It is clear that local governments can contribute to disaster risk reduction and the resilience of cities in numerous ways. Disaster risk reduction has to be achieved, mainly, through the proactive means of implementing mitigating measures with the participation of community groups and other stakeholders.

Even though the role played by local governments in making their cities resilient to disasters has been widely recognised in literature, several authors (Malalgoda, 2014; Friend et al., 2015) and researchers have identified that gaps exist in the actual contributions made by local governments towards disaster risk reduction endeavours. This is especially true within the context of the implementation of risk reduction factors (UNISDR, 2015). Local governments need guidance on addressing the underlying risk factors through resources, incentives and decision making responsibilities.

THE METHODOLOGY FOLLOWED IN DEVELOPING THE NEW ESSENTIALS

Looking towards the implementation of 2030 global agendas, to increasing risks and to the future estimates of uncontrolled urbanization, there is a need to design the "Ten Essentials" to be more actionable and to encourage cities to move towards their implementation.

Member states and stakeholders have called for revisions to the local indicators, which are informed by the essentials, and to the reporting process; these revisions are required within the new framework including the goals of the Sustainable Development Goals (UN, 2016).

The Steering Committee of the Making Cities Resilient Campaign met in September 2014 and laid out guidance for the UNISDR for the revision of the ten essentials. The recommendations included:

Establishing a group consisting of technical agencies, experts and partners working at local level to lead the modification and harmonization of the Ten Essentials;
Engaging National and Local Governments in the process to ensure that relevant linkages are built into the measurement and monitoring;
Ensuring pilot studies are undertaken to factor in the realities on the ground;
Focusing on action oriented actions; and
Engaging in the intergovernmental processes to get the new essentials and indicators endorsed.

Accordingly, an expert group of 50 global agencies', experts', cities' and government representatives was established and the group first met in December 2014. As an input to this process, UNISDR, in advance, conducted an evaluation of the ten essentials' associated local government indicators that engaged cities from all regions, partners and stakeholders.

The expert group proposed a set of new Ten Essentials that was shared with cities and partners at the Third UN World Conference on Disaster Risk Reduction, held from 14th to 18th March 2015 in Sendai, Japan. These essentials were then finalised after further consultations and a pilot implementation. These new essentials were aligned to the guidance provided by the Sendai Framework for disaster risk reduction monitoring at the local level, the work of the inter-governmental working group on indicators for the global targets of the Sendai Framework, and the overall Sendai Monitoring framework. Identified technical agency leads (who were recognised experts in their specific fields relating to any of the proposed new ten essentials) assisted in the process of the development of the indicators and the guidance notes for users. These guidance notes provide city officials with examples on how to implement the essentials.

Pilot tests of the new essentials, their indicators and the generation of the guidance notes were carried out in 20 cities commencing in January 2016. Feedback generated in the pilot studies were used to revise the new ten essentials and in establishing the final indicators and the guidance notes. These revisions were then fed into, and assisted in forming, the new indicators for the combined monitoring and action planning tool for disaster risk reduction at the local level.

NEW ESSENTIALS

As already identified above, the main objective of the new essentials is to be actionable. These new Ten Essentials are built upon the previous essentials, just as the Post 2015 framework for Disaster Risk Reduction builds upon the Hyogo Framework for Action (2005-2015), with interlinks with priorities for action, representing a transition to the implementation stage.

The new "Ten Essentials" listed below should be viewed as the key and interdependent steps that need to be undertaken in order to build and maintain resilience. The first three Essentials are the foundation blocks from which all other Essentials can be acted upon, in parallel. Essentials 4-10 are, therefore, not presented in a specific sequential or prioritized order:

<u>Organise for disaster resilience</u> - Put in place an organizational structure

and identify the necessary processes to understand, and act on, the reduction of exposure, its impact and vulnerability to disasters;
Identify, understand and use current and future risk scenarios - City governments should identify and understand their likely risks, including hazards, exposure and vulnerabilities, and use this knowledge to inform decision making;
Strengthen financial capacity for resilience - Understand the economic impact of disasters and the need for investment in resilience. Identify and develop financial mechanisms that can support resilience activities;
Pursue resilient urban development and design - The built environment needs to be assessed and made resilient as applicable, informed by the risks identified in essential 2;
Safeguard natural buffers to enhance the protective functions offered by natural ecosystems - Identify, protect and monitor critical ecosystems' services that confer a disaster resilience benefit;
Strengthen institutional capacity for resilience - It is important to ensure that all institutions that are relevant to a city's resilience have the capabilities they need to discharge their roles;
Understand and strengthen societal capacity for resilience - Ensure the understanding of and strengthening of societal capacity for resilience. Cultivate an environment for social connectedness which promotes a culture of mutual help through a recognition of the role of cultural heritage and education in disaster risk reduction;
Increase infrastructure resilience - Assess the capacity and adequacy of, as well as the linkages between, critical infrastructure systems and upgrade these as necessary according to the risks identified in essential 2;
Ensure preparedness and an effective disaster response - Ensure that the creation and updating of disaster response plans are informed by the risks identified in essential 2 and are communicated to all the stakeholders through the use of an organizational structure as per essential 1;
Expedite recovery and build back better - Ensure the existence of sufficient pre-disaster plans according to the risks identified and that, after any disaster, the needs of the affected are at the centre of recovery and reconstruction, alongside the support needed to design and implement rebuilding.

Foundations for these new essentials have been the need to organise for resilience, to identify, understand and use current and future risk scenarios, and to strengthen financial capacity for resilience.

The annex contains further details including a detailed description of each Essential.

IMPLEMENTATION OF THE 'TEN ESSENTIALS'

The outcome of any city development strategy should be sustainable and resilient systems, services and communities. Unfortunately, the relationship between sustainability and resilience is not clearly understood or applied and quite often "being sustainable" has also been incorrectly assumed as "being resilient". The confusion is brought about by a lack of standards in both disciplines and a lack of clarity in language and concepts resulting in fragmented and disjointed efforts to achieve sustainable and resilient communities (UNOPS, 2016). Cities progress with the new Ten Essentials can be reviewed through various tools. Through the monitoring of progress, the needs of cities can be identified and, thereafter, partnerships can be sought with those in appropriate positions, and with the expertise to assist with improvements.

In order to build resilience a common and shared understanding of what makes cities resilient must be established. If a city has certain characteristics or elements present it is likely to perform better than a city without them. The Ten Essentials define the elements or characteristics that need to be present in order for a city to be able to absorb, or recover quickly from, shocks and stresses. The indicators that support the essentials "measure" if these characteristics are present or not and to what degree they are present so that decision makers can get an indication of "how the city would perform if faced with shocks and stresses". In some instances this may require a qualitative approach in assessing the degree to which the characteristic is present or not. Each Essential covers one characteristic. However, in order to understand to what degree it is present, a number of sub-indicators are used to reflect the makeup of the main characteristic. The sub-indicators should be assessed and a qualitative score set with reasons given. This will provide more granularity and substance for each of the main indicators.

This process establishes a "baseline" at multiple levels. Strategically, it provides cities with a clear guidance for determining the priorities for action while, at the sub-indicator level, it enables gaps or weaknesses to be identified so that remedial actions can be taken in order to build resilience in a coherent and systematic fashion. Output indicators that will enable progress to be measured on specific actions within each element can be defined action by action.

Furthermore, the new Ten Essentials are in line with the focus of the second phase of the Making Cities Resilient campaign. Starting in 2016, this phase will be dedicated to implementation, aiming to ensure that the commitments made by governments are integrated into the local context. Serving as a means for implementing the Sendai Framework and the Sustainable Development Goals (SDGs), the Campaign will shift its focus to implementation support, to partners' engagement, investment-cooperation opportunities, local action planning and the monitoring of progress.

The Campaign will continue to advocate widespread commitment by local governments in the building of resilience to disasters, aiming to reach 5,000 city-local government participants by 2020 with at least 500 of them developing and implementing DRR and resilience strategies. Standardized approaches to resilience such as the checklist for the new "Ten Essentials" and corresponding indicators, targets and a reporting process applicable to all cities will be introduced.

Private sector partners will also be targeted as well as looking for connections with local governments and other development partners to actively contribute to the development of products and services, and the tools and technical support required for innovative urban risk reduction solutions.

CONCLUSION

Local governments and local authorities are key to building urban resilience. They are well placed to understand the local/national context, to leverage public interest in climate change once specific risks become salient, and to plan for, and implement, resilience measures. However, local governments face complex and interrelated challenges in attempting to take effective action such as a lack of coordination between different departments, a lack of clear authority (even with devolved responsibilities) and a lack of capacities to carry out policies effectively.

The Ten Essentials will assist local governments and local authorities in building urban resilience (by assisting them in identifying gaps and priorities), in building up the trust of their investors and, consequently, in reducing losses both to human lives and investments.

Since 2010, the Making Cities Resilient Campaign has served as the primary means of supporting the implementation of disaster risk reduction at a local level. Among global initiatives, the Campaign is unusual in its focus on both urban and local governments which are seen as the “front line” in disaster risk reduction. The Campaign promotes: resilience-building in cities through many mechanisms, including raising awareness of DRR among local governments through high-profile events; providing tools, technical assistance and training for local authorities and facilitating city-to-city support networks and learning opportunities, including building on experiences gained from previous disasters and refining local sustainable disaster management systems; the use of cost effective local resources; participatory institutional systems for effective disaster management; mediation with national agencies to bring in locally relevant scientific advancements for effective disaster management, and interaction between local communities and national governments to implement policy changes in order to support locally relevant development measures.

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Annex – The New "Ten Essentials"

E#	Essential	Description
	Organise for disaster resilience.	Put in place an organizational structure and identify the necessary processes to understand and act on reducing exposure, its impact and vulnerability to disasters. Recognizing that the exact format/structure will vary within and between countries, this will include but is not limited to: Establishing a single point of coordination in the city, accepted by all stakeholders (see below). Exercising strong leadership and commitment at the highest elected level within the city authority, such as the Mayor. Ensuring that all departments understand the importance of disaster risk reduction for achieving the objectives of respective departments' policies and programmes and identifying measures to reduce disaster risk within the departments' roles and responsibilities, and that they have a framework within which to collaborate as required. Engaging and building alliances with all relevant stakeholder groups including government at all levels (e.g national, state, city, parish or other subdivisions, neighbouring cities or countries as applicable), civil society and community organizations, the private sector. Engaging and learning from other city networks and initiatives (e.g. city to city learning programmes, climate change, resilience initiatives, etc.) Establishing necessary strategies, acts, laws, codes or integrating resilience qualities into existing policies aimed at preventing the creation of risk and the reduction of existing risk. Creating policies to gather and manage data for sharing amongst all stakeholders and citizens. Ensuring that all city government discussions routinely capture resilience implications; that the resilience implications of policies and standards in use are also assessed, and that action is taken upon these as needed. Putting in place reporting mechanisms that capture key information about resilience and promote transparency, accountability and improved data capture over time.
	Identify, understand and use current and future risk	City governments should identify and understand their risk scenarios, and ensure that all stakeholders both contribute to, and recognize, these. Risk scenarios should identify hazards, exposures and

	scenarios	vulnerabilities in at least the most probable and most severe (worst-case) scenarios, paying particular attention to the following: How hazards might change over time given the impact of factors such as urbanization and climate change; how multiple hazards might combine; and how repeated small scale disaster events (if there is a relevant risk of these) might accumulate in their impact over time. Geographic areas exposed and territorial impact; Population segments, communities and housing exposed Economic assets and activities exposed including their impact on the society, health, education, environment, and cultural heritage. Critical infrastructure assets exposed and the consequent risk of cascading failures from one asset system to another (for example, where loss of power prevents water being pumped or weakens the hospitals' system). Timescales over which risks, vulnerabilities and impacts occur and responses are required. Creation and publication of risk and exposure maps detailing the above. Scenarios should be: A means for current and future investment decisions. Based on participatory processes that seek input from the full range of stakeholders (including ethnic and social groupings). Regularly updated. Widely communicated and used for decision-making purposes and the updating of response and recovery plans.
	Strengthen financial capacity for resilience	Understand the economic impact of disasters and the need for investment in resilience. Identify and develop financial mechanisms that can support resilience activities. Key actions might include: Understanding and assessing the significant direct and indirect costs of disasters (informed by past experience, taking into account future risk) and the relative impact of investment in prevention rather than incurring more significant costs during recovery. Assigning a ring-fenced capital budget for any major works found to be necessary to improve resilience. Including risk management allocations in operating budgets as required to maintain the required state of resilience over time (including supporting the actions set out in the Ten Essentials). Assessing disaster risk levels and the implications coming out of all the planning and capital spending decisions, and adjusting those decisions as needed. Creating incentives for homeowners, low-income families, communities, businesses and the public

		sector to invest in reducing the risks they face (e.g. business continuity planning, redundancy, building upgrades). Applying for (and if necessary, generating) insurance coverage for lives, livelihoods, city and private assets. Exploring as needed innovative financing mechanisms such as specialised bonds, specialised insurance, tax efficient finances, development impact bonds, etc.
	Pursue resilient urban development and design	The built environment needs to be assessed and made resilient as necessary. Building on the scenarios and risk maps from essential 2, this will include: Land zoning and the management of urban growth to avoid exacerbating resilience issues; the identification of suitable land for future development taking into consideration how low-income groups can access suitable land. Risk-aware planning, design and implementation of new buildings, neighbourhoods and infrastructure using innovative or existing/traditional techniques as applicable. Addressing the needs of informal settlements including basic infrastructure deficits such as water, drainage and sanitation. Assessing infrastructure for resiliency to potential hazards; incorporating appropriate retro-fitting of prevention measures. The development and implementation of appropriate building codes and guidelines for heritage structures. Education about hazard-resistant building practices for all construction sector actors. Integrating the protection of cities' natural and cultural heritage. Maximizing the use of urban design solutions (such as impermeable surfaces, green areas, shadowing, water retention areas, ventilation corridors, etc) that can cope with risks and also reduce the dependency on technical infrastructure like sewage systems, dikes, etc. Engaging affected stakeholders in appropriate and proportional participatory decision-making processes when making urban development decisions. Incorporating exemplary sustainable design principles into new developments. Link to other existing standards where appropriate (BREEAM, LEED, Greenstar, etc). Updating building regulations and standards regularly (or periodically) to take account of changing data and evidence on risks.
	Safeguard natural buffers to enhance the protective	Identify, protect and monitor critical ecosystems' services that confer a disaster resilience benefit. Relevant ecosystem services may include, but are not

	functions offered by natural ecosystems	limited to, water retention or water infiltration; afforestation; urban vegetation; floodplains; sand dunes; mangroves and other coastal vegetation, and pollination. Many ecosystem services that are relevant to a city's resilience may well be provided outside its geographical area. This Essential includes: Recognising value and benefits from ecosystem services for disaster risk prevention and protecting and/or enhancing them as part of risk reduction strategies for cities. Integrating ecosystem services to enhance more urban resilience into urban land use management, urban design and into relevant investment projects. Considering also natural buffers in the rural hinterland of cities and their wider region, and cooperation with municipalities there to establish a regional approach to land use planning in order to protect the buffers. Anticipating changes from climate trends and urbanization and planning to enable ecosystem services to withstand these.
	Strengthen institutional capacity for resilience	It is important to ensure that all the institutions relevant to a city's resilience have the capabilities they need to discharge their roles. "Institutions" include, as applicable, central, state and local government organizations; private sector organizations providing public services (depending on locale, this may include telephones, water, energy, healthcare, road operations, waste collection companies and others as well as those in a volunteering capacity or the equipment required in the event of a disaster); industrial facility owners and operators; building owners (individual or corporate); NGOs; professionals, employers' and labour organizations, and cultural institutions and civil society organizations (see Essential 8). Capacity should be developed across the five key DRR areas of understanding, prevention, mitigation, response and recovery planning. Factors affecting capacity will include: A shared understanding of roles and responsibilities. Skills, including, but not limited to, hazard/risk assessment, risk-sensitive planning (spatial and socio-economic), integrating disaster and climate risk considerations into project evaluation/design (including engineering design), co-ordination, communication, data and technology management, disaster management, response, recovery,

		assessment of structures post disaster, and business and services continuity planning. Training, based ideally on case studies how DRR can be implemented and what business continuity requires. Creating and implementing information and data frameworks for resilience and disaster risk reduction that build can consistency in data capture and storage and can enable access to data, their use and re-use by multiple stakeholder groups for regular development processes.
	Understanding and strengthening societal capacity for resilience	Social "connectedness" and a culture of mutual help have a major outcome on the impact of disasters of any given magnitude. These can be encouraged by measures that include: Establishing and maintaining neighbourhood emergency response groups and training. Engaging and co-opting civil society organizations such as churches, youth groups, clubs, advocacy groups (for example, for the disabled). Providing community groups with "unvarnished" data on risk scenarios, on the current level of response capabilities and thus on the situation they may need to deal with. The formulation of neighbourhood plans by reference to such groups (see Essential 9). Offering education, training and support to such groups. Undertaking formal or informal censuses of those who may be vulnerable and less able to help themselves in each neighbourhood, and understanding from them what their needs are. Using government "touch-points" with the public (such as welfare or social services' visits) and offices, police, libraries and museums to build awareness and understanding. Ensuring that the education curriculum within schools, higher education, universities and the workplace includes disaster awareness and training. Recognizing the role of cultural heritage in building resilience and in protecting the sites, structures and artefacts they represent. Engaging with employers and using them as a communications channel with their workforces for disaster awareness and training. Engaging with local media in capacity building (TV, print, social media, etc). Mobiles (phones/tablets) and web-based "systems of engagement" (for example, crowd sourcing or disseminating data on preparedness). The translation of all materials into all languages used in a city.
	Increase	Understanding how critical infrastructure systems will

	infrastructure resilience	cope with disasters the city might experience (see Essential 2) and developing contingencies to manage risks caused by these outcomes. This should be addressed via measures which include, but are not limited to: An assessment of capacity and adequacy in the light of the scenarios in Essential 2. For example, considering possible damage to parallel infrastructure (for example, the impact on evacuation capacity if one of two roads out of a city is blocked) and considering linkages between different systems (for example, the impact created if a hospital loses its power or water supply). Systematic triaged processes for the prioritization of retrofit or the replacement of unsafe infrastructure. Liaising with, and building connections between, infrastructure agencies (including those that may be in the private sector) to ensure resilience is considered appropriately in project prioritization, planning, design, implementation and maintenance cycles. Tendering and procurement processes that will include the resilience criteria agreed upon by the city and stakeholders and is consistent throughout. For emergency management infrastructure, an assessment of "surge" capacity – the ability to deal with suddenly increased loadings from law and order issues, casualties, evacuees, and so on. Protecting or supporting cultural and other sites of historical, cultural heritage and religious interest. Critical infrastructure includes that required for the operation of the city particularly that required specifically for emergency responses where different. Infrastructure required for the operation of a city includes, but is not limited to: Transport – roads, rail, airports and other ports. Vehicle and heating fuel supplies. Telecommunication systems. Utilities' systems (water, wastewater, electricity, gas, waste disposal). Health care centres, hospitals and other healthcare facilities. Schools and educational institutes. See pink highlight below Community centres, institutions. Food supply chain. Police and fire services. Jails. "Back office" administration – welfare payments, housing computer systems and the data which support the above cultural heritage sites and structures.

		The infrastructure required for any disaster response may include the above, plus (as examples): Emergency or incident command centres and associated communications and monitoring/situation awareness systems. These may include cameras, sensors and crowd sourcing mechanisms such as the reading of SMS and Twitter feeds. Additional fire, police and ambulance vehicles. The national guard or other military services. Earth and debris-removing equipment. Pumps. Generators. Sports facilities, school buildings and so on, that provide places of shelter. Mortuaries. Back-up computing facilities.
	Ensure preparedness and effective disaster response	Building on the scenarios in Essential 2, ensuring effective disaster response by, for example: Creating and regularly updating contingency and preparedness plans which should be communicated to all stakeholders through the structure in Essential 1 (especially including other levels of government and adjacent cities, infrastructure operators, community groups). Contingency plans should include law and order, providing vulnerable populations with food, water, medical supplies, shelter and staple goods (e.g., for housing repairs). Developing and installing detection and monitoring equipment, early warning systems and effective associated communication systems for all stakeholders and community groups. Ensuring the interoperability of emergency response systems with adjacent countries, between agencies and with neighbouring cities. Holding regular trainings, drills/tests and exercises on all aspects of the wider emergency response "system", including community elements and volunteers. The integration of risk reduction and emergency responses from engineers, contractors etc. in order to be able to effectively and efficiently engage in preparedness, response and recovery operations. Coordinating and managing response activities and relief agencies' inputs Ensuring in advance that a viable mechanism exists for the rapid, rational and transparent disbursement of funds after a disaster. Assigning and ring-fencing adequate contingency funds for post event response and recovery.
	Expedite recovery and	After any disaster: Ensuring that the needs of the survivors and the affected communities are placed at the centre of

	build back better	recovery and reconstruction, with support for them and their community organizations to design and implement rebuilding shelter, assets and livelihoods at higher standards of resilience. Planners should ensure that the recovery programmes are consistent and in line with the long-term priorities and development of the disaster affected areas. Recovery, rehabilitation and reconstruction can, to a considerable degree, be planned ahead of a disaster. This is critical to building back better and making nations, cities and communities more resilient to disasters. Pre-disaster plans for post-event recovery should cover the following including necessary capacity building, where relevant: Mechanisms for the integration of disaster risk reduction in all investment decisions on recovery and reconstruction. Providing shelter, food, water, communication and the addressing of psychological needs, etc. Limiting and planning the use of schools as temporary shelters. Identifying the dead and notifying next of kin. Debris clearing and management. Specific actions for the recovery of sectors including livelihoods, health, education, critical infrastructure, environment and ecosystems, psycho-social support, cultural heritage and governance issues (such as accountability, roles and responsibilities and corruption control). Taking over abandoned property. The management of local, national and international aid and funding, the coordination of efforts and the prioritizing and managing of resources for maximum efficiency, benefit and transparency. The integration of further disaster risk reduction in all investment decisions for recovery and reconstruction. Business continuity and economic rebooting. Systems to help communities integrate disaster risk reduction into the decisions they take to recover from a disaster in order to reduce future vulnerabilities. Learning loops: undertaking retrospective/post-disaster assessments to assess potential new vulnerabilities and to build learning into future planning and response activities.

IMPROVING THE RESILIENCE OF SMALL AND MEDIUM ENTERPRISES (SME'S)

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Organisations play a vital role in community recovery following disasters. They are the providers of goods and services needed in both response and recovery efforts; they provide employment and support the economic base of communities; and they contribute immensely to people's sense of 'normality' and psychological wellbeing. There is growing recognition of the importance of engaging the business community in resilience building efforts, however there are currently limited tools to incentivise and guide small and medium sized organisations to engage with resilience.
This paper describes the development of a major new initiative being undertaken by the Red Cross's Global Disaster Preparedness Centre (GDPC). This initiative aims to build the disaster resilience of small and medium-sized enterprises internationally. The GDPC, in partnership with Resilient Organisations, is developing a scalable and adaptable suite of business continuity tools and services to be used globally by the Red Cross and Red Crescent national societies. This presentation will offer insights into how agile design techniques can be used to create products that actively engage businesses in building response and recovery capabilities.

Keywords: Business Continuity, Disaster Resilience, Organisational Resilience, Risk Management

CONNECTIONS BETWEEN THE RESILIENCE OF THE BUILT ENVIRONMENT AND COMMUNITY

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Many resilience measurement methodologies are siloed into domain specific areas. The built environment's resilience has a large effect on community and individual resilience. Research on the interactions of built environment and community resilience is ongoing to determine the attributes of the built environment and community environments that support resilient societies. The Resilient America Roundtable of the National Academy of Science (US) has brought together experts in social and engineered science to start to address this challenging topic. To support this effort, the roundtable has initiated a Community Pilot Program in Cedar Rapids/Linn County, Iowa, Seattle, Washington, and Charleston, South Carolina in order to help understand the linkages between the built environment and community resilience. The pilot communities all have unique experiences and needs when it comes to building and maintaining community resilience. This paper will summarize the processes that were used to gather input from the Pilot Communities and how that data can be used to help communities become more resilient. The linkages between the resilience of the built environment and the resilience of communities will be examined with emphasis on how increased resilience in one of the two areas can support additional resilience in the other area. The characteristics of the built environment and communities that were seen to have been successful in building resilience will be discussed as well. Recommendations of expansion of the methodology will be provided.

Keywords: Communities, Built Environment, Resilience, Methodology

HEALTH RISK ANALYSIS OF INTERNATIONALY DEPOYING FIRST RESPONDERS FOLLOWING A NATURAL DISASTER

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ABSTRACT

This study bridges the gap of available information between the occupational health of first responders and the epidemiological studies of populations affected by the natural disasters. The study summarize health risks associated with natural disasters. The focus of this paper is on physical rather than mental health consequences following natural disasters.

Due to interdependent nature of many disasters and their location it is important for first responders to take a proactive role in their health hazard risk management and be personally responsible for taking appropriate mitigation and preparedness measures to reduce their risk of becoming a victim and further endangering health of the affected population.

With an increasing number of natural disasters occurring worldwide there is an increasing pressure on first responders to be prepared for the deployment. Natural disasters differ in their triggering event and effects they cause on the impacted communities. Geography also plays a role in the severity and likelihood of disasters. Health hazards associated with natural disasters are just as diverse. This paper includes a table of health hazards and is useful when put into a context of the type of natural disasters in which these hazards occur.

Keywords: first responder health, natural disaster, health risk, emergency preparedness

INTRODUCTION

Definition of health

The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2003). There are three models for studying health and disease; they are biomedical, sociological, and political economy, each having its scope and limitations (Birn, 2009, p133). Traditionally health is studied from a biomedical perspective where health and illness are studied on an individual level examining the root of the disease (Birn, 2009). In a sociological model, studies are focused on learning how a person understands health and the choices they make on a household level (Raphael, 2010). Finally, political economy models mainly focus on how politics and economics shape health (Raphael, 2010). For the purpose of this paper, the biomedical model is considered to be the most appropriate model.

Understanding natural disasters

Definition of a disaster is taken from the paper on "the role of the epidemiologist in natural disasters", by Sue Binder and Lee M. Sanderson which is an "event that causes adverse health impacts on a population; usually, but not always, causes widespread destruction to the environment; and occurs suddenly or over a relatively short period of time".

Disasters are generally divided into natural, man-made or technological events. Technological events can be intentional such as terrorist attacks, or unintentional which can be due to human errors or a consequence of a natural event. Unintentional events following a natural disaster were defined by Stacy Young and associates as natech events, which can release small or large amounts of hazardous materials into the air. Such releases from plants or industrial sites lead to higher health risks for the exposed population (Young, 2004). They further state that natech events are mainly preventable if mitigation actions are taken prior to disasters.

Disasters can be further divided into pre-impact, impact and post-impact phases. Each phase is associated with its own health hazards, which will be discussed later in this paper. It should be noted that only post-impact phase is relevant to internationally deploying first responders with few exceptions such as wildfires and draughts.

Natural systems and earth processes function independently of social systems, and disasters occur only when the two intersect (Burton, 1993). Their interaction does not have to result in a negative consequence and can be beneficial to the exposed population if they are properly protected. For example, a flood does not have to be destructive. It fertilizes the land, flushes out salts and toxins, recharges ground waters, and deposits sediment, among other benefits (Few, 2003). However, in order to decrease human suffering from floods, which are considered one of the deadliest disasters, mitigation and preparedness measures need to be adapted by vulnerable communities via installation of early warning system, channel controls such as dykes and flood walls, et cetera. It is at the intersection of natural events and vulnerable populations that loss of life, property and livelihood occurs.

There has been considerable progress with implementation of policies and mitigation measures to reduce future disasters. However, in her paper on "Disaster risk management", N. Nirupama stressed that in order to effectively and efficiently manage disaster risks, focus has to be on addressing vulnerability; which are "conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" while at the same time improving the resilience and coping capacity of populations. She defined disaster risk management as "a comprehensive approach involving the identification of threats due to hazards: processing and analyzing these threats; understanding people's vulnerability; assessing the resilience and coping capacity of the communities; developing strategies for future risk reduction; and building up capacities and operational skills to implement the proposed measures" (Nirupama, 2013).

Even though vulnerability is an immensely important subject to consider, this paper will not include analysis of local policies that led to the natural disasters since first responders will be arriving in the response stage of the disaster management and when any mitigation and preparedness measures have failed.

First responders

Natural disasters attract a lot of attention and can urge people to help in whatever capacity they can. People might opt to volunteers their time and expertise and be either (un) trained or may (not) be associated with an organization (not) established in the area. Before the 2004 Indonesian Tsunami there were only a handful of Non-Governmental Organizations (NGOs) present in the province of Aceh, Indonesia, however, following the disaster the number swelled to approximately 300 (Canny, 2005). Such an influx of volunteers does not always lead to positive effects. After the 2010 earthquake in Haiti there was an accidental introduction of Cholera bacterium, which led to an outbreak resulting in 8,300 deaths (Chin, 2011). It is believed that the outbreak started due to sewage leakage from a U.N. base housing Nepalese peacekeepers (CNN, 2013). It is, thus, imperative that first responders arrive at the site of events not only prepared physically and mentally for the deployment, but also healthy enough not to endanger vulnerable local population. Occasionally, first responders can become victims themselves and use resources originally allocated to the affected population. In 2014 during an Ebola outbreak, 375 health care workers became infected and 211 of them were killed (Cohen, 2014). When first responders become victims, not only are they using up resources delivered for the affected population, but is also reduced overall staff availability. It is from this standpoint, that first responders need to be aware of their health risks upon deployment and be personally responsible for taking appropriate mitigation and preparedness measures to reduce their risk of becoming victims themselves.

This paper will approach the study of first responder health risks by compiling epidemiological studies related to health effects due to the exposure to various pathogens or hazardous materials following a natural disaster. Research has been done on victims of natural disasters immediately after and years following an event. Separate studies exist on occupational hazards and health of first responders such as police, firemen and paramedics. This paper will combine the two types of studies together to create a comprehensive list of health hazards for first responders following natural disasters, which could be used as a tool by organizations and responders to assess their health risk prior to an international deployment based on the type of an event they are responding to.

This paper limited the definition of health to biomedical perspective which eliminated a number of factors influencing individual health, which further limited health risk analysis when considering geopolitical location of the disaster. Future studies should focus on exploration of political and social perspectives on pre-deployment health status of first responders.

DISCUSSION

As mentioned above natural disasters can be divided into pre-impact, impact, and post-impact phases (Binder, 1987). During the pre-impact phase, public health interventions have the most impact on saving lives. For example, most deaths following earthquakes are due to structure collapses, as a result city officials can decrease morbidity of the population by enforcing building codes appropriate for the area. This phase is characterised by mitigation and preparedness actions as summarized in Figure 1.

In the impact phase, health is affected by the release of energy of the event; be it either a volcanic eruption or a tornado. In this phase, vulnerable population will have the greatest suffering. In this phase, first responders will generally be local survivors of the disaster.

Finally, the post-impact phase includes secondary injuries usually to local and international first responders as they perform relief operations.

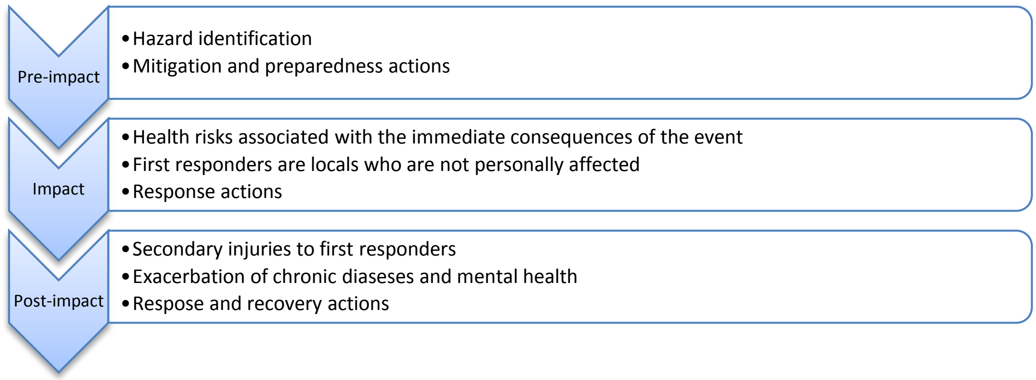

Figure 8 Natural disaster phases and factors affecting population health. Adapted from Binder, 1987.

Intersection of natural disasters with vulnerable population can lead to various health effects. In general, developing countries are more affected by health outbreaks due to pre-impact lack of resources and infrastructure (Watson, 2007, Waring, 2005), while natech events affect industrialized countries to a greater extend because of high population density living in close proximity to industrial sites (Young, 2004). Natural disasters can cause a high mortality rate, and there is a common myth that dead bodies pose a health risk, however it is only the case when a pathogen spread, such as cholera occurs by direct contact with infected body fluids (Watson, 2007). Biggest threat of epidemics post a natural disaster is due to overcrowding among the displaced individuals, poor ventilation, poor health status and immunization prior to the disaster as well was lack of safe water and sanitation, which leads to either respiratory or gastrointestinal diseases (Watson, 2007, Jobe, 2011, Birn, 2009). It should be noted that depending on the geographical location of the disaster, the same event can lead to different health risks. For example, a flood occurring in the developed world can cause an industrial spill potentially leading to an exposure to hazardous materials; on the other hand if flood occurs in the developing world there is an increased rate of gastrointestinal epidemics due to suboptimal sanitation and hygiene, as well as fecal contamination of drinking water (Watson, 2007). Health risk of first responders is thus dependant on the class of natural disaster as well as geographical location of the event.

Health effects can be classified into waterborne, crowding, vector-borne, wound and other diseases that are summarized in the table below (Table 1).

Table 10 Summary of various types of health hazards and their method of affecting individuals.

Health Hazard	Method of affecting health
Waterborne disease	Contamination of drinking water, poor sanitation and crowded shelters (Watson, 2007, Waring, 2005). Cases are reported following flooding or other related displacement.
Crowding conditions	Common if population is displaced by natural disaster, occur due to a high number of people who are potentially malnourished living in close proximity to each other with poorly ventilated areas (Watson, 2007, Waring, 2005).
Wound related disease	Occur when wounds become contaminated in people who have not been immunized in the last 10 years. People who are at risk are both victims and first responders if they are working with natural disaster debris.
Other diseases	Fungal contamination of the found in soil when individuals are exposed to airborne dust (Watson, 2007)
Vector-borne disease	Occur when new breeding sites for vectors (mosquitos) are created by standing water as well as due to disaster related displacement individuals changing their living habits (i.e. sleeping outside) thus increasing their risk of being infected (Watson, 2007). Onset usually occurs up to 8 weeks following a disaster (Waring, 2005).
Natech events	Increase risk of epidemics in cases of power failures which can lead to failure of water treatment and supply facilities, thus increase the risk of waterborne diseases and disrupt functioning of health facilities and vaccine preservation (Watson, 2007).

Canadian Centre for Occupational Health and Safety recommends breaking health risks into hazards, example of hazards and harm they cause (CCOHS, 2009). Applying the CCOHS framework to Table 1 and combining it with disease and risk factors following the emergency information presented in the WHO paper on “Moving beyond the Tsunami, a WHO story” Table 2 presents health hazards and associated harm following natural disasters.

Table 2 Health hazards and their harm to human health. Information compiled from WHO, 2005, Young, 2004, Watson, 2007.

Health hazard	Health hazard example	Associated harm	Comments
Overcrowding	Inadequate shelter	Crowding diseases	Overcrowding is exacerbated by poor immunization
Food insecurity	Malnutrition	Acute respiratory infections	
		Vitamin deficiency and associated diseases	
Poor quality or quantity of water	Poor hygiene Poor washing facilities Poor sanitation	Waterborne diseases Wound related diseases	
Standing water	Increased exposure to mosquitoes Increased number of breeding sites	Vectorborne diseases	Population movement and interruption of vector control measures increases risk of vectorborne diseases
Inadequate health care services	Disruption of basic services		Waterborne diseases Crowding diseases
Debris	Open wound or lacerations Trauma and injury	Wound related diseases Infections	
Natech	Toxin release	Exposure to harmful toxins	
Infrastructure damage	Electricity	Electric shock Burns	
Power outage	Improper use of indoor generators, heaters or cooking devices	Carbon monoxide poisoning	

Natural disasters can have direct impact on health, such as dangers associated with flooding itself; or they can cause secondary disasters which can be of technological nature (i.e. contaminated water supplies) or secondary natural disaster such a landslide following an earthquake.

Occurrence of natural disasters is not evenly distributed. Hydrological disasters constitute 44% of all natural disasters (Figure 2), while geophysical disasters happen approximately 8% of the time and thus requires special consideration during training and deployment preparations.

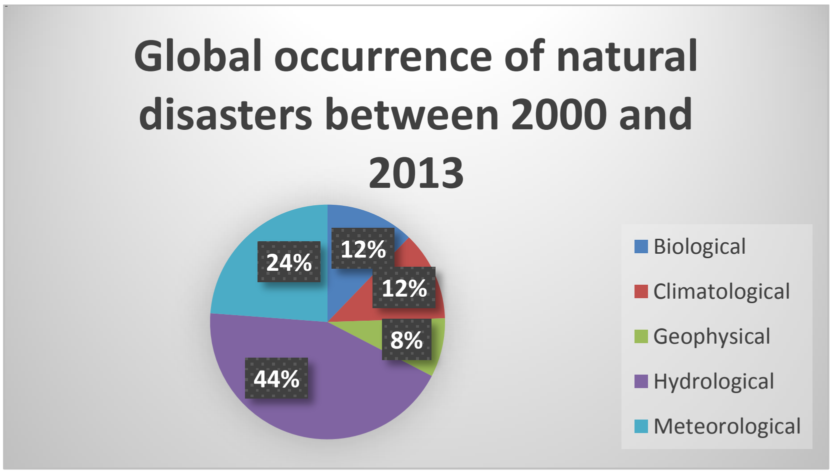

Figure 9 Global distribution of types of natural disasters between the years of 2000 and 2013. Data compiled from EM-DAT website.

Distribution of natural disaster consequences depicts the relative distributions of damage associated with each type of a disaster (Figure 3). In this view, biological disaster causes a lot of injuries and deaths, however it does not affect many people, and doesn't leave many homeless. Hydrological disasters, on the other hand, affect a lot of people and leave many homeless, while not causing as many injuries or deaths. Each disaster, thus, presents unique distribution of consequences and adequate preparation depends on understanding health risks associated with each type of disaster.

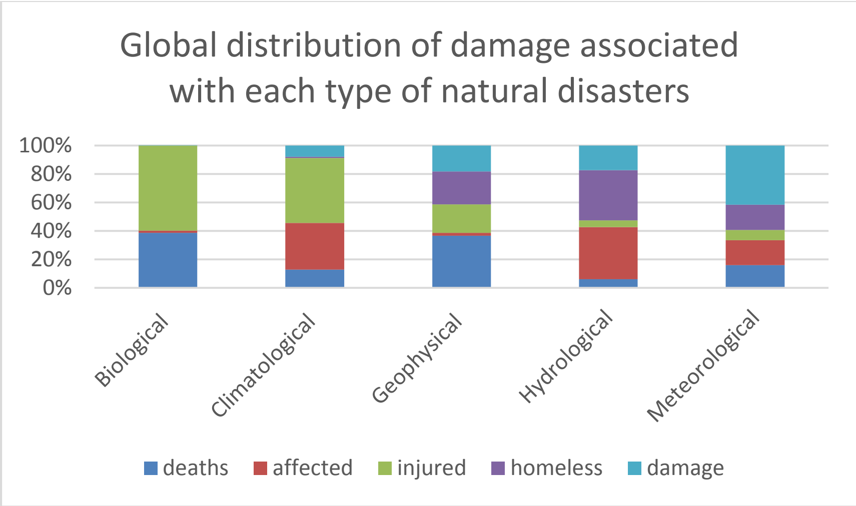

Figure 10 Relative consequences of natural disasters divided into their types. Data gathered from EM-DAT website.

CONCLUDING ARGUMENTS

Natural disasters differ in their triggering event and effects they cause on the impacted communities. Geography also plays a role in the severity and likelihood of disasters. It is estimated that a nation in Asia is 28.5% more likely to experience a disaster in any given year than Africa (Kahn, 2005). Health hazards associated with natural disasters are just as diverse. Primary health hazards that were presented in Table 2 have been expanded based on natural hazard risks and are presented in Table 3.

Table 3 Updated table on health hazards associated with natural disasters based on information presented in the text.

Health hazard	Health hazard example	Associated harm	Comments
Overcrowding	Inadequate shelter	Crowding diseases	Overcrowding is exacerbated by poor immunization
Food insecurity	Malnutrition	Acute respiratory infections Vitamin deficiency and associated diseases	
Poor quality or quantity of water	Poor hygiene Poor washing facilities Poor sanitation	Waterborne diseases Wound related diseases	
Standing water	Increased exposure to mosquitoes Increased number of breeding sites	Vectorborne diseases	Population movement and interruption of vector control measures increases risk of vectorborne diseases
Inadequate health care services	Disruption of basic services		Waterborne diseases Crowding diseases
Debris	Open wound or lacerations Trauma and injury	Wound related diseases Infections	
Natech	Toxin release	Exposure to harmful toxins	

Health hazard	Health hazard example	Associated harm	Comments
Infrastructure damage	Electricity	Electric shock Burns	
Power outage	Improper use of indoor generators or heaters	Carbon monoxide poisoning	
Lightening	Delivery of electrical current	Fire Burns Death	
Hail	Fast falling large icicles	Properly damaged Killed livestock	
Wind	Properly damage Projectiles Knocked down trees Knocked down power lines Knocked down mobile homes Unsafe traveling conditions	Injury from the projectiles Trauma during clean up Electrical burns Power outage (see above) Debris (see above)	
Snow	Building collapse Downed trees/power lines (see above) Isolation of homes in rural communities Poor driving conditions	Debris (see above) Motor-vehicle accidents	
Dust	Elevated soil or sandstorm	Poor visibility Respiratory diseases Acute respiratory infections	
Heat stress	Inability to lower internal body temperature	Skin eruption Heat fatigue Heat cramps Heat syncope Heat exhaustion Heat stroke	

Table 3, thus, answers the research question and presents information on health risks that internationally deploying first responders could face following a natural disaster. This information is useful when put into a context of the type of natural disasters in which these hazards occur.

Since many natural disasters occur alongside others, Table 4 summarizes commonly co-occurring events.

Table 4 Natural disasters that occur alongside other disasters.

Flood	Mass movement	Wildfire	Tornado	Strong winds	Tsunami
• Blizzard followed by a tempearture increase • Tropical cyclone • Tsunami • Local storms	• Volcanic eruption • Earthquake • Melting snow • Rain downpoor • Hurricane • Tsunami	• Heatwave • Drought • Lightening	• Thunderstorm • Hurricane	• Winter storm • Hurricane • Blizzard	• Volcanic eruption • Earthquake • Meteor impact • Underwater explosion

It would be beneficial for first responders to familiarise themselves with health hazards associated with each disaster presented in the first row of

Table 3 since it is likely their response will involve one of these events. Similarly, there may be unique health effects for some events and organizations should consider All-Hazards Planning when preparing their teams for deployment.

There are few disasters in which first responders might arrive during the impact stage, such as a heat wave, drought or a winter storm. However, most of the time internationally deployed first responders will be arriving in the post-impact stage. Majority of natural disasters are associated with some level of property damage and population displacement. As a result it is crucial to ensure that first responder's immunizations are up-to-date, personal protective gear is available and the responders are adequately trained in its usage to ensure that donning and doffing does not result in contamination.

Finally, natech events present a particular complication since their presence is dependent upon the geo-political locale of the country in distress. Developed countries are at a higher risk of natech events because of the close proximity of industrial sites to communities with high population density. Identifying locations of these sites prior to deployment would decrease the risk of toxic exposure by allowing first responders to take appropriate preparedness and mitigation measures.

Pre-deployment health of first responders is also of importance since disasters such as wildfires and volcanic eruption can exacerbate pre-existing conditions. Organizations might opt to not deploy vulnerable responders to ensure their continual health.

First responders should be in their most optimal health pre-deployment since biomedical approach to health studies omits other important aspect of the determinant of health. This paper attempted to compile a comprehensive list of health hazards associated with natural disasters with the hope of providing practical reference to future responders.

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ENGINEERING DESIGN PARAMETERS FOR TRANSITIONAL SHELTER STRUCTURES IN THE PHILIPPINES

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ABSTRACT
Temporary shelters are required almost immediately after the occurrence of a disaster, hence limiting the time for conceptualization, design and construction of such structures. Such limitation, however, should not lead to a compromise in the safety of the shelter. These structures should not be designed with similar engineering parameters as in permanent structures as it may result to uneconomical and impractical design. Higher design loads result to higher strength requirements and sizes for structural members; thus, increasing the weight and cost of the shelters. This also impedes the rapid deployment of such structures. Design standards in some countries recognize this and applicable reduction factors for lateral loads, specifically wind loads, were derived based on the annual probabilities of exceedance of specific events. However, in terms of scope, these codes specify that the standards are not applicable for temporary residential structures that would be used beyond six months up to five years. The wind load provisions of the National Structural Code of the Philippines are based on historical data from weather stations in the country, indicating the 3-sec gust wind speeds with the probability of exceedance of 0.02 or 50-year return period. As this method generally applies to permanent structures, there are no established design parameters yet for temporary residential structures such as emergency and transitional post-disaster shelters. Based on the statistical analysis of wind speed data, a reduced wind speed of 78% of the Code-specified value is recommended for design of transitional shelters for a 5-year design life. However, considering the limited available wind speed data and taking note of the 2-year average duration of stay in transitional shelters, ASCE-7 recommended reduction factor of 66% may be used.

Keywords: transitional shelters, temporary shelter, structural design parameters, Philippines

INTRODUCTION
Disaster events usually entail scenarios where affected people are displaced from their houses, either when their houses get damaged or when they have to be temporarily relocated. Shelter types that arise after

a disaster event differ on the kind of hazard and the nature of the disaster. Generally, these temporary structures are categorized into three: emergency, transitional and progressive.

Emergency shelters are designed to provide the most basic shelter support immediately after a disaster event. (International Federation of Red Cross and Red Crescent Societies (IFRC), 2013). Emergency shelters may be in a form of a tent, a school building or an open space where the displaced people may stay for a short period of time. This type of shelter is often used in the aftermath of a disaster, thus the comfort, sanitation and privacy are not taken of utmost importance.

Transitional shelters are designed to be used longer than emergency shelters up to a period of two years. (The Sphere Project, 2004) This type of shelter is typically built on leased lands. These shelters are designed as a rapid shelter solution where speed of construction and cost effectiveness are of utmost importance. Due to these, the lifetime of the shelter is limited. Temporary or transitional shelters can provide appropriate shelter which can be dismantled when the affected population could already return to their original homes or go to their resettled homes.

Progressive shelters are post-disaster shelters typically built on permanent sites specifically designated for housing projects. This type of shelter is designed in a way where future alterations or upgrades may be made. A progressive shelter is also a rapid shelter solution; the only difference is that it could be upgraded to be a permanent shelter.

One of the challenges faced by the government in reconstruction and relocation of displaced families is the availability of land. Finding land that are suitable for permanent resettlement since acceptable sites should be titled and should be in safe areas not easily vulnerable to natural hazards and secured appropriate clearances. Aside from selecting appropriate site for permanent housing programs for displaced population, procurement process and securing permits and licenses from agencies takes time (Housing and Urban Development Coordinating Council, 2015). Because of this, transitional shelters are the most prevalent mode of post-disaster housing in the Philippines.

The Sphere Handbook: Humanitarian Center and Minimum Standards in Humanitarian Response (2004) prescribes that a shelter should provide security, personal safety, protection from climate and resistance to ill health and disease. Shelter Centre Transitional Shelter Standards 2009 states that the design of a shelter shall be consistent with known climatic conditions and is capable to withstand loadings due to natural phenomena. For durability of a transitional shelter, it must last for a minimum of 36 months from the moment of deployment. Shelter Cluster Philippines recommends a shelter life-span of two to five years.

There is, however, no clear standard for the design of transitional shelters because the National Structural Code of the Philippines (NSCP) only set standards for permanent structures. There is a need to establish a set of design parameters for transitional shelters that is applicable ~~to~~ in the Philippine setting.

This will not only lead to better structural performance of post-disaster housing but will also contribute to broaden the knowledge in designing temporary housing structures.

METHODOLOGY

To propose structural design parameters for transitional shelters that can be deployed in the Philippines, current and existing local and international guidelines, standards, and designs were reviewed in terms of design, construction methods materials, and design load factors.

The design of existing transitional shelters in the Philippines deployed after typhoon Haiyan in Tacloban and the 2013 earthquake in Bohol were assessed. Field surveys and consultations as part of the assessment of shelters were conducted to come up with the proposed design parameters especially on structural system and construction method. End-users were surveyed regarding comfort ratings on covered shelter area and shelter materials. Some shelters whose coordinators were present at the site were interviewed regarding construction method, buildability, and any design parameter set for each shelter type. Traditional construction method used coconut lumber as frame member and "sawali" (bamboo matting) or plywood as wall material.

Figure 11 Existing Transitional Shelters in Leyte and Samar, Philippines

Probabilistic approach using Gringorten estimation for a Gumbel distribution used by Statistical Engineering Division, National Institute of Standards and Technology (NIST) to model extreme wind data sets for non-directional wind speeds in the US (Simui, Changery, & Filliben, 1979) was used in this study. The data consist of maximum annual wind speed data regardless of wind direction. The model estimation parameters are as follows:

Table 11 Gringorten Estimation model parameters for a Gumbel Distribution

Parameter	Description
V	Maximum annual wind speed sorted from lowest to highest
M	Rank of wind speeds from lowest to highest
N	Total number of annual maximum observations
Pv (Gringorten Estimation)	(m-0.44)/(N+0.12)
-ln (Pv)	Negative of natural logarithm of Pv
-ln (-ln(Pv))	Negative of the natural logarithm of Pv taken twice

RESULTS AND DISCUSSION

The resilience of a structure against natural hazards can be mitigated through proper design standards. Codes and standards generally set the design parameters for each structure type.

Permanent versus Transitional Shelters

Basic design loads consist of dead load, live load, seismic and wind loads. The primary code basis for the NSCP after the 1992 edition shifted from Uniform Building Code (UBC) to American Society of Civil Engineers' Standard 7, "Minimum Design Loads on Buildings and Other Structures" (ASCE 7). Major change in this transition was mainly due to the shift in the wind design methodology to consider the dynamic affects for wind-sensitive structures and use of the 3-second gust speed rather than the fastest wind speed. However, there is no provision on the NSCP regarding temporary or transitional shelter design.

Designing transitional shelter structures for full loads similar to permanent structures would result to uneconomical and impractical solutions. Higher design loads would require bigger structural members; thus, increasing the weight and cost of the shelter. Transitional shelters should preferably be made of lightweight and economical materials to provide immediate assistance to displaced people.

Design parameters for light weight temporary structures are not as readily available as those for permanent structures. Some design standards consider options to reduce the lateral loads (i.e. wind and seismic loads) as these are incurred by natural phenomenon and their probability of occurrence would be different in the design life of temporary and permanent structures.

The Transitional Shelter Standards by Shelter Centre specified that the erected shelter should be able to withstand a wind speed of 18 m/s (64.8 kph) which is significantly less than the design wind speed in the NSCP. Temporary shelter prototypes designed by different international organizations used different design speeds. For better comparison, Table 12 shows the various design wind speeds and the conversion factors for reducing wind speeds.

Table 12: Design Wind Speed References

References	Design Wind Speed (kph)
National Structural Code of the Philippines 2010	150, 200, 250
Transitional Shelter Standards	64.8
ASCE 7-05 (American Society of Civil Engineers, 2006)	Conversion factor of 0.66 for 5 year MRI

Lateral load reduction factors may also be determined from probabilistic method approach by analyzing actual data through extreme value theory. Applicable probability distributions include Generalized Extreme Value (GEV), Gumbel and Weibull distributions.

Existing Transitional Shelter Design Wind Speeds

Existing Transitional shelters have already adjusted design wind speed to reduce wind loadings as seen in Table 3. World Shelter's Transhel Proposal for the Haiti Relief used wind forces calculated as shown in Table 3 per International Building Code/ASCE-05 with Exposure Type as C (Open Terrain with scattered obstructions having heights generally less than 9.1m). Liina Transitional Refugee Shelter by Aalto University used the design wind speed of 25 m/s. Maddel's Pophut Shelter is designed to withstand 22 m/s wind for the shelter service life of 5-7 years.

Table 13: Existing

Transitional Shelter	Design Wind Speed
World Shelter	64.8 kph (18m/s), 79.2 kph (22m/s)
Liina Transitional Refugee Shelter	90 kph (25m/s)
Maddel Shelter	79.2 kph (22 m/s)

Statistical Evaluation of Available Wind Speed Data

Wind speed data from DOST-PAGASA for 1998 to 2013 with the rest of wind data for the other years obtained from Typhoon2000 were used in this study. Typhoon2000 is a third-party database of typhoon data from different sources such as Weather Philippines Foundation Inc., PAGASA, U.S. Navy's Joint Typhoon Warning Center (JTWC) based in Pearl Harbor, Hawaii, United Nations' Regional Specialized Meteorological Centre (RSMC) Tokyo-Typhoon Centre (Japan Meteorological Agency), & Hong Kong Observatory. A statistical analysis of the wind speed data was done to obtain the appropriate load reduction factor for a 5-year design period for transitional shelters.

Maximum annual wind speeds from 1964 to 2013 were plotted in linearized form using Gringorten Estimation (Pv) for Gumbel distribution as shown in Figure 2 below. The wind speeds at different mean recurrence interval (MRI) as well as reduction factor based on a 50-year return period is shown in Table 4.

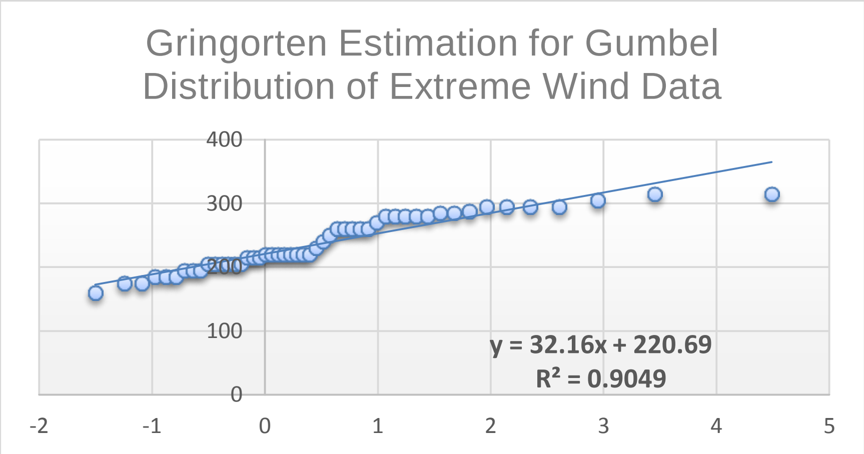

Figure 12: Gringorten Estimation for a Gumbel Distribution of Philippine Wind Data

Table 14: Wind speed from a Gumbel Distribution using Gringorten Estimation

MRI	x	Wind Speed	Factor
5	1.4999	268.92807	0.776852815
10	2.2504	293.0618132	0.846567986
15	2.6738	306.6778673	0.885900697
20	2.9702	316.2114792	0.9113440452
50	3.902	346.1763472	1
100	4.600	368.6307991	1.0648642

The resulting wind speed of 350 kph for 50-year return period is significantly higher than what is specified in NSCP, which is 250 kph for the same MRI. The generated estimate for a 5-year wind using Gringorten is around 78% of the 50-year wind, a higher relationship value compared to what was indicated in ASCE manual (66% of the 50-year wind).

The generated wind estimate using Gringorten may still be validated if the available annual wind speed per region is available rather than an annual wind speed for the whole Philippine archipelago.

Design Parameters for Transitional Shelter

The design parameters developed in this study is for a proposed transitional shelter for Philippine setting. The proposed transitional shelter consists of steel frame elements and connection systems that is quite different from conventional residential structures in the Philippines. Typical houses in the Philippines use reinforced concrete and lumber for construction, while the proposed Transitional Shelter utilizes hot-rolled and cold-formed steel as frame members with specialized connections. Design of members were therefore based on the steel design provisions of the NSCP.

The transitional shelter was designed to be modular for ease of installation and reusability, i.e. it is anticipated to be used after two years by one family and it could be deployed to another family who could be affected by another calamity. It can also be prepositioned in anticipation of an emergency situation.

Details of the structural design parameters are as follows:

Structural Material Properties

Frame members of the structure are to be of A36 hot-rolled structural steel and A653 Grade 33 Cold-formed steel. Material properties used were based on standard ASTM specifications.

Dead Loads

Dead loads considered includes self-weight of the frame members and superimposed loads due to the weight of the roofing materials. Dead load from flooring and wall were assumed to rest directly on the ground and were not considered in the design.

Live Loads

Values used for live loads were obtained from the NSCP. Live loads considered were 1.90 kPa for residential occupancy and 0.75 kPa for roof live load.

Wind and Earthquake Loads

Wind and earthquake loads were determined in accordance with NSCP 2010. As the transitional shelter is assumed to be deployed to any region in the country, lateral load parameters considered conservative assumptions (i.e. zone 1 on wind zone map with 250 kph design wind speed, predominant seismic and geologic properties in the Philippines) with a design life span of 5 years. Table 5 summarizes the seismic load parameters and Table 6 summarizes the wind load parameters. Pending the availability of sufficient wind load data per region, wind reduction factor per ASCE-7 of 0.66 was used in the design.

Load Combinations

The temporary shelter structure was designed to resist load combinations as stated in the NSCP. Load combinations include dead load in combination with live load, and wind or earthquake load.

Table 5: Summary of Seismic Load Parameters

Seismic Load Parameters	Value
Importance Factor, I	1.0
Soil Profile Type	S_c
Seismic Zone Factor, Z	0.40
Seismic Source Type	B
Distance to source	10 km
Near Source Factor, N_a	1.0
Near Source Factor, N_v	1.0
Resistance Factor, R	6.5 (Light-framed walls sheathed with wood structural panels/ sheet steel panels)

Table 6: Summary of Wind Load Parameters

Wind Load Parameters	Symbols	Value	Description
Design Wind Speed	V	165	Zone 1 with reduction factor of 0.66 (ASCE 7-05)
Wind directionality factor	K_d	0.85	Main Wind Force Resisting
Importance Factor	I_w	1.0	Occupancy Category IV
Exposure category	Exposure B		Ground surface roughness condition. As defined by surface Roughness B
Velocity pressure exposure coefficients	K_h and K_z	0.70	Exposure B, Case 1, height above ground=0-4.5m
Topographic Factor	K_{zt}	1.0	
Gust effect factor	G	0.85	
Enclosure classification			Enclosed Building
Internal pressure coefficient	GC_{pi}	+0.18 -0.18	For enclosed building

Wall pressure coefficient	C_p	0.80 (windward) -0.5 (leeward)	Use with q_z L/B=0-1; Use with q_h
Roof pressure coefficient	C_p	-0.3, 0.2 (windward) -0.6 (leeward)	For θ = 25°; h/L = 0.5 (0.46) For θ ≥ 25°; h/L = 0.5 (0.46)
Roof pressure coefficient (wind parallel to ridge)	C_p	-1.01, 0.18 -0.85, 0.18	From 0 to h/2 >h/2

CONCLUSION

In the absence of specific provisions for the design of temporary shelters in the National Building Code of the Philippines or in the National Structural Code of the Philippines, international design standards and literature from several international relief organizations were reviewed. Available wind data for the Philippines were also analyzed for possible guidance in the design wind speed.

Design parameters for dead load, live load, as well as earthquake load similar to permanent structures were used for transitional shelter design. Analysis of wind data for the Philippines suggested rather high wind loads, with 50-year wind speed higher than what the current National Structural Code prescribes for permanent structures. While the statistical analysis of available wind speed data indicated a 78% factor for wind speed, a reduced design wind speed of 66% of the 50-year wind speed following the ASCE-7 provision was followed considering the relatively small amount of wind speed data available and the temporary nature of transitional shelters. Load combinations prescribed by the National Structural Code of the Philippines were also adopted.

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SHARED LEADERSHIP AND RESILIENCE ENGINEERING – A TALE OF TWO TEAMS

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The purpose of this presentation is to demonstrate practical application and positive contribution of resilience engineering and shared leadership to the sustained resilience performance following a natural disaster.
This presentation brings stories of two acute clinical teams following their initial response to 6.3 magnitude earthquake in Christchurch, New Zealand. In the first example, author describes his personal experiences in utilizing resilience engineering and shared leadership while leading nursing team of one of the medical wards of Christchurch Hospital. The second example is based on published qualitative research conducted by the presenting author which describes shared leadership in the intensive care unit of Christchurch hospital. As transcribes from the conducted research and recorded personal experiences, shared leadership and resilience engineering assisted in achieving safe patients care in complex environment and provided an innovative framework, contributing to overall teams' resilience. To adopt these approaches and foster teams' resilience, managers need to articulate values and behaviours such as open and frequent communication, placing a high value on staff well-being, nurturing and empowering emergent leaders within teams. Shared leadership and resilience engineering played an important role in building adaptive resilience in both teams. They were not just a practical tool for crisis management but vital components of a genuine process of collaboration, learning and success.

KEY WORDS: Christchurch earthquake, resilience engineering, shared leadership

INTEGRATING DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION INTO THE BUILT ENVIRONMENT

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ABSTRACT

Recent disasters across the world have highlighted the fragility of the built environment to a range of natural hazards, including those that may be influenced by climate change. Moreover the rapid pace of urbanisation has increased concerns about the resilience of cities; with contemporary discussions considering how physical/protective interventions can be integrated into the built environment or, indeed, what types of interventions are most effective. Too often Disaster Risk Reduction (DRR) and Climate Change Adaption (CCA) have been treated as separate issues. Despite a shift to more pro-active and pre-emptive approaches to managing disaster risk, DRR appears to have been overly influenced by more reactive emergency management practices. At the same time, CCA activities have typically fallen within the realm of environmental sciences. As a result there appears to be critical disconnects between policies for CCA and DRR; often centered in different departments with little or no coordination. Moreover, there is a lack of integration of these policies within building regulations; the scope of which is largely limited to rigid restrictions in height and volume and specifications of materials and technology. Most often these building regulations are focused on the mitigation of a single hazard such as earthquakes, floods or cyclones.

This opinion paper will highlight the lack of integration between DRR and CCA in built environment related policies and regulations, and demonstrate how policy and regulations can be used to make DRR including CCA inputs from key built environment stakeholders more proactive and thus more effective.

Key words: *disaster risk reduction; climate change adaptation; built environment; policy*

INTRODUCTION

As pointed out by Wisner et al. (2012, p.31), the "natural environment is neither a hazard nor resource until human action makes it one or the other (or both)". Vulnerability is thus created not by the environment but by poor decision-making, practices (including construction practices) and planning. Natural hazards only become disastrous if a settlement (or any kind of a built environment) is located in a hazard-prone area, poorly constructed and/or does not have a warning system in place.

The built environment is one of the largest contributors to greenhouse gas emissions worldwide (Anderson et al., 2015) and at the same time it can be extremely vulnerable to the effects of climate change. This emphasises the increasing importance of the role of the built environment in reducing its negative contributions to climate change by making the building stock more energy efficient, and in adapting to the negative impacts of climate change by increasing resilience through investment in DRR measures (Lizarralde et al., 2015). However, while the concepts of climate change and DRR are widely discussed, it is not always clear to what extent these notions are interrelated. There appear to be fundamental conflicts between perspectives dominated by eco-efficiency (minimising the use of resources) and long-term resilience (robustness of built assets) to the impacts of climate change. This however does not mean that both these perspectives cannot be addressed simultaneously. It is becoming clear that DRR and CCA must go hand in hand - particularly when it comes to the planning, design, construction and operation of the built environment, with the references to both areas increasingly appearing in international guidance and reports.

Based on the extensive review of literature, this opinion paper will discuss the above mentioned issues by highlighting the lack of integration between DRR and CCA in built environment related policies and regulations in the UK, India, USA and Barbardos. It will highlight how policy and regulations can be used to make DRR including CCA inputs from key built environment stakeholders more proactive and thus more effective.

CCA, DRR AND THE BUILT ENVIRONMENT

An increasing number of international and national policy documents acknowledge climate change as a 'risk multiplier' (e.g. UK National Security Strategy), although it can also diminish risks, and as a result a large number of climate change mitigation strategies aimed at reducing greenhouse gas emissions (mainly by reducing fossil fuel consumption and introducing new renewable energy technologies) have been introduced in recent decades. Being a global challenge (and which can only be addressed globally), climate change has become a distraction from other equally important concerns, or 'creeping environmental problems' (Glantz 1994), such as resource overexploitation or inequality. Therefore whilst it is not appropriate to ignore climate change, it is important to bear in mind other hazards. CCA efforts should be seen as a part of the DRR agenda, with climate change being treated as one of the hazards (Kelman, 2015), although it is equally important not to overlook climate change mitigation.

The impacts of climate change on disaster risks are not only relevant to the increase in frequency and severity of a hazard, but also to encompassing vulnerabilities, as climate change rapidly affects local environments changing them in a way that local knowledge becomes less applicable (Kelman, 2015). Taking into consideration the possible effects of hazards and threats related to climate change and disasters that may affect the built environment presents a great challenge to both policy-makers and built environment professionals. They have to make a choice of either taking as a basis the upper limits of uncertainties provided by the projection scenarios, or continue with current practices therefore potentially reducing the lifetime of a structure. Whilst the former is a more effective adaptation strategy, it may be less cost-effective.

A large number of cities have introduced and applied numerous mitigation measures aimed at greenhouse gas emissions and energy consumption reduction, however only a few cities have been creative and productive in the realm of adaptation (Jabareen, 2015). This suggests that built environment professionals and policy-makers do not act enough to mitigate uncertainties from climate change and other natural hazards and human-induced threats. Instead of developing strategies for coping with risks, the vulnerabilities are often increased by decisions that do not take local context into account or are not appropriately enforced (Bosher, 2014).

Regulations and policies that address how the built environment is designed, planned and operated are critical for DRR including CCA, as the ways in which land is used and buildings and infrastructure are designed and operated influence exposure to hazards and threats. Once the investment in built assets in a risk-prone location has been made, it will remain there for a long period of time; in addition, once in place it is more expensive and less effective to correct and add new DRR measures than it would have been to avoid the creation of the risk in the first place (UNISDR, 2011). It is therefore clear that building regulations and planning policies can be a primary prevention, mitigation and adaptation mechanism.

During the past 25 years, building regulations and codes have been developed for virtually every type of construction; there are also an increasing number of informal guidance documents for the construction sector. They are constantly revised and improved, and the evidence shows that in those countries where building codes have been effectively applied, there is a dramatic improvement in performance of new construction (Krimgold, 2011). The majority of the current building codes and regulations and land-use planning policies take into account various hazards and threats (e.g. floods and storms, earthquakes). However whilst these policies and regulations have shifted towards addressing the root causes of vulnerabilities to disasters such as structural integrity of a building, they do not often do so explicitly and tend to focus only on a single hazard or one part of the problem. In addition, mandatory built environment policies are based on the historical trends and previous events thus neglecting future projections that are critical for effectively embedding CCA within DRR.

CHALLENGES AND OPPORTUNITIES FOR INCLUDING CCA IN DRR

DRR and climate change are addressed in separate policy arenas at international and national levels. However starting with Hyogo Framework for Action 2005-2015 and 2007 Bali Action plan, a number of efforts have been made to point out the importance of addressing DRR and CCA together (UNISDR, 2008). This has also been reemphasised in the Sendai Framework for DRR, and further strengthened during the COP21 meeting in Paris in 2015. For instance, the building code reviews, which usually reflect the most recent impact of a disaster event (be that natural hazard (e.g. an earthquake) or a human-induced threat (e.g. terrorism)), will now likely be made based also on future projections of change in wind speeds or height of storm surges, as well as other climate impacts.

However, despite recent debates for integrating CCA into DRR, there is hardly any evidence about technical and institutional challenges in practice (Davies et al. 2013). Around the world, solid frameworks for CCA and DRR exist, however these frameworks are not easily included into the built environment-related regulations and policies. There is a disconnection in the way that DRR and CCA are treated: for instance both CCA and DRR are often preparedness and response oriented, thus paying less attention to prevention considerations into a country's development and planning practices, and consequently not sufficiently mainstreaming DRR and CCA into policy-making.

Whilst the issues addressed under CCA and DRR policies relate to the built environment, the interventions are often planned and implemented by different ministries. Neither DRR nor CCA are a sector, as they require informed action across a number of sectors (from education to health to utilities). DRR is often handled by civil defence and emergency management departments, which do not have links with environmental or economic ministries that overlook national planning and climate-change related policies. In addition, DRR and CCA are not the sole responsibilities of these departments and therefore tend not to be at the top of their priority lists. This creates further challenges for the built environment when building regulations, codes, and planning policies are introduced, as often the contribution of both DRR and CCA into these policies is negligible. Moreover professional training of the built environment professionals does not mainstream DRR and CCA as these competencies are not required in order to follow the existing regulations.

Building regulations and planning policies present an excellent opportunity for incorporating CCA into DRR. However there are some challenges that can diminish the role of building regulations and codes in DRR. For instance, land use planning maybe ineffective if it is implemented at a local level but a given risk crosses legislative boundaries of that locality. In addition, planning processes are often long-winded and inconsistent with the rapid development of a city (this is particularly an issue in the middle- and low-income countries). Similarly, building codes and regulations often do not take local specifics into account, and their implementation is often hindered by a lack of required expertise and manpower within the local government to monitor and enforce the regulations (UNISDR, 2011). Governments are often reactive and slow in responding to the issues related to CCA and DRR, and although new improved regulations are introduced, there is often a lack of incorporation of older buildings' and infrastructure upgrade. The lack of government initiative also drives market barriers, as often risk-averse construction professionals are reluctant to invest in new technologies and practices that could be more appropriate in terms of CCA and DRR (van Heijden, 2014). Another issue is lack of implementation of these regulations and policies. Moreover these regulations and policies are not designed to address specific design and construction technologies as prevalent in various regions; their contextualisation thus indeed being a challenge. Another important challenge is a lack of stakeholder engagement, particularly in the private sector. DRR is often seen as a responsibility of emergency managers, however multi-stakeholder participation can increase the capacity and capability of those who take part in DRR. Involvement of various public and private stakeholders can also lead to and facilitate knowledge and experience sharing. It is essential to identify those stakeholders who can have a positive influence over DRR in the built environment at various stages of the design, construction and operation processes, including commissioning, operation and maintenance, as effective decision making requires an integrated understanding of how to avoid and mitigate the effects of disasters (Chmutina et al., 2014).

Tensions created by CCA and DRR policies

Whilst complementary, CCA and DRR policies create some tensions when addressing the challenges faced by the built environment, due to differing interpretations of terminology, institutional responsibilities and contextual differences:

Specific vs. broad scope: CCA policies largely focus on what can be achieved in terms of adapting to climate change-induced threats, in particular storms and floods. DRR policies put emphasis on the capacities that are (or should be) available in order to cope with a wider range of risks and threats, both natural and human-induced often regardless of their connection to the impacts of climate change.
Efficiency vs. redundancy: The overarching climate change agenda that informs CCA policies often endorses a lean approach to development and

streamlining processes that goes hand in hand with climate change mitigation, i.e. to reduce consumption and minimise environmental impacts. DRR policies are more open to the potential benefits of over-designing (i.e. using more material resources to increase robustness) in order to avoid damages and prevent disasters.

Emphasis on standards vs. emphasis on potential: CCA policies have been informed by, and focused on, globally accepted standards often neglecting local context. DRR policies are often driven at the local level and encourage the identification and reinforcement of local potentials and capacities of the system.

Reactive vs. proactive: CCA policies acknowledge that climate change will have a negative impact on the built environment and therefore suggests the ways of adapting to these impacts. DRR policies (at least on a theoretical level) acknowledge the importance of a more pro-active approach to dealing with risks.

Main areas in which synergies could and should be created

These tensions are important to consider, however a number of areas in which synergy can (but does not necessarily do so yet) complement both CCA and DRR is in relation to the challenges faced by the built environment.

Similar goals: CCA and DRR policies implemented at the local level essentially address the same issues.

Synergising CCA and DRR can provide a basis for the much needed *multi-stakeholder engagement*: currently CCA is mainly addressed by environment-related departments, whereas DRR is a responsibility of emergency managers, with the private sector and communities in many cases not being involved in decision-making at any stage. Multi-stakeholder engagement can bridge disconnected policy and practice by putting those at risk (e.g. businesses and vulnerable sections of society) to the forefront.

Knowledge sharing: Multi-stakeholder engagement will allow for the integration of scientific knowledge of the environmental (and other) professionals, local knowledge of communities that is prevalent in the DRR, and practical context-specific knowledge of the built environment professionals. In addition, CCA can draw from some of tools developed within DRR (e.g. risk monitoring).

Overarching DRR plans can employ a *holistic approach* by emphasising natural resource protection, land-use planning and building codes that also address reduced energy consumption.

Time scales: synergies between CCA and DRR would allow for the expansion of DRR’s efforts time horizon by utilising future projections developed as part of CCA. In doing this it could be easier to justify

investment in pre-emptive risk reduction considerations for future developments.
Budget allocation will be more effective if it is aimed at both DRR and CCA thus helping to reduce doubling efforts and increasing institutional effectiveness.

However in order to create these synergies, some basic challenges need to be overcome. These include existing institutional gaps and lack of coordination between various departments/ministries linked to DRR and CCA. Also there is challenge of using commonly understood vocabulary for DRR and CCA. Another common issue is the nature of financial allocations that are made under separate budget heads for DRR, CCA and other related areas thereby making it difficult to pull the resources for integrated planning and implementation. Last but not the least is the challenge of integrating CCA into DRR policies and programmes at national, district and local levels.

CONCLUSIONS

As demonstrated in this paper, the contribution of the built environment to climate change and CCA is well accepted in current building policies and regulations, however the risk reduction rationale in these regulations originates mainly from the past. This sets a challenge of expanding the current existing focus of building regulations: there is a need to incorporate a wider holistic ecological approach that looks at regional impacts and vulnerabilities and is not just limited to the performance of the built environment.

CCA and DRR initiatives currently work in silos, neglecting and underestimating their commonalities and goals, or being unable to overcome political constrains. Such a lack of synergy should not be ignored as it increases the risk of unsuccessfully reducing vulnerabilities of the built environment in the long run. Whilst there is enough understanding about how to place CCA within DRR, there is a lack of appropriate governance approaches and tools. This leads to multiple negative consequences, including duplicating efforts that lead to organisational inefficiencies and ineffective use of resources as well as counter-productive efforts, in particular by reinventing older approaches (Mercer, 2010).

In order to achieve a truly sustainable and resilient built environment it is critical to achieve an effective scale of hierarchically interdependent built elements. If such hierarchy is weak, the vulnerability of a built environment increases and therefore an impact of one hazard may exacerbate the impact of another hazard, thus creating a complex/compound hazard. Vulnerability continually increases in many places because the size and complexity of the built environment is increasing, with systems and networks planned, designed, constructed and operated without appropriate attention to the potential risks. Climate change presents an additional challenge and opportunity; therefore what were previously considered reasonable margins of safety in the traditional engineering approaches may no longer be relevant or effective.

Climate change has become a part of the built environment's political agenda nationally and internationally in many countries, and it therefore could act as a mechanism to attract attention of policy makers to DRR. This however has to be done carefully in order not to shift the agenda to climate-induced hazards only, but instead it is critical to make DRR part of the sustainability agenda. Whilst it is important to build a structure that is energy efficient and constructed using materials that have minimal impacts on the environment, it is equally important to make sure that it is not in a risk-prone area and is not going to be destroyed by the next earthquake or flood. DRR including CCA should play a bigger role in building regulations and planning policies.

Structural measures can predominate in DRR – but this is also appropriate for CCA. Incorporation of CCA into DRR in the context of the built environment can be imposed through effectively implementing, monitoring, and enforcing building regulations and codes and land use planning and zoning requirements, ensuring that responsibility for preventive, protective and mitigation actions lies with engineering and planning professionals. It can also contribute towards climate change mitigation. Planning policies also present a unique opportunity to integrate policies of mitigation, adaptation, land use and other sustainability-related measures in one legally binding document. However, it is important to incorporate ecological perspectives through adaptable design, which increases flexibility and durability of the built environment. Better integration of CCA into DRR can promote more structured and coordinated planning, construction and operation mechanisms and simultaneously provide support for overall sustainable development.

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MEASURING SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACTS OF ROAD STRUCTURE FAILURE

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ABSTRACT

With the occurrence of disasters caused by natural hazards rising in frequency and intensity, the importance of conducting research on the effect of disasters on major infrastructure becomes evident. Road infrastructure such as bridges, culverts and flood-ways play an important role before, during and after a disaster since providing access to affected areas is a vital factor influencing the evacuation, rescue, recovery and also reconstruction activities. Consequence assessment of disasters on road structures provides valuable information for decision makers to measure the potential risk on structures and to identify and implement appropriate strategies and programs to sustain the infrastructure. Assessment of social, environmental and economic consequences of failure of road structures provides necessary data to design road structures that are not only more resilient to natural hazards, but also sustainable in the long run. This paper reviews the current literature which focuses on measuring sustainability (i.e. social, environmental and economic) impacts of road structure failure due to disasters. The paper also analyses the strengths and weaknesses of relevant studies in order to understand the knowledge gap and to build a more rigorous, holistic model that could be used to assess sustainability impacts of failure of road structures in varied disaster scenarios.

Key words: *Natural hazards, Road infrastructure, Sustainability impacts*

INTRODUCTION

Natural disasters by definition, are natural events, which cause extensive economic loss or loss of life (Wisner, 2003), and as a result the impacts of disasters are commonly measured in terms of lives lost and / or economic costs caused by the event. However, damage to infrastructure, and its consequent reconstruction, can exacerbate the damage to the natural environment and thus reduce its ability to recover after a disaster. Therefore, when measuring the impacts of a disaster it is important to take into account the impacts the event has had on ecological systems as well.

As Holling (2001) illustrates, defining boundaries for these three systems can be a complex task as social, economic and ecological systems overlap each other frequently. This issue is further complicated by the fact that there is no common unit of measure for social and environmental impacts, while in contrast quantifying economic impacts is simpler.

As the scope of this paper is to review methodological research used to measure social, environmental and economic impacts of failure of road structures, categorisation of the impacts will only be done to ensure that all aspects will be incorporated and to minimise any double counting errors.

The impacts studied will be limited to the impacts caused by structural damage to the infrastructure and the usability of it at a local scale, while wider social, economic and environmental impacts of the disaster will be considered to be out of the scope of this paper.

MEASURING SOCIAL, ECONOMIC AND ENVIRONMENTAL IMPACTS OF DISASTERS

Economic impacts

Media reports on economic losses caused by disasters, even before rescue efforts have ended, can imply that economic impacts are easy to quantify. However such reports are mere estimates of the actual economic impact and can vary significantly from the empirically measured values. In addition most economic valuations tend to rely on insurance claims after a disaster or in the replacement value of damaged infrastructure (Pelling et. al., 2002). Therefore it is important to understand the current literature on methodological approaches to measuring economic impacts in order to use / develop a method which incorporates the most relevant economic data.

Costs of disasters have typically been categorised into direct and indirect based on the spatial and temporal effects; and as tangible and intangible based on the ability to measure the costs. (Gentle et.al., 2001 & Merz et. al., 2010).

Tangible costs are costs that have a market value which can be attributed to them and hence tangible costs, both direct and indirect, are often used to measure the economic costs of disasters.

Table 1: Classification of disaster losses

	Type of loss	
Measurement	Direct	Indirect
Tangible	Damage to infrastructure, buildings and contents, vehicles; destruction of harvest; damage to livestock; clean-up costs	Disruption of public services outside the flood area; cost of traffic disruption; induced production losses
Intangible	Death and injury, loss of items of cultural significance	Inconvenience and disruption, especially to schooling and social life; Stress

	and personal memorabilia	induced ill-health and mortality

Note: Adapted from Review article: Assessment of economic flood damage by Merz, B., Kreibich, H., Schwarze, R. & Thieken, A, 2010, *Natural Hazards and Earth System Science, 10,* 1697-1724.

The Bureau of Transport Economics (BTE)(2001) presented a framework to estimate economic costs based on standard costs obtained from an Emergency Management Australia (EMA) database. The disaster cost estimation principles used by BTE are useful as it is based on previous cost estimation principles developed by Australian authorities.

A major limitation of this framework is that the cost estimates used have been calculated based on insurance payments and media reports and not based on actual empirical data. In addition since the BTE report takes a national view on the economic losses some indirect costs such as business disruption costs have been excluded, even though such costs would need to be included when measuring economic costs at a local level.

In addition to direct and indirect costs Pelling et. al., (2002) adds another classification termed as secondary costs, which take in to account the overall performance of the economy as measured through the most significant macro-economic variables. Such indicators may include effects on sectoral and local GDP, levels of indebtedness and long term impact on public finances. However such costs will be harder to measure as they may be felt over a number of years after the disaster and would have to be de-coupled from impacts due to normal economic cycles.

Stephenson et. al., (2013) presented a Socio-Economic Impact Assessment Model for Emergencies (SEIA-Model), based on a Cost-Benefit-Analysis (CBA) approach, which addresses some of the deficiencies highlighted in previous models by taking a local approach to the impact assessment and by incorporating social and environmental costs into the model.

However by assigning monetary values to social and environmental impacts, social and environmental capital is regarded as directly tradeable with economic capital, which can be misleading. Hence it may be appropriate for social and environmental impacts to be measured separately from economic impacts.

Table 2: Summary of economic models discussed

Model	**Advantages**	**Limitations**
Economic cost estimation (BTE report)	Takes an Australian perspective Easily replicable	Not based on empirical data Cost estimates are out dated and based on insurance claims Ignores local costs
Cost Benefit Analysis	Incorporates intangible costs Uses opportunity cost	Assigns monetary values to social and environmental costs

	values	
Secondary cost analysis	Focuses on a wider temporal and spatial scale	Measurement can be subjective and hard to measure

Social impacts

Previous research on the quantification of social impacts of disasters, typically seek to assign a monetary value to social impacts (Stephenson et. al., 2013, Chang, 2003 and Chang et. al., 2009). Such quantification using a human capital approach, assigns values to human beings purely as economic actors and places a financial value on an individual based on the average contribution a person would have on the potential output of the economy.

Using a human capital approach to quantify social impacts can be beneficial, as it allows to integrate social impacts to a traditional economic impact assessment. Though such a method may add value to an economic Cost-Benefit-Analysis it can be very misleading as the quality of life of individuals affected by the disaster are not considered.

Lindell and Prater (2003) presented a resource-based approach to assess societal impacts of disasters, based on dependency relationships and the availability of resources after the disaster. This approach however is better suited for measuring resilience and recovery of the society rather than to measure the social impacts.

Chang et. al. (2009) measured the social impacts of infrastructure failure using a system functionality approach, which looked at the number of people affected and the loss in functionality of the system affected by a disaster.

Gardoni and Murphy (2009 & 2010) proposed a capabilities-based approach to assess the social impacts of natural disasters. A capabilities-based approach refers to dimensions of well-being of individuals and takes into account what different individuals actually do with a resource and the opportunities they have. Though the final Disaster Impact Index proposed by Gardoni and Murphy (2010), incorporates the selected capabilities, its main purpose is for a comparative study of disasters rather than to measure the absolute social impact of a disaster.

Deshmukh et.al. (2003) use a similar approach to estimate social costs of critical infrastructure after a disaster by identifying the activities of communities and functions of industries supported by infrastructure in order to assess the serviceability of them. The serviceability level of an infrastructure for supporting an activity is considered to be 100% before the disaster, while the post-disaster serviceability level is estimated through a Monte Carlo simulation process.

Table 3: Summary of social impact models

Model	Advantages	Limitations
Human Capital Approach	Can be incorporated in CBA A single unit of measure can be used	Views society as a group of economic actors Quality of life is not considered
Resource-based approach	Suitable to assess resilience of societies	Only negative social impacts are calculated Absolute social impact is hard to measure
Systems (network) approach	Relevant for road networks and infrastructure	Application to individual infrastructure assets is limited Outcomes are measured based on number of people affected
Capabilities-based approach	Focuses on the capabilities affecting well-being of individuals Can be used to measure positive and negative social impacts	More suitable for comparative studies

An appropriate way forward would be to measure social impacts using a capabilities-based approach and to represent it as a percentage of pre-disaster serviceability levels. Such a method would enable a wide range of, both quantitative and qualitative social impacts to be measured and presented in a meaningful manner.

Environmental impacts

Environmental (ecological) impacts of disasters are the least researched into impact category, mainly as it is hard to identify and distinguish environmental impacts caused by a disaster. The fact that there is no commonly accepted principle to measure and amalgamate environmental impacts makes such assessments even more challenging.

As environmental impacts are considered external to economic transactions most economic assessments do not incorporate environmental impacts in such models. Those economic assessments that internalise any environmental impacts through a Cost-Benefit Analysis, assigns a monetary value to any environmental cost or benefit considered.

The three most common environmental valuation methods used are the Hedonic Pricing Method, Travel Cost Method and the Contingent Valuation Method, while each of them have their own benefits and limitations, the exact method to be used will depend on the type of environmental impact under consideration (Al-Kandari, 1994).

A major drawback of such valuation methods is that by giving a monetary value to environmental impacts, environmental capital is regarded as directly tradable with financial capital, which can be very misleading.

The most common method used to study the environmental impacts of road structures, without assigning economic values to impacts, has been Life Cycle Assessment (Du et. al., 2014, Pang et. al., 2015 & Zhang et.

al., 2016). LCA is an internationally recognised, comprehensive methodology, which can be used to assess the environmental impacts of a wide range of products and processes. The scope and depth of an LCA study could be varied according to the requirements of the researcher, which helps more relevant research to be conducted (Rebitzer et. al., 2004).

However most LCA studies focus on the overall environmental impacts of road structures throughout its life cycle, from the design stage to the end-of-life stage, and don't focus on the impacts that can be caused by failure of the bridges. Studies that link assessment of environmental impacts with failure of road structures have focussed on structural design and repair options that minimise environmental costs (Sobanjo & Thompson, 2013 and Tapia & Padgett, 2016), while minimal focus is given to the actual environmental impacts caused by the failure.

The environmental impacts of the failure of a road structure due to a disaster could be evaluated using a LCA approach by considering the failure of the road structure as the process being studied. As the environmental impacts of the physical damage as well as reconstruction will be assessed, this method would help to understand the resilience of structures in disaster situations.

Table 4: Summary of environmental impact methods

Model	**Advantages**	**Limitations**
Environmental valuation methods	Can be incorporated in CBA A single unit of measure can be used	Uses economic pricing models Regards environmental capital as tradable with economic capital
Life Cycle Assessment	A higher number of environmental impacts could be considered Scalable	Aggregation is based on applying weightages No common unit of measure

MODELS USED FOR MULTI-CRITERIA DECISION ANALYSIS

An important component of measuring social, environmental and economic aspects of a disaster would be to integrate these three dimensions to one common platform. As the impacts in these three areas are not directly comparable with each other, a systematic and understandable framework needs to be used for aggregation purposes.

Multiple Criteria Decision Analysis (MCDA), is an umbrella term used to describe a collection of formal approaches, which seek to take explicit account of multiple criteria to help make decisions in an objective manner (Belton & Stewart, 2002).

Though most MCDA approaches are based on the same fundamentals where, values for alternatives are assigned for a number of dimensions, and then multiplied by weights in order to arrive at a total score, the approaches differ on how the values are assigned and aggregated (Huang et.al., 2011). Thus it is important to analyse the different MCDA approaches so that the most relevant method could be used.

Multi-Attribute Utility Theory (MAUT) is an approach, which assigns utility values to the different dimensions, based on preferences of decision makers and then look to optimise the total utility function to arrive at the best decision. MAUT facilitates rational choices and will be applicable in a scenario with one decision maker who is able to clearly express preferences over outcomes and clear trade-offs for specific levels of achievement across dimensions (Huang et.al., 2011). This benefit in itself would be a disadvantage in that the ultimate outcome will be subjective and include preference bias of the decision maker.

The Analytic Hierarchy Process (AHP) uses pair-wise comparisons of criteria in order to rank the criteria based on verbal judgments of the importance of one criteria over another, which makes it possible to compare both quantitative and qualitative data together (Saaty, 1990). AHP is a good tool to be used when there are a high number of alternatives and multiple decision makers, although the value judgments used in the model can render it to be subjective.

Outranking is a MCDA method typically used to compare alternative options by assigning preference scores for the different dimensions of options. A range of possible scores for the different options is considered for each dimension, to develop preference functions across dimensions. An options score within a dimension will show how it compares against the other options (Murat et.al., 2015). Outranking is an approach that can be used for comparability of options hence does not necessarily identify the best options.

A study by Huang et. al. (2011) found that AHP applications have been used in the vast majority of MCDA research and concludes that this is mainly related to the availability of user-friendly and commercially supported software packages and enthusiastic and engaged user groups, rather than the analytical methodology of the model.

Table 5: Summary of MCDA models

Model	**Advantages**	**Limitations**
Multi-Attribute Utility Theory	Preference of a decision maker is taken into consideration	Final weightings are subjective
Analytic Hierarchy Process	Preferences of multiple decision makers is considered Can be used when there are a number of diverse alternatives	Based on value judgements
Outranking	Easy to compute and understand Can be used as a comparative tool	Identification of a best option is harder

In conclusion it can be stated that the methodology to be used for the integration and assessing of social, environmental and economic dimensions would depend on the preferences of the relevant decision makers. However, a hybrid method using AHP and MAUT models could be developed. Pair-wise comparisons as in the AHP model could be used to reduce subjectivity, while using the aggregation process of MAUT for convenience and transparency.

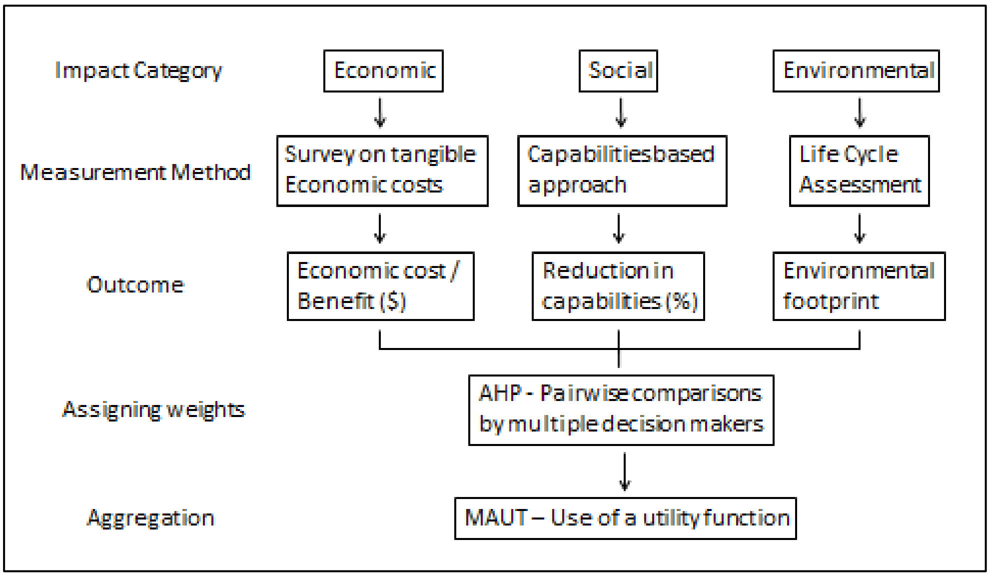
PROPOSED METHODOLOGY

The methodology proposed in this paper is summarised below.

The economic, social and environmental impacts of the road structure failure would need to be measured using three different approaches, each of which will be the most relevant and representative of the impact category.

Since the outcome of the three impact categories will not be directly comparable, MCDA methods would be used to assign weights and for aggregation purposes.

Figure 1: Proposed methodology



CASE STUDY: ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF THE FAILURE OF THE KAPERNICKS BRIDGE, QUEENSLAND

The following section of the paper focuses on the application of the relevant models identified above to measure the sustainability impacts of the failure of the Kapernicks Bridge due to the 2013 floods which affected Queensland.

The most relevant tangible economic costs of failure of a bridge could be categorised as per Table 2.

Table 6: Economic cost categories and estimation principles

Cost Category	Estimation principle	Data Source
Damage to infrastructure	Depreciated economic value Discounted restoration cost	Replacement cost – additional strengthening cost Replacement cost discounted at 85%
Clean-up costs	Cost of material + opportunity cost of labour	Survey Insurance paid out
Increased vehicle operating costs	Extra fuel cost, depreciation,	Survey
Extra travel time	Loss or reduction of income	Survey
Business disruption	Loss of value added	Survey
Alternative accommodation	Cost of staying away from home	Survey

When assessing the social impacts through a capabilities-based approach, the capability group that would be most impacted would be affiliation and mobility, as it is these capabilities that would be most affected by disruption to transport networks. Within this group two capabilities are identified to be affected;
Ability to engage in a desired activity
Ability to move freely from place to place
Since these two aspects can be interrelated, measures need to be taken to avoid any double counting errors.

Ability to engage in a desired activity would include activities like time at school and with family, while ability to move freely would include time taken to travel. A list of probable capabilities that could be impacted and needs to be surveyed based on previous research conducted by Mullet et.al., (2015) are listed in Table 7.

It is important to note here that any direct economic costs of extra travel time like extra fuel costs should not be included under social costs, as these costs will be included in the economic cost calculations.

As data regarding which capabilities had been affected and its magnitude are not available, a survey would need to be conducted among residents who frequently use the Kapernicks bridge in order to gather this information.

Table 7: Capabilities that may be impacted

Capability	Measure	Impact
Attend school	No. of school days missed	% of days in school year
Spend time at home	Extra time taken to travel	% of normal travel time
Spend time at home	Days away from home	% of calendar year
Access to markets	Extra time to obtain necessities	% of average time (days)

Access to medical and other required facilities	Time away from such facilities	
Live a healthy life	No. of injuries & deaths	

The environmental impacts of the failure of the bridge would be assessed by conducting a process level LCA. The functional unit for the LCA would be the “process of repairing the bridge to pre-disaster serviceability levels”.

An important aspect of conducting a LCA would be the identification of the different environmental impacts. When conducting a LCA study all possible impacts categories need to be assessed and then assigned weightages in order to normalise and convert them to a common unit of measurement.

However a more simplified method would be to select the most relevant impacts, which will reduce the time and effort needed to conduct the study. The most common environmental impact categories identified for bridges (Du, et.al., 2014, Horvath & Hendricks, 1998, Kendall et. al., 2008, Pang et.al., 2015 and Zhang et.al., 2016) are Global Warming Potential, energy use, non-renewable resource depletion and ecosystem quality.

Table 8: Environmental impact categories and indicators

Impact Category	**Indicator**
Global Warming Potential	Kg Co2e
Eutrophication	Eutrophication potential
Energy use	Mj (embodied energy)
Non-renewable resource use	Kg oil / mineral used

CONCLUSION AND FUTURE RESEARCH DIRECTION

This paper has studied the methodological applications presented in recent years to measure social, environmental and economic impacts of road structure failure. These models will need to be amalgamated and used to develop a holistic model, which is more relevant to disaster scenarios.

Based on the analysis of the models and the data requirements identified an empirical study on road structure failure needs to be carried out. Such a study will help identify any limitations of the model so that it could be improved and used in empirical studies of road structure failure.

The empirical model developed would also need to be compared with existing mechanistic models of road structure failure in order to compare the validity of the assumptions used and the final outcome of two different types of models.

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DISASTER RISK MANAGEMENT DECISION-MAKING: A REVIEW

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ABSTRACT

Effective and targetted disaster risk management is essential in building more resilient communities. Decision-makers are regularly required, through legislative frameworks, to determine how much, and where, to invest in disaster risk management to maximise economic and community benefits. Despite this mandate, there are few frameworks available to adequately support decision-makers in these complex decisions.

We review formal economic approaches to decision-making as well as existing risk management decision-making frameworks internationally. We summarise the types of tools used and the relative strengths and weaknesses of existing approaches. We find that many existing decision-making frameworks rely on cost-benefit analyses that tend to focus on monetized benefits and costs. We seek to increase the efficiency of risk management processes by providing guidance on the full range of outcomes that are likely to occur in a risk management context, and the appropriate decision support tools to apply when evaluating options. Many outcomes of risk management are not valued in markets, and the ability to undertake valuations is often limited due to resource and information constraints and system complexity. Importantly, we aim to address uncertainty, which is critical to the evaluation of risk management options.

This review is part of a two-year project developing a prototype framework for effective disaster risk management intervention decision-making. The framework will help decision-makers to better value disaster risk management investment in the current sustainability and well-being focused legislative/policy context.

Key words: *Cost-benefit analyses; Decision making; Disaster risk management; Full cost accounting;*

INTRODUCTION

Natural disasters bear a heavy financial, social and environmental cost for New Zealand. Despite a number of international studies illustrating the benefits of disaster risk reduction and mitigation (for example, Rose *et al.* (2007), Fenwick (2012), Mechler et al. (2014) and Shreve and Kelman (2014)) decision-makers sometimes find it difficult to justify investment in disaster preparedness. A robust disaster risk decision-making framework is needed to provide a good 'evidence base' for decision making.

Current decision-making methods, such as cost benefit analysis and multi-criteria analysis, are used broadly. However, there are some challenges in applying these to disaster risk assessments due to the long time horizons being considered and high levels of uncertainty around quantification of benefits.

In addition, current assessment techniques also tend to favour easily quantifiable costs and benefits (often impacts that can be monetized). Within the current New Zealand policy context there is emphasis towards a 'multi-capital' approach to policy evaluation. Treasury's Higher Living Standards (HLS) (New Zealand Treasury, 2011), The Resource Management Act and the Local Government Act all point toward a need to assess actions by environmental, social and economic means. The tools currently available, however, cannot do this robustly, transparently or in an agile fashion (Counsell, 2010).

This literature review is part of a New Zealand government funded research project 'Full Cost Accounting of Disaster Risk Management: Risk, meanings and metrics with uncertainty'. This project seeks to develop a prototype decision making framework fit for disaster risk management.

GENERIC DECISION SUPPORT TOOLS

Existing economic and decision-making tools generally fall into three broad categories:

Cost benefit analysis (CBA)
Costs effectiveness analysis (CEA)
Multi-criteria analysis (MCA)
A brief description of each of the decision-making tools is included in Table 15, including strengths and weaknesses for application to disaster risk management decisions and suggested applications.

Note that, the evaluation methods and tools are not necessarily mutually exclusive nor compete with each other. It may, for example, be beneficial and enlightening to complement CBA with MCA or other qualitative tools (Brouwer et al., 2010) or one method may be more applicable than another in a given situation.

Table 15 Application of decision-support tools within disaster risk management

Tool (key references)	Description	Strengths	Challenges	Suggested Application
CBA cost-benefit analysis (Atkinson and Mourato, 2008; Boardman *et al.*, 2001; Florio, 2014)	Framework for comparing projects/policies based on efficiency Usually expresses costs and benefits in the common metric of today's money	Follows an established and open methodology Encourages disciplined consideration of choices	Valuation techniques are imperfect and loaded with assumptions Tempting to only include benefits/costs for which information is readily available Difficult to balance non-quantifiable costs/benefits with quantifiable Conclusions may be highly sensitive to assumptions, incl. discount rate	Options are well defined Costs/benefits that are not able to be monetised are unlikely to be significant or are at least included in decision making through other analyses
CEA cost effectiveness analysis (Brouwer *et al.*, 2010)	Compares costs of projects/policies against a defined goal or benefit (e.g. disaster risk reduction)	Follows an established and open methodology Does not necessarily require the monetisation of benefits	Objective or target must be well defined Limited ability to consider multiple and/or competing benefits See also challenges for CBA	Clearly defined goal or objective Prioritisation of least-costly/highest benefit option is paramount
MCA multi-criteria analysis	Establishes preferences between options by	Enables decision-makers to handle large amounts of	Subjectivity of assessment Time-consuming to	Effects of a project/policy are likely to be complex and information on effects is

(Keeney and Raiffa, 1976; Dodgson *et al*., 2009; Huang *et al.,* 2011)	assessment against a set of agreed objectives and measurable criteria	complex information in a consistent way Flexible to allow for alternative objectives and values Can incorporate diverse range of information	undertake stakeholder engagement processes and buy-in is required Weighting dimensions can be complex and subjective	diverse

INTERNATIONAL DISASTER RISK DECISION-MAKING FRAMEWORKS

Formal frameworks for disaster risk decision-making are growing but are not widely adopted. The majority of the frameworks reviewed (Table 16) use CBA as their base method; adding a variety of methods for managing 'non-market values' including qualitative assessments, multi-criteria analyses and willingness to pay methods. Benefits were valued on an average annualized losses basis and discounted using rates between 3-12%.

Across the frameworks a number of key steps within the assessment are recommended:

Define the problem and assessment objectives
Establish the baseline ('do-nothing' option)
Carry out risk analysis (including hazard intensity, recurrence, vulnerability)
Identify intervention options (could include hard (e.g. engineering) and soft (e.g. policy) approaches) and their probability of success
Identify and value the full range of costs and benefits
Carry out assessment
Compare and select preferred option
A diverse range of potential costs and benefits are described in the frameworks. Generally these can be categorised as:

Social, environmental, economic,
Direct and indirect
Tangible and intangible, and
Market and non-market.
Methods for calculating the costs and benefits range from bottom-up approaches (using unit estimates scaled to the hazard impact) to top-down approaches using historic data.

Table 16 Summary of example disaster risk management decision frameworks

Framework	Primary evaluation method used	Management of 'non-market' costs / benefits
Australian Business Roundtable for Disaster Resilience and Safer Communities: Building our nation's resilience to natural disasters (Deloitte Access Economics, 2013)	Cost benefit analysis	Qualitatively included
United States FEMA: Benefit Cost Toolkit 5.2.1. (FEMA, 2015)	Cost-benefit analysis	Not included directly. Opportunity to discuss but not integrated into the assessment
United Kingdom Environment Agency: Flood and coastal erosion risk management appraisal guidelines (Environment Agency, 2010)	Cost-benefit analysis combined with swing multi-criteria analysis.	Recommends monetizing values where possible. Otherwise the guide advocates 'swing' multi-criteria analysis (MCA): within each type of impact, options are weighted relative to the difference between the worst and best outcome. Options are then assigned 'implied' monetary values by comparing the monetised and non-monetised impacts and their relative weights

Framework	Primary evaluation method used	Management of 'non-market' costs / benefits
GTZ: Cost-benefit Analysis of Natural Disaster Risk Management in Developing Countries (Mechler, 2005)	Cost-benefit analysis	Recommends two methods: direct preference (price someone is willing to pay to prevent a consequence) and the indirect method (estimate of market losses).
World Bank: Climate-Smart Development. Adding up the benefits of actions that build prosperity, end poverty and combat climate change (World Bank, 2014)	Cost effectiveness analysis. Bottom-up modelling of future losses / benefits combined into a macroeconomic assessment tool.	Some established monetary valuations for benefits incorporated into financial modelling (value of statistical life, crop value, social cost of carbon, carbon dioxide mitigation cost, and energy savings). Others intangible benefits considered qualitatively.

KEY CHALLENGES

With all of these evaluation methods there are a number of challenges when applying them to disaster risk decision-making.

Deep uncertainty

When valuing the costs and benefits of a particular disaster risk management intervention, we are valuing benefits that may or may not occur at some point in the future. There is uncertainty around the extent of these benefits due to both our ability to predict the impact of hazard events and also the future social, economic and natural environment that will be affected. Often compounding the problem, parties to a decision have competing priorities and beliefs (Kalra et al., 2014). Inevitably this uncertainty leads to a bias in the analysis of costs[5].

For most DRM projects, the lack of data, especially regarding benefits, means it is not easy to apply CBA (Mechler, 2005; Toyama & Sagara, 2013). Kalra et al. (2014), note that uncertainty can paralyse sound and effective decision-making and, therefore, needs to be managed carefully.

Valuing the Future

A common criticism of CBA analyses is 'the tyranny of 'discounting' (Atkinson & Mourato 2008; Hepburn 2007; Pearce *et al.,* 2003). The purpose of discounting is to ensure effects at different time periods are expressed in their present value (EPA, 2010). However, currently used discount rates means that effects occurring more than 25-35 years into the future will have a value near to zero: thereby devaluing the importance of reducing burdens on future generations. We need to review the role and applicability of discounting.

Distributional Equity

Many economic analyses assess the impacts on society as a whole. There is an assumption that the 'winners' will somehow compensate the 'losers'. However, this is often not the case. For example, if a proposed policy results in a gain of $100 to individual A and a loss of $50 to individual B, we cannot assume that social welfare has increased; for if A is rich and B is poor, it may be that the loss of satisfaction to B of $50 is far greater than the gain of $100 for A. Evaluation methods can be adjusted to record the costs and benefits against the parties to which these accrue, however, this is not widely practiced (cf Florio, 2014).

[5] In a recent review of environmental regulations, the U.S. EPA found that all regulatory impact analyses estimated (some) costs, but less than half included some form of benefits (Hahn & Dudley as cited in Atkinson & Mourato, 2008). Only about a quarter provided a full range of benefit estimates.

Risk preferences

There is often an assumption, particularly in CBA, that people are rational and risk neutral (cf Stæhr,2006). That is, they make choices that maximize their individual well-being now. However, some individuals may be more altruistic and make decisions based on others' well-being or some may be risk averse and prefer guaranteed losses now over potential future losses. Decision makers are also faced with a difficult problem of determining the appropriate degree of risk to manage at a macro (community) level and at individual level.

Techniques to adjust for risk preferences, such as expected utility theory (Smith & Vignaux, 2006) and multi-attribute utility theory (Wallenius et al., 2008) are available to account for people's individual risk preferences but these are not widely used.

Interactions between different impacts

Disaster risk management assessment will inevitably be multi-faceted. Decision-makers will be trying to balance competing objectives: social, environmental and economic. This challenge is two-fold: how do you weight or value the importance of each objective, while taking into account the range of individual preferences. Second, are the effects additive or is one or a particular combination of effects more significant? For example, people might feel more strongly negative about a project a project that imposes both environmental and social costs than would be estimated by adding separate valuations of the two effects. More explicit guidance is needed on how to balance different impacts.

Monetisation of costs and benefits

Particularly in CBA and CEA, the emphasis on monetary valuation of costs and benefits has drawn criticism. A number of techniques, based on the concepts of 'willingness to pay' or 'willingness to accept' have evolved to aid in the monetary valuation of items not typically traded in markets (Boardman et al., 2001). Techniques such as stated preference methods, revealed preference methods, and cost-based valuation techniques can be employed, however these are complex and relevant data is often not available or is too expensive to collect. There are also ethical questions around the valuation of things such as human lives (Mechler, 2005), cultural and biodiversity values.

Residual risk and moral hazard

When determining the costs and benefits of an intervention, a consideration often over-looked is the potential for residual risk and moral hazard. An important part of intervention evaluation is to consider the effect of the intervention on behaviour change (that is, does it induce riskier behaviour) and the consequences of other events (for example, does a flood bank stop a 1 in 20 year flood only to make the consequences of a 1 in 50 year flood worse?). The use of insurance can be an example of a moral hazard: if someone has insurance, they arguably have less incentive to reduce the losses from occurring (Courbage and Stahel, 2012).

Optimism bias

There is a tendency for analysts to be overly optimistic in their assessment of interventions. Some guidance documents recommend artificially adjusting (percentage increase) projected costs prior to completing a CBA assessment (HM Treasury, 2011).

CONCLUSIONS

There are a number of established decision-making techniques that can be applied to disaster risk management decisions. Their effectiveness, however, is dependent on the management of a number of key challenges, including deep uncertainty, valuing the future, distribution equity, risk preferences, interactions between impacts types, monetisation of costs and benefits, residual risk and moral hazard, and optimism bias.

The next step in this project will be to develop a user friendly framework to guide analysts and decision-makers towards more effective and robust disaster risk decision-making.

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DISASTER RESILIENCE: IS IT THE SAME FOR EVERYBODY?

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Disasters continue to have a dramatic impact on lives, livelihoods and environments communities depend on. In response to these losses the global community has developed various theories, assessment methodologies and policies aimed at reducing global losses. A contemporary outcome of these interventions is to build the disaster resilience. However, despite the disaster resilience building endeavours espoused by policies, theories and methodologies, very little progress is being made in reducing disaster losses. This paper argues that a possible reason behind the limitations of current resilience building policies and methodologies could be that most of these policies are based a mechanistic scientific paradigm that places an emphasis on system components that are perceived to build resilience and not the function of systems as a whole. This often leads to resilience building initiatives that are based on a "one size fits all" approach. This paper argues for the use of a complex adaptive systems approach to building resilience. This approach argues that contextual factors within different social systems will have a non-linear affect on disaster resilience building efforts. Therefore it is crucial to move away form one size fits all" approaches to more flexible approaches to building resilience. This hypotheses are tested by means of a correlation statistical analysis of agricultural communities in Southern Africa. Results of this analysis indicate that unique resilience profiles are evident in almost all of the communities. This indicates that resilience is not the same for everybody, and that resilience building endeavours should be flexible enough to be adapted from community to community.

Key words: Resilience, Mechanistic Paradigm, Complex Adaptive Systems, Non-linearity, Flexible

DEVELOPING A CULTURE OF PREPAREDNESS: EMBRACING VULNERABILITY TO BUILD RESILIENCE

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ABSTRACT
The Small Island Developing State of Vanuatu is widely recognised as one of the most at-risk countries due to its simultaneous high exposure and vulnerability. Although the impacts of Cyclone Pam illustrated this high level of risk, it also highlighted a path to resilience through the development of a culture of preparedness by embracing and exploiting vulnerability resulting from social, physical, economic, political and cultural fragmentation in the country. The Vanuatu disaster governance system developed mechanisms to turn potential vulnerability factors into catalysts to more effectively and continuously build resilience of the diverse communities scattered across the islands of the archipelago. These strategies resulted in the development of a culture of preparedness relying on the recognition that the concept of resilience-building is not the absence of vulnerability factors but the ability of communities to integrate these factors into their life as positive dynamics to better prepare for extreme events and response activities. The Vanuatu disaster risk and climate change governance system in place before Cyclone Pam was mobilised during the cyclone response phase; this paper focuses on the qualitative analysis of the cultural dimension of this system. Through the analysis of cooperation patterns, the integration of vulnerability factors as triggers for cooperation in preparedness strategies was highlighted as a particular priority for developing a culture of preparedness among organisations and communities, and to more effectively build resilience.

Key words: Climate Change; Culture of Preparedness; Disaster Risk Reduction; Governance; Resilience; Small Island Developing State

INTRODUCTION
Building resilience is a complex process relying on the ability of communities to face hazards, including climate change, without serious harm. This ability relies on their aptitude to identify (and understand), adapt and prepare for the actual and potential threats of hazards. The consideration of culture is essential to analyse disaster risks and build such ability (Krüger et al., 2015). Bankoff et al. (2015) define culture "as a constantly and shifting configuration of social practices, or as outcomes of

experiences, social arrangements and situation that are inscribed into a society" (p.4). Accordingly, the concept of culture of preparedness explores social structure and practices developed within a society to prepare organisations and the broader communities for extreme events and response activities. Developing a culture of preparedness does not mean that a society will not be vulnerable and will not face losses during disasters. It does mean that people understand the risk and can perceive the potential of a risk of a hazard more violent than ever experienced, and recognise the need to prepare as effectively as possible for such an event. It also means that organisations and communities are prepared for the management of response activities, which may involve extensive cooperation with known and unknown stakeholders, as well as significant mobilisation of human and material resources (often already scarce before the disaster). The society will need the ability to adapt its social structure and practices for effective disaster management before, during and after a disaster while constantly building capacities and understanding to be prepared for the next potential extreme event (of the same or a different nature).

This paper aims to increase understanding of the potential of a governance system based on networking to develop a culture of preparedness among organisations and communities. It uses the case study of Vanuatu, identified as the most at-risk country (Welle and Birkmann, 2015). Through the qualitative analysis of results of a Social Network Analysis conducted for the purposes of the author's PhD research, this paper explores the patterns of cooperation (its structure, leadership and processes) at the formal and informal levels in routine (pre-disaster) and disaster times. This increases understanding of the impacts of networking on the level of preparedness of organisations and communities in the process of resilience-building.

Over the last few years, a governance system, referred to as the Vanuatu-Networked-System in this paper, based on networking was developed in Vanuatu to address the challenges inherent in disaster risk reduction and climate change adaptation. The Vanuatu-Networked-System comprises more than 50 more or less formal networks covering all dimensions of building resilience to hazards (hazard monitoring, disaster management, protection of vulnerable groups, project management etc.). These networks have strong links with one another, and are supported by an extensive legal and institutional background recognising the value of cross-sectoral cooperation between government and non-government stakeholders. The networking process that has evolved within the Vanuatu-Networked-System builds long-term relationships among stakeholders (organisations and communities) and enables continuous understanding and capacity building that addresses the different challenges that can be met in the process of resilience-building in Small Island Developing States. This paper focuses on some of the main recurrent challenges to resilience-building: tensions between traditional and modern systems; numerous diverse stakeholders with few resources and subjected to a high rate of staff turnover; high exposure to multiple hazards; and geographic and cultural distances among the at-risk communities. This paper analyses how the Vanuatu-Networked-System addresses these challenges inherent in the context of Vanuatu by adapting strategies to suit them instead of trying to reduce them. This results in the development of a culture of preparedness among organisations and communities.

TENSIONS BETWEEN TRADITIONAL AND MODERN SYSTEMS

As illustrated by Tabani (2002), defining 'traditions' in a context like Vanuatu is difficult, and often amalgamated with 'customs' and 'Kastom' (comprising not only customs, habits and uses but also ancestral beliefs and culture). For the purposes of this paper, the 'traditional' systems (such as knowledge, leadership, culture, mechanisms) refer to systems based on ancestral – pre-colonial – structures constantly evolving through the indigenisation and absorption of received influences into local systems. 'Traditional systems' are expressed in this paper in contrast to 'modern' systems developed externally to the country and used as such.

The consideration of traditional knowledge, and more particularly its complementarity with modern knowledge, is increasingly recognised as a condition to building resilience to hazards (e.g. Gaillard, 2007; Mercer et al., 2012; Cook, 2015; Kelman et al; 2015). In the case of Vanuatu, the recognition of the value of traditional systems in resilience-building was shared among most respondents. This situation was well reflected by a NGO country director willing to better understand the concept of resilience often loosely used by the diverse stakeholders: *"I looked at synonyms for resilience and there hidden among terms such as elasticity, buoyancy, hardiness and toughness was a word that fitted better: spirit. A simple term, but one which captured the essence of what I was seeing and feeling among our Oxfam team and the general population - a spirit that was strong, positive, realistic, practical under stress and located somewhere deep in the fabric of the people of Vanuatu, deep in their culture and traditions, deep in their hearts and minds."* (Van Rooyen, 2015).

However, challenges related to conflicts between traditional and modern perspectives remain in countries based on oral traditions such as Vanuatu.

The Vanuatu-Networked-System considers carefully these potential tensions. It benefits from networks relying on traditional systems (e.g. the Church Working Group) and networks relying on modern systems (e.g. the Melanesian Volcano Network). Certain networks directly aim to identify and utilise traditional knowledge (e.g. the Traditional Knowledge Working Group), while others aim to bridge the two systems (e.g. the Vanuatu Rainfall Network). The interconnections between all these networks and between their members (from the civil to the high-level decision-maker) build a whole system propitious to identify the most effective lines of knowledge from the traditional and modern systems to develop an effective, comprehensive and complementary system appropriate to the specific context of Vanuatu. Combining traditional and modern systems however creates a complex governance system that may become inherently more inefficient and slower to react in extreme situations. The bottom-up-top-down approach of the Vanuatu-Networked-System circumvents this potential issue, more particularly through the recognition and empowerment of the lowest levels of governance for decision-making and implementation.

Ni-Vanuatu is an oral culture, potentially resulting in the gradual loss of traditional knowledge from one generation to another one. Networks like the Traditional Knowledge Working Group directly aim to capture traditional knowledge to make it more sustainable and transferable, addressing the challenge of potential loss inherent in oral culture. However, the oral nature of the Vanuatu culture should also be seen a real asset for networking and cooperation, since relations are easily built during informal and formal group meetings, community gatherings and ceremonies. Vanuatu is a family- and social-supportive environment. The Vanuatu-Networked-System recognises the particular input of informal relations and gatherings to share lessons and knowledge, and investing in building a network culture (such as food and drinks after meetings or group activities). Overall, most networks within the Vanuatu-Networked-System take a community-based approach, by sharing experience and lessons learned from the field to develop more effective projects, supporting continuous empowerment of civil society to be self-reliant and more resilient. Adopting community-based processes (Maclellan et al., 2012), the networked approach advocates resilience-building with communities, instead of for communities. The networks and networking processes within the Vanuatu-Networked-System relate to the inherent culture of Vanuatu promoting face-to-face oral interactions, while utilising relevant modern findings on climate change management and disaster risk reduction.

Furthermore, the inequality of Internet access and the relational culture of the country based on oral exchange result in a significant reliability on more traditional mechanisms of communication. Eisenman et al. (2009) underlined the need to deliver information on disaster risks in general, and preparedness in particular, to communities through formal and informal networks to ensure that information is culturally appropriate and relevant, as well as understandable and properly understood. The Vanuatu-Networked-System developed complementary formal and informal, modern and traditional mechanisms to effectively communicate and exchange information and resources. A set of networking tools and mechanisms to disseminate information, both modern (e.g. online newsletters, phone messages, satellite information) and more traditional (e.g. group meetings, radio forums, nature observation) ensures a comprehensive consideration of the complex culture of Vanuatu in the process of resilience-building.

This complex complementarity between traditional and modern systems (knowledge and communication tools) in the process of resilience-building relates to the complex culture of Vanuatu, balancing the strong traditional structure and beliefs, and social changes induced by the increasing introduction of modern tools (Internet, high-technologies etc.) and involvement of external secular actors. This ensures the development of strategies related to resilience-building, and more particularly preparedness, appropriate to the evolving social structure and practices of the diverse at-risk communities.

NUMEROUS STAKEHOLDERS, SCARCE RESOURCES AND TURNOVER

Most stakeholders involved in the process of resilience-building reported the overwhelming amount of diverse stakeholders (at-risk communities, civil leaders, local officers, national decision-makers, regional advisors and international actors) making cooperation particularly difficult. This situation is further exacerbated following major disasters, such as Cyclone Pam.

The analysis of the Vanuatu-Networked-System for the purposes of this research focussed on 260 stakeholders involved in the different dimensions of building resilience to hazards, connected by 417 networking ties. These ties occurred strongly across sectors and types of organisations, building long-term and trusting social relationships. These formal and informal relationships play a key role in the effectiveness of formal cooperation to manage climate change and disaster risk management. The flexible dimensions of these relationships motivated by social experiences, affinities and aspirations support the development of clear, trusting and valued channels to network. The institutional structure of the Vanuatu-Networked-

System helps to harness these individual mechanisms to the benefit of the whole system, consistently inscribing the process of resilience-building into the formal and informal practices within the society.

The positive impacts of pro-active establishment and continuous development of relationships and trust across and in the Vanuatu-Networked-System were particularly well illustrated during Cyclone Pam management. Staff well involved in the networking process were particularly well prepared to conduct coordinated and cooperative operations, whereas organisations and stakeholders not well integrated in the process were overwhelmed by the difficulties in cooperating with the other actors. Hence, the Vanuatu-Networked-System (its structure, leadership and processes) is propitious to the development of social structure and practices evolving in routine times effectively preparing its members for extreme events and response activities.

Furthermore, the Vanuatu-Networked-System is a propitious system for meeting the challenge of turnover. The disaster and climate change governance system faces critical obstacles to sustainable and reliable achievements due to the high-level of staff turnover. Loss of capital related to turnover occurs when foreigners leave the country, or when locals change position and do not effectively use the capacities acquired during past work (which happens frequently since government and non-government positions are often project-funded). This loss of capital concerns particularly social networks, individual capacities and institutional memories. The strong informal networking processes supported and empowered by the existence of the interconnected flexible and long-term networks supports the stability of the capital at the whole network level. Hence, stakeholders were often involved in informal networking to utilise their capital (human, social and cultural) developed during a previous position to the benefit of their collaborators. The development of the networks on their own and as part of the whole system stimulates resource exchange among members, and help stakeholders to have an optimal use of their resources invested in one project for the benefit of others.

Hence, the continuous development of trusting relationships within and between networks across sectors and types of organisations simultaneously addresses the issues related to competition between the numerous diverse stakeholders, turnover and resource scarcity. Thereby, the Vanuatu-Networked-System develops in the long-term comprehensive social structure and practices propitious to continuous formal and informal cooperation, equipping and preparing organisations for extreme events and response activities, cooperatively and with few resources.

HIGH EXPOSURE TO MULTIPLE HAZARDS

Vanuatu is considered the most at-risk country in the world, based on its level of exposure and vulnerability (Welle and Birkmann, 2015), and assessed as particularly vulnerable to climate change (UNDP, 2014). A large majority of the population is indeed critically exposed to severe weather, climate and geo-hazards. Tectonic hazards are a key concern for resilience-building, with significant exposure of the population to constant earthquakes (11 000 seismic events from magnitude 5 to 8 between 1973 and 2005, with an average of one to two events of magnitudes above 7 per year in the area), and significant risks of tsunamis and volcanic hazards (Campbell, 1990; Galipaud, 2002; Siméoni, 2012). Climatic events are also a constant risk in the country, which has registered at least one cyclone per year since 1959 (Siméoni, 2012). Based on the official position of the Government of Vanuatu, these events are increasingly worsened by climate change (Government of Vanuatu, 2015). Category 5 Cyclone Pam in March 2015 illustrated the high exposure of the SIDS to these events.

The co-existence and interconnections between networks focussed on geo-hazards (such as the National Seismic and Volcanic Monitoring Network), meteorology-hazards (such as the Vanuatu Rainfall Network), climate change (such as the COP-Working-Group), as well as general development issues (such as the Gender Partner Group) within the Vanuatu-Networked-System enables the dissemination of data on the level of vulnerability and/or resilience captured for one type of hazard that may affect the level of vulnerability and/or resilience for other types of hazard.

Contexts exposed to multiple hazards like Vanuatu (e.g. cyclones, earthquakes, floods) may face disasters in chain, hindering recovery and making preparedness complex. The networking processes within the Vanuatu-Networked-System limits these risks, through capacity building in information dissemination (by organisations and authorities) and information reception (by organisations and communities) for the different types of hazards. One example is how organisations involved in climate change adaptation and disaster risk reduction cooperated to develop short phone messages and conducted campaigns to build capacity (within organisations and communities) to manage these messages. Short phone messages are particularly valuable communication channels in Vanuatu, as phone coverage is wide. Hence, SMS texts cope with Internet limitations and geographic distances to distribute written material and even short vocal messages to negate literacy limitations. The SMS texts system was officially integrated in the National Standard Operating Procedures as a resilience-building tool (NDMO, 2013). Messages were widely sent to inform, warn and help communities to prepare for Cyclone Pam, as well as to update regularly on the response and recovery operations. More impressively, during the emergency period following Cyclone Pam, texts concerning the potential threat of El-Niño advised communities to prepare for this event, expected six months after (Box 1), while pursuing response and early recovery of the most devastating cyclone they had experienced. The positive reception of this text in time of disaster illustrates the long-lasting capacity building on the understanding of the value of preparedness.

Box 1. Example of informative SMS to build resilience
Received on May, 27th 2015 from Vanuatu Meteorology and Geo-Hazards Office

"Meteo dipatment i advisem public se wan drae taem (El Niño) i stap kam mo bae i stap kasem early 2016. Sevem wota mo plantem kakai we i grow gud long drae taem. Yumi mas pripea gud nowia"

VMGD notifies the public that a dry weather (El Niño) is coming and will remain until early 2016. Save water and plant food that grows easily in dry weather. We must all prepare well.

The Vanuatu-Networked-System, with cooperation ties between the stakeholders working on different types of hazards and with preparedness mechanisms cross-hazards such as the phone short messages, enables organisations and communities of Vanuatu to build resilience to all hazards by recycling (hence optimally using the scarce resources) and adapting mechanisms and capacities developed within one sector for all others.

GEOGRAPHIC AND CULTURAL DISTANCES AMONG COMMUNITIES

The 88 island-group of Vanuatu, separated into six provinces, covers a land area of less than 12,500 km^2 but is spread over a maritime exclusive economic zone of around 700,000 km^2 (UNICEF, 2011; NDMO, 2014). Such scattered geography, coupled with limited communication and transportation means, critically hinders information management in a timely, affordable and equal manner among the communities. These challenges inherent in communication about national planning in the country reinforce the fragmentation of programs conducted by government agencies, NGOs, foreign aid and civil society groups (UNISDR and UNDP, 2012; IFRC, 2012). These difficulties are also deepened by the significant economic, infrastructure and political differences between the different geographic areas, especially between rural and urban areas. Although more than 75% of the population were assessed as living in rural areas (UNICEF, 2011), decisions are mainly made in the cities of Port Vila and Luganville, often considered significantly disconnected from the actual needs in the remote areas. This situation is a critical issue for effective implementation of resilience-related decisions. The cultural diversity of the country is often illustrated by the overwhelming number of languages spoken across the Vanuatu communities: more than 110 languages (for only a little over 270,000 inhabitants), three of them being official (Bislama, English and French) (Siméoni, 2012). Cultural diversity between the different islands is reflected in the complexity of leadership. Community organisations may significantly differ based on the area; a divide is particularly recognised between the north and the south (e.g. material used to build houses, traditional power distribution, cultural beliefs etc.) (Siméoni, 2012). These different lines of diversity make the development of appropriate and implementable national strategies related to resilience to hazards in the different communities (especially the most rural ones) particularly difficult.

A NGO expatriate however observed that "the more rural and isolated communities are, the more resilient they are". These communities already rely on themselves and local resources in routine times, a disaster may affect their own resources but not their incentive to work on their own and to capitalise all local resources before calling for external assistance. Civil self-reliance and civil/local/national cooperation, induced by this context, are considered to be well utilised by the Vanuatu-Networked-System during the process of resilience-building. Indeed, addressing the issues of geographic scattering (and connected difficulties of transport and communication) and diversity between the different areas, sub-levels of Disaster and Climate Change Committees were put in place to facilitate appropriate decision-making and implementation. More particularly, Community Disaster and Climate Change Committees (CDCs) were established in several at-risk communities across the whole archipelago.

The CDCs are composed of local and civil stakeholders aware of the specific needs and available resources in their respective communities (such as women, farmers or local businesses). In their respective communities, the CDCs participate in the identification of priorities, awareness raising, information sharing and development of projects related to climate change and disaster risks, as well as facilitating impact and needs assessments, and preparedness, response and recovery operations. By directly involving local and civil stakeholders, these networks, supported by the whole networked system, develop social structure and practices evolving around the continuous mindfulness of risks and mobilisation of at-risk communities, resulting in the development of their culture of preparedness. International actors involved in the management of response to Cyclone Pam reported significant differences of preparedness levels, impacts and utilisation of aid between communities with established CDCs and communities without.

Furthermore, tools developed for communication are particularly adapted to the scattered and diverse context. Taking again the example of the phone short messages before and during Cyclone Pam, regular and detailed warning SMS texts reached around 120,000 people (half of the whole Vanuatu population) (RRU, 2015). Coverage was well scattered throughout the islands, as private companies constructed networks into less commercially attractive areas, in the primary interest of expanding vital information dissemination (Perry, 2015). Thanks to this wide coverage, complemented with traditional and social networking communication and supported by institutional and civil networks empowered within the Vanuatu-Networked-System, the information in SMS texts reached a major part of the society.

The official recognition and empowerment of local and civil involvement to address issues related to distance, resulting in pre-determined channels to directly involve local and civil stakeholders in decision-making and communication, build the ability of grassroots leaders to take in charge essential preparedness strategies for extreme events and response activities within their communities. This developed the continuous ownership of preparedness strategies instead of an external capacity building process, facilitating the integration (more or less conscious) of preparedness considerations into everyday life. This process results in higher resilience in more remote areas, where communities are more and better involved in preparedness decision-making and strategy implementation than in urban areas where most organisations and government agencies take charge in operations.

CONCLUSION

Resilience-building in developing countries based on oral culture is often hampered by key vulnerability factors: the tensions due to the lack of optimal use of existing systems and the differences between traditional and modern systems; the diversity of the numerous stakeholders involved, subjected to a high rate of staff turnover, scarce resources and geographic and cultural distances; and a complex multi-hazard exposure enforcing simultaneous work on the different risks. Such vulnerability factors are often inherent to the context of these countries, and sometimes inexorable; however, the case study of Vanuatu highlighted that resilience and vulnerability factors may co-exist within a society.

The Vanuatu-Networked-System benefits from a comprehensive set of institutionalised networks and networking ties within and across these networks. This social networking process is maintained by a supportive legal and institutional background as well as appropriate cooperation tools. This complex structure focuses on the utilisation of positive impacts of the diversity of the numerous stakeholders involved in resilience-building, the high rate of turnover, the complex multi-hazard context, and the diversity of the communities exposed to develop a more comprehensive, flexible and complementary governance system. This structure makes the Vanuatu-Networked-System propitious to the continuous and effective development of social structure and practices among and across all stakeholder groups.

Hence, good governance for resilience-building relies on the potential of the system in place to support the continuous and optimal use of social experiences of the disaster society (organisations and communities) to prepare for extreme events and response activities, appropriately to the different contexts exposed. This process can result in a sustainable culture of preparedness if the strategies developed within the governance system aim to build resilience, by recognising, integrating and embracing vulnerability factors, instead of aiming to reduce these vulnerabilities.

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GRASSROOTS LEADERSHIP TO BUILD RESILIENCE IN SMALL ISLAND DEVELOPING STATES

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ABSTRACT

Building a long-term cooperative system is crucial for better disaster governance in Small Island Developing States. Such a system, however, faces many challenges, and requires strong, yet flexible, institutional and legal mechanisms to manage resilience-building strategies conducted under the scope of DRR, CCA and development. This paper focuses on networked governance promoting inclusiveness and integration to build resilience to hazards in the Small Island Developing State of Vanuatu. The concept of good leadership as shared by the diverse actors for CCA and DRR in the country illustrated the critical need to integrate grassroots leadership into the governance system. More particularly, grassroots leadership particularly played a key role in this governance system. The diverse mechanisms to address critical disaster governance challenges in the country resulted in a continuous bottom-up-top-down flux of consultations, negotiations and decision-makings. Civil leaders and groups were widely enabled to conduct resilience-building within the cooperative governance system. Civil society was allocated key positions in the development and implementation of policies, strategies and projects related to DRR, CCA and development. Civil leaders play a particularly key role in ensuring the effectiveness and appropriateness of communication in their communities. The disaster governance structure of Vanuatu aims to optimise grassroots leadership, not by framing and regulating it, but by facilitating its development and involvement in formal governance. This system ensures the pertinence, effectiveness and continuity of decisions made at the upper levels and project implementation at the different community levels. This recognition and empowerment of grassroots leadership is a key asset to address the challenges inherent to resilience-building in the context of a Small Island Developing State.

Key words: Disaster and Climate Change Governance; Grassroots Leadership; Resilience; Vanuatu; Small Island Developing State

INTRODUCTION

Like many Small Island Developing States (SIDS), the Republic of Vanuatu is characterised by critical challenges to resilience-building (Ali, 1992;

Jayaraman, 2004; Gero et al., 2010; Walshe and Nunn, 2012; NDMO, 2014; Welle and Birkmann, 2015), such as:

High multi-hazard exposure;
Resource scarcity;
Scattered geography (80 islands covering 12,500 km^2 of land area spread over a maritime exclusive economic zone of around 700,000 km^2), with particularly difficult transport and communication in remote areas;
Cultural, political, social, economic and environmental diversity among the numerous exposed communities;
Complex decision-making relying on equally strong influence of national, regional and international agendas, which can be in conflict and/or not appropriate to local levels;
Lack of optimal use of traditional knowledge in strategy development.

These challenges make the development of effective and appropriate national decision-making and strategy implementation particularly difficult. A governance system was developed in the country addressing these challenges by allowing grassroots leadership to play a key role in resilience-building. This paper aims to better understand how the governance system developed in Vanuatu optimises grassroots leadership to support formal authority, and vice versa, in order to better address the complexity of disaster and climate change governance in SIDS.

Grassroots leadership is the set of individuals without formal authority affecting the process of decision-making through a bottom-up approach. Grassroots leadership often emerges when individuals find that authority cannot address challenges in their community. Grassroots leadership is mostly studied under the scope of social movements and their impacts on the social change of authority. Research on the impacts of the potential complementarity between authorities and grassroots leaders is lacking.

This paper is based on the qualitative analysis of results of a Social Network Analysis conducted for the purposes of the author's PhD research on Networked Disaster Governance in Vanuatu. Ninety stakeholders from all types of organisations, sectors and governance levels involved in Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) in Vanuatu responded to a survey on their networks (institutional and individual), and on their perceptions of cooperation trends and leadership in the country. This paper focuses on respondents' perceptions of governance structure and processes (institutionalised networks, actors' and decision-makers' positions, formal and informal cooperation patterns etc.) promoting grassroots leadership in CCA and DRR in Vanuatu captured through this survey, and complemented by an extensive literature review.

This paper identifies the shared understanding of good leadership among the diverse respondents and analyses how the effective consideration of grassroots leadership (civil society and local officers) in the Vanuatu governance system echoes with this understanding of good leadership for resilience-building. The processes of consideration and empowerment of grassroots leadership make the Vanuatu disaster and climate change governance system (referred to as the Vanuatu-Networked-System in this paper) a concrete example of systems propitious to more effective resilience-building in SIDS.

THE CONCEPT OF GOOD LEADERSHIP SHARED BY DISASTER AND CLIMATE CHANGE STAKEHOLDERS IN VANUATU

Good leadership was spontaneously recognised among most disaster and climate change stakeholders who responded to the survey of this research as an essential enabler for effective resilience-building. Based on the respondents' perceptions of the impacts of networking on CCA and DRR, key characteristics essential to leaders to support good leadership were conceptualised for the purposes of this article. These characteristics included political goodwill, taking of responsibility, trust, representativeness (of the whole society), humility, and development of community representatives' self-confidence.

Data analysis did not find any link between the references of good leadership characteristics by the 90 respondents and their attributes, whether they were government or non-government, international or local, empowered or grassroots, women or men. This highlights a shared and commonly built understanding of good leadership. Interestingly, respondents systematically emphasised the need for the identification, recognition and empowerment of grassroots leaders, and better integrate them into the process of decision-making.

Political goodwill for transparent and accountable cooperative decision-making was considered as one the main characteristic of good leadership. Respondents highlighted that political goodwill depended on the direct involvement of grassroots leaders representing the different at-risk communities in the process of decision-making. This involvement was considered the condition for the development of accurate leaders' understanding of the context in which cooperation evolves, and for effective transparency and accountability of decision-making for resilience-building.

The taking of responsibility on the part of leaders for the decisions made and operations conducted was considered as another characteristic of good leadership, complementing political goodwill. Respondents highlighted however that this taking of responsibility had to be distributed across levels. They considered that grassroots leaders had to be identified and empowered, and had to be made as accountable as authorities to ensure effective strategy implementation and service delivery in the different communities without discrimination.

The development of trust among all stakeholders, and more particularly the most remote communities, was considered a particularly key priority that had to be pursued by leaders to achieve good leadership. Stakeholders must trust in the leaders' willingness and capacities to shoulder their responsibilities in order to develop trust in strategies and decisions, and ensure their effective implementation. Building such trust however was recognised as one of the hardest tasks in leadership, especially during crises. Respondents considered direct interactions between the authorities and grassroots leaders as conditions to the development of such trust.

Respondents often associated good leadership with the fair representation of the diversity of the society within the governance structure. This fair representation was seen as a condition to the respect of the community as a whole, without discrimination, and including the whole scope of stakeholders (the different levels of government agencies, types of actors, communities and groups of civil society). Hence, the identification, recognition, empowerment and direct involvement of grassroots leaders within the governance system, and more particularly in the decision-making process, were seen as essential to achieve fair representation and consequent good governance.

This fair representation of the diverse communities, supported by the integration of grassroots leaders, was also a key asset to achieve another characteristic of good leadership: humility. Respondents believed that interactions, and confrontation, between diverse leaders (official and non-official, central and decentralised) prevented leaders to focus on their own interests or the interests of only a part of the system members. The development of leaders' humility was then facilitated by cooperation between authorities and grassroots leaders in the decision-making process.

Finally, the lack of community self-confidence to interact with the decision-makers was often considered as an obstacle to good leadership. This prevented leaders developing an accurate understanding of needs of all communities, which may prevent them from ensuring that strategies were appropriate to the specific needs of certain communities. Respondents believed that authorities had to identify, recognise and empower grassroots leaders to develop trusting relationships with them and build self-confidence of community representatives to get involved directly within the decision-making process.

THE DEVELOPMENT OF GRASSROOTS LEADERSHIP SUPPORTED BY THE GOVERNANCE SYSTEM

The analysis of formal and informal networks and ties for the purposes of the Social Network Analysis resulted in the structural description of the Vanuatu-Networked-System (Vachette, 2014, 2015a, 2015b, 2016). This system was considered by all respondents as particularly propitious to enable the achievement of these good leadership characteristics. Within the Vanuatu-Networked-System, the 90 respondents identified and described 50 more or less formal networks bringing together government and non-government stakeholders across levels around discussions and decision-making related to DRR and CCA. The effectiveness of these networks relies on a supportive inclusive and integrated system (legal and institutional background, shared leadership and active capacity building activities). The positive impact of inclusive decision-making through a multi-level leadership in Vanuatu has been well-appreciated for decades (e.g. ADB, 1991; Ali, 1992), with the recognition of the key role of NGOs, community leaders and civil groups, as well as the private sector in support of the Government policies and plans. Several grassroots groups, in particular women, youth and churches, are particularly considered within the Vanuatu-Networked-System.

Most respondents, and more particularly non-government, highlighted that women often play a leading role in everyday resilience in developing countries. At the community level, women are increasingly empowered through their primary role in the micro-economy system of Vanuatu (UN, 2010). On several islands, women's groups have come together to apply for small grants and generate income for the whole community. The Department of Women's Affairs (Ministry of Justice) coordinates, among other programs, the Women in Shared Decision-Making (WISDM) program that aims to empower women in the political sphere. For instance, this program supported in 2014 the election of five women in the Port Vila Municipal Council (AusAID, 2014). However, according to respondents, mostly women representatives, real discussions around the role of women in DRR and CCA are relatively new and remain fragile in Vanuatu. Several key institutions and networks, such as the Gender Partner Group or the long-term Gender Protection Cluster for emergency preparedness and management, were established to facilitate discussions about and with women, and help a better consideration of this group as key grassroots leaders.

Parallel to women, empowering youth is crucial to develop effective future grassroots leadership. Vanuatu is a young country, with 58% of the population under 25 years old (UNICEF, 2011). Youth in Vanuatu is recognised as an active and adaptive group with potential for a positive engagement in decision-making related to disaster and climate change risks and development in the country (UN, 2010). Networks developed in Vanuatu for DRR and CCA are particularly aimed at Youth. For example, 350 Vanuatu or the National Youth Symposium on Climate Change, in which young local volunteers can directly get involved in discussion, decision-making and implementation strategy. The network 350 Vanuatu for example showed particular impact during Cyclone Pam preparedness and management with the mobilisation of young volunteers to disseminate information on social media or assist with evacuation management. Cooperation between government and non-government stakeholders to educate the future generation of leaders in CCA and DRR is well demonstrated by a project, which started in 2012, aiming at the inclusion of subjects related to climate change and disaster risks in school curriculum.

The significant role of churches in leadership is also recognised by the Government of Vanuatu (UN, 2010). The key position of Church was strongly captured in the survey; this recognition was equally shared by government and non-government respondents. Vanuatu is characterised by a strong involvement of churches in providing public services and taking part in decision-making for affairs related to CCA and DRR. Church representatives are members of many networks focused on CCA and DRR, and in particular the Community Disaster and Climate Change Committees (cf. below), and are included in government strategies. This correlates with the traditional involvement of the churches in disaster planning, as pastors and other church leaders were key members of the NGO Disaster Coordinating Council, NGO Disaster Management Committee, and NGO preparedness and awareness workshops right after independence (Ali, 1992). The mobilisation of churches by the Government for providing evacuation centres, and the empowerment of churches and their networks to participate in effective response during Cyclone Pam confirmed the potential of such systems in contexts like Vanuatu to lead more effective operations. Although churches cannot be considered as grassroots leaders since they have established and official structures and a network recognised by authority, they play a central role in enabling grassroots leadership development. Churches are a central symbol of power in Vanuatu, whether through membership for the majority of the population (with around 83% of the Vanuatu population being Christian based on US

Department of State, 2007) or by rejecting it as a symbolic opposition to the colonial heritage (such as the Yakel village in Tanna promoting traditional beliefs against western religion). The continuous and trustful relationships with the communities put them in an ideal position to develop grassroots leadership by being a platform for grassroots leaders to grow among their community, being a venue for grassroots leaders to conduct discussions among their communities, and being a connector between the communities and the decision-making levels.

Government and non-government local respondents described that traditional response to disasters, developed before the colonial system, focused on civil capacities to support food security and relief assistance from one community to another. Over time, relief gradually switched from the civil to the national, regional and international levels (Campbell, 1990). Respondents reported this induced a fracture between the "new" decision-makers (national leaders and donors) and the traditional way to address needs (communities). However, grassroots leadership in disaster and climate change matters is increasingly being re-introduced. The 5-year national review of the Mauritius Strategy (UN, 2010) highlighted a slow return to consideration of traditional institutions such as Chiefs, churches, women groups and youth groups. The report (UN, 2010) stresses the community influence, talking about the Vanuatu "Hidden Power" or "Power of Faith", which is the individual willingness to participate in general well-being (p.22).

Thanks to their wide community coverage, the influence and potential of the churches, women's groups and youth groups as key platforms for civil leadership, , is recognised throughout the recent policies, plans, strategies and reports focused on Vanuatu governance for resilience-building (e.g. UN, 2010; UNICEF, 2011; Maclellan et al., 2012; AusAID, 2014; Government of Vanuatu, 2015a). Representatives of women and youth were requested as part of the national delegation for the United Nations Climate Conferences (Government of Vanuatu, 2015b), which highlights this increasing recognition and empowerment. Likewise, civil society was particularly well represented in the development of key institutions (e.g. the National Advisory Board on Climate Change and Disaster Risk Reduction) and policies (e.g. the National Sustainable Development Plan). This involvement is strongly enabled by the networked structure in place. Although representatives of the Vanuatu Association of NGOs (VANGO) underlined the lack of recognition from the Government of the numerous informal and ad-hoc networks existing in the rural areas, most local respondents acclaimed the sectoral networks for their capacity to stimulate leadership and technical capacities among the whole community.

Based on the survey, the most important networking structures enabling civil leaders to get involved in decision-making are the Community Disaster and Climate Change Committees (CDCs) established in several at-risk communities. The purpose of the CDCs is to have fair representation on their respective communities; therefore, CDCs are composed of representatives of the different civil groups existing in their communities, such as women, farmers, local businesses, people with disabilities and youth. The objective is to ensure that all groups are effectively assisted at preparedness, response and recovery stages, depending on their specific needs, and with a particular attention to the vulnerable groups. The CDCs have a wide range of responsibilities, from the identification of CCA and DRR priorities in the community to building community awareness on 'Building Back Better'. They also have the responsibility to advocate for, raise understanding of, and ensure sharing of information on DRR and CCA among the whole community. Furthermore, the CDCs are in charge of gathering data critical for DRR and CCA policies and programs, such as on crops or rainfall. Also, most respondents reported that following a disaster, the CDCs were the best positioned platforms for conducting the first impact and needs assessments, and to facilitate the work of the rapid technical assessment teams, using templates that are being developed by the Government and NGOs. Utilising CDC for such work aims to collect the most accurate data to the operational level. Therefore, the CDCs are key venues to facilitate the involvement of grassroots leaders, who can ensure the good development of projects related to disaster risks and climate change, led by government agencies, NGOs and other organisations, in their respective communities. This bottom-up flow of leadership is essential, given the difficulties encountered at the national, regional and international level for developing strategies appropriate to the special needs of each at-risk communities. All respondents who had been in more or less direct contact with these civil networks highlighted that the CDCs were a perfect illustration of the strong awareness and efforts at the civil leadership level to mainstream pertinent, consistent and effective strategies for DRR and CCA, as well as the desire and efforts of authorities to recognise and empower grassroots leadership.

DISCUSSION

By supporting the development and empowerment of grassroots leadership, the Vanuatu-Networked-System offers the example of a governance system propitious to resilience-building in SIDS. The co-existence of more or less informal and flexible networks linking decision-makers, local officers and civil society, and the recognition of grassroots value in formal institutions and policies optimise the potential of grassroots leadership. This system developed an effective bottom-up-top-down approach to resilience-building.

Grassroots leaders have diverse profiles and serve individual objectives (a certain community, a certain line of work, a certain etc.). When brought together, the diverse groups of grassroots leaders can be a real asset by covering all dimensions and areas in need of resilience-building, supporting the development of a national strategy despite challenges inherent to resilience-building in SIDS (such as diversity among the different at-risk communities, resource scarcity, political instability etc.). This requires a more formal overriding supervision that can be fostered and facilitated by authorities without undermining the informal level of activities of grassroots leaders.

Grassroots leaders cannot create national strategies, positions or budget priorities, but can induce authorities to make these decisions. To have an actual impact, it is essential that grassroots leaders have a clear understanding of the formal authority level and know the actual gaps and challenges on which they can have an impact. This requires that dissemination of information and knowledge takes place in a two-direction process, such as the bottom-up-top-down approach adopted by the Vanuatu-Networked-System. The recognition of grassroots leadership as a value to governance effectiveness by authorities facilitates the impact of these unofficial leaders, by allowing social change to happen through cooperative instead of conflictual actions. The Vanuatu-Networked-System is a special case study in which authorities and grassroots leaders tend to have similar objectives, allowing the development of the bottom-up-top-down approach. The arrival of external actors during Cyclone Pam management challenged this balance. For instance, the strong involvement of churches in strategy development was not always well accepted by secular international humanitarian actors. The strong ties established pro-actively between grassroots leaders and national actors in Vanuatu for DRR and CCA prevented these conflicts from hampering emergency management, through the clear position of grassroots groups in the process of decision-making.

Accordingly to the perceived criteria of good leadership, a multi-level leadership system, strongly recognising and empowering grassroots leaders, was developed within the Vanuatu-Networked-Governance. This multi-level leadership is mainly enabled by the set of networks bridging across levels. More particularly, to remain effective, grassroots leadership needs to evolve within a flexible, non-binding and informal system in order to prevent the politicisation and fear of commitment of potential grassroots leaders. The set of networks, and their role as flexible venues to link grassroots leaders with authorities, is the main asset for SIDS to build an effective governance system. It allows the different groups of grassroots leaders across the different communities to have access to all resources and knowledge developed by international, regional, national and local stakeholders often involved in SIDS development, without binding engagement.

The co-existence of formal and informal networks, of traditional and modern structures, and of grassroots leadership and authorities develop a whole system propitious to simultaneously formalise grassroots dimensions that require more structure (such as development of national policies), and to keep other grassroots dimensions informal (such as non-binding cooperation for ad-hoc emergencies).

CONCLUSION

The governance system developed in Vanuatu, and its bottom-up-top-down approach, developed a flexible, comprehensive and enabling structure effective for making appropriate, consistent and pertinent decision-making in a SIDS to build resilience to hazards and develop a culture of preparedness among at-risk communities. This system particularly recognises the value of grassroots leadership and evolved around the objective to empower this asset to support effective decision-making and its implementation.

The full understanding on the impact of grassroots leadership is limited in this paper, which reflects the perception of actors only. The findings of this paper highlight how grassroots leaders can facilitate appropriate, pertinent, consistent and effective decision-making and its implementation for effective actions in resilience-building. Further research among the non-leading civil society targeted by this grassroots leadership is needed to complement this governance perspective with the concrete outcomes on the level of resilience of communities.

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REBUILDING NEPAL: TRADITIONAL AND MODERN APPROACHES, BUILDING OR DIMINISHING RESILIENCE?

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ABSTRACT

Nepal suffers devastating earthquakes on a regular basis, with its central region affected approximately every eighty to one hundred years, and is subject to other hazards much more frequently. As a consequence the people of Nepal have developed building typologies that respond to the local conditions and contribute to local resilience. In recent years, and particularly in the wake of the 2015 Gorkha earthquake, very different approaches and construction solutions have been brought from abroad with the claim that they will assist the people of Nepal to 'build back better'.

Based on field observations and discussions with local community members, artisans, architects and engineers, as well as international experts, and focusing on housing in areas impacted by the 2015 eathquakes, this paper examines: the design and performace of traditional building typologies to various hazards in Nepal, including earthquake; the changes that have occurred over time leading to the failure and/or rejection of these typologies; and reconstruction options and approaches offered, both traditional and modern, and their impacts on architectural diversity, cultural identity and local resilience.

Key words: Nepal, traditional building resilience, architectural diversity and culture, changing technologies

INTRODUCTION

Nepal suffers devastating earthquakes on a regular basis, with its central region affected approximately every eighty to one hundred years. The 2015 Gorkha earthquake and its powerful aftershocks caused extensive damage around the Kathmandu Valley and the mountains to its west, north and east. Almost 9,000 lives were reported lost when mountainsides crumbled and buildings collapsed.

But seismic events are not the only hazards that the Nepali people face in their occupation of the land. Annual hazards include freezing winters, high winds, snowmelt and torrential monsoon rains in summer causing landslides and flooding. Empirical knowledge, gained through the cyclical testing of communities and structures by these events, has developed over generations and is reflected in the settlement patterns and traditional housing models that are scattered across the Nepalese landscape and throughout the historic urban centres, contributing to their distinctive character.

Over recent years, however, particularly since the 1970s, the importation of foreign knowledge, practices, materials and technologies has brought about substantial change to people's aspirations and the built environment (Adhikary, 2016). Since the recent earthquakes, there has been increased pressure to reject traditional construction technologies and to adopt fully imported solutions with the claim that these will enable the Nepali people to 'build back better'. But are these claims well founded? Why did the traditional solutions fail and will the modern solutions provide a more resilient future?

This paper raises issues identified through pre and post-earthquake field observations and through discussions with local community members, artisans, architects, engineers, international experts and NGOs (local and international) involved in the reconstruction. It highlights the complexity of issues that must be considered in assessing earthquake damage and potential new solutions. It argues for the recognition of empirical knowledge and vernacular architecture in building resilience and maintaining diversity in Nepal.

RESEARCH METHODOLOGY

The methodology for this study was generally qualitative in nature, with information gathered through action research and field observations undertaken over a two-year period (2014–2016). Research was participative, with individual and focus group interviews with local people and experts in the field contributing to the research process. Analysis and critical reflection further informed the approach, underscored by the author's application of knowledge gained through years of field experience. In short, data for this paper has been drawn from multiple sources and critically analysed within an action based research framework which is considered to be well suited to the conditions and circumstances as it is flexible and responsive.

The author, an architect and specialist in traditional building construction and conservation, first visited Bhattedande and neighbouring villages in 2014 to study the vernacular housing. She also investigated historic urban housing in Dhulikhel and Kathmandu. Some of the buildings clearly bore the scars of previous earthquakes and damp issues associated with the annual monsoon rains. These were recorded photographically, in field notes and annotated sketches.

Immediately following the earthquake of 25 April 2015, the author was involved in discussions with members of ICOMOS–ICORP (UNESCO's International Council on Monuments and Sites–International Scientific Committee on Risk Preparedness) regarding the earthquake's impact on traditional buildings in Nepal. Geologists, remote sensing experts, engineers and architects with expertise in traditional construction in seismic zones made rapid assessments of the damage by analysing satellite imagery, video footage and before and after photographs provided by people in the field.

In the wake of the earthquake, the Nepal Rebuilds network was established by local Nepali professionals and local and international NGOs to share information to facilitate recovery and reconstruction. The author prepared an open discussion paper outlining the issues identified through these discussions, as well as findings of rapid assessments prepared by others involved in the emergency response. The paper was circulated within the group for review and comment. Email correspondence was entered into to clarify observations and issues reported.

In October 2015, the author returned to Nepal as a member of the Joint World Heritage Centre, ICOMOS and ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) Reactive Monitoring Mission to review the impact of the earthquakes on the World Heritage Property of the Kathmandu Valley. This included a review of damage to vernacular housing located within the property. Discussions with architects, engineers and other experts in the Department of Archaeology (the state party responsible for the management of the property) and ICOMOS Nepal focused on the type, extent and potential causes of damage to the structures, as well as issues for recovery. Consultation was also undertaken with various community stakeholder groups and representatives of local government.

In February 2016, the author returned to Dhulikhel and the village of Bhattedande to examine both the collapsed buildings and those that had survived, and to observe reconstruction within the village. Issues were raised and discussed with local village leaders and artesans, as well as NGOs involved in the reconstruction effort.

This paper highlights and critically reflects on the various issues identified through these investigations and discussions.

TRADITIONAL SETTLEMENT PATTERNS AND HOUSING TYPES

Settlement Patterns

The Kathmandu Valley has been highly urbanized for several hundred years with city states established around the historic urban centres of Kathmandu (Hanuman Dhoka), Patan (Lalitpur) and Bhaktapur. The cities feature brick and timber palaces, tiered temples and vernacular housing gathered along narrow streets and around public squares. The buildings closely abut each other, creating dense blocks with shared internal courtyards.

By contrast, rural settlements located on the steep mountain slopes surrounding the valley are generally looser in arrangement, with free standing houses laid out along the contours of the land, closely hugging the hillside whilst maintaining close contact with the rice terraces that feed them. Nevertheless, they form close communities that provide mutual support and some protection from the elements and wild animals.

Housing Typologies

The traditional houses are generally rectangular in form, three storeys high, with the top storey nestled within the large pitched roofs. In rural areas, they are raised on a plinth, approximately 450mm high, to keep the water out. Cooking and livestock are accommodated on the ground floor to provide warmth to the sleeping and storage areas above. Verandahs provide external work and living spaces. In the cities, the ground floor often accommodates a shop or workspace in a timber framed undercroft.

The houses vary in construction, depending on the local material resource, geography and climate. Within the study area the houses are of masonry and mud construction laced with timber, brick in the Kathmandu Valley and stone on the mountainsides. The windows are small and the walls thick to contain the heat. The mud and clay tiled roofs also provide insulation against the cold. The steeply pitched roofs and wide eaves protect the walls from the driving rains; fibrous mud plaster is reapplied regularly to the external wall surfaces to keep them waterproof; and drains take the water away from the footings. Thus the buildings are well designed for the cold winters and wet summers, whilst providing the necessary accommodation for daily life within the confined space offered by the small city allotments or narrow mountainside terraces.

Seismic Design

Although the masonry walls are loadbearing, the key seismic components of these structures are the timber elements (Langenbach, 2015; Adhikary, 2016; Pauperio & Romeo, 2016). These include: timber ring beams distributed at various heights throughout the buildings (floors, lintels and ceiling) to bind the walls together; long timber sills and lintels to spread the loads over the window and door openings; timber posts to transfer the loads vertically; timber floor structures that project through the walls to form structural diaphragms; and braced timber roof structures that contain and stabilize the tops of the walls. The timber is able to flex and move to absorb the seismic forces, and is used to contain the masonry, which has no tensile strength. Although the soft mud mortar joints allow the masonry elements to slide across each other, large corner stones and through stones help to bond the walls together (Yoemans, 1996; Desai, 2015).

FAILURE OF TRADITIONAL AND MODERN HOUSING

As these types of structures were predominant in the areas most affected by the 2015 earthquakes, their failure was extensively reported in the media (Adhikary, 2016). Very little was said about the failure of modern concrete buildings, and even less about the vernacular buildings that survived. However, it is not sufficient just to say that the buildings failed. It is important to ask what failed and why. Was it the design that failed or were there other causes? Detailed investigations of the buildings revealed the following (Forbes, 2015; Langenbach, 2015):

Essential timber components in many buildings had decayed (rot and/or insect attack), compromising their structural integrity;
Essential timber elements had been substantially reduced in size and/or number, or were missing altogether from many buildings;
Masonry walls separated through lack of adequate bonding (missing large through stones);
Masonry gable end walls fell out due to lack of containment;
Mud mortar was missing from masonry joints;
Cement mortar on the other hand had caused stones to fracture due to its strength and rigidity;
Internal cross walls were lacking;
Houses were poorly located on unstable ground; and
In city locations, the addition of unapproved floors to the tops of buildings caused overloading and failure of the walls below.
It is evident from these findings that construction traditions had either been forgotten or compromised.

CHANGING CONDITIONS

In order to better understand the causes of failure and to prevent or mitigate these in the future, it is necessary to understand the historical, environmental, technological and societal changes that have occurred over the last hundred years.

Timber shortage

Following the earthquake of 1934, it was recorded that suitable construction timber was in very short supply (Adhikary, 2016). This has continued to be the case in many areas affected by the recent earthquakes, with buildings being built with young poor quality timber, often untreated softwood (treated timber not being available) rather than the traditional more durable hardwood that is resistant to rot and insect attack (Forbes, 2015). Although deforestation has been recognised as a major issue in Nepal for many years and forestry programs have been established to provide slope stabilization, new agricultural products and a fuel source for cooking and heating, the establishment of forests for the production of quality hardwood for construction does not appear to have been a priority. Restrictions on timber harvesting have also made suitable construction timber expensive and difficult to get. This has contributed to people not only using poorer quality timber, but also reducing the size or number of critical timber elements, or omitting them from their buildings altogether (Adhikary, 2016; Forbes, 2015).

Changing technologies

Since the 1970s, the importation of new construction materials and technologies has introduced new building typologies to urban areas, but also to areas easily accessible by road (Desai, 2015). The globally popular reinforced concrete frame is now prominent across the landscape of the Kathmandu Valley, reflecting peoples' aspirations for modernity as well as their strong belief in the strength and durability of cement. Their intrusion into more remote mountain areas only accessible by foot has not been as great.

Loss of memory, knowledge and skills

Although reinforced concrete construction requires specialist engineering knowledge and construction skills, the workforce has followed the demand and adapted, abandoning the traditional artesan skills and knowledge that would previously have been handed down from one generation to another. These changes are reflected in the professional training of architects and engineers, which focuses totally on modern construction (Adhikary, 2016), and have contributed to the low status of traditional artesans within society and the devaluing of their knowledge, despite its continued relevance to anti-seismic design and appropriate design for climate and place.

As eartqhuakes usually occur only once in a person's lifetime, the memory of disaster and its impact on buildings is often lacking. Thus, without the intergenerational transfer of knowledge, critical safety elements can be forgotten and not implemented. The trust placed in the strength of cement mortar has lead to the construction of thinner walls and the removal of through and corners stones as key building elements. It has also lead to risking construction on less stable ground (eg. building on the filled outer edges of mountain terraces rather than on the solid ground back against the hillside) (Forbes, 2015).

Building Codes

Followiing extensive research into both traditional and modern construction technologies, Nepal developed building codes for seismic design in 1994 (DUDBC). These incorporated 'mandatory rules of thumb' that reflected empirical knowledge of the past, although not the full diversity of solutions developed across the country, as well as engineering requirements for the use of modern materials (Sharpe, 2015). However, as there was no inspection or certification process to ensure that buidlings were correctly built, these codes were never fully implemented. Lack of proper engineering input, skimping on materials and later additons to buildings that were not designed for them, saw many modern structures collapse as well as traditional ones (Jain, 2015).

Maintenance and Urban Infrastructure

In rural areas, annual maintenance of structures in the form of remudding of walls, weeding of roofs and maintenance of drains are embedded in the local culture (site evidence, 2014 and 2015). However, in city areas, the installation and upgrading of modern infrastructure, such as sealed roads, water supply and sewerage systems, has changed the environment in which the buildings exist (site evidence 2015 and 2016). Over time, rising ground levels have resulted in roads, through multiple layering and resurfacing, being half a metre above internal floor levels instead of half a metre below. This, together with the pressure of tall new structures built up against the old, has made access for maintenance and repair extremely difficult. Monsoon rains flood into the shops and houses at both roof and ground level accelerating their decay. The loss of mortar from joints and the decay of bricks and timber elements contributed to the failure of many traditional city buildings during the earthquakes (site evidence, 2014, 2015 and 2016).

RESPONSE AND RECOVERY

Although the current crisis is a result of earthquake, reconstruction must address all hazards and all aspects of daily life, both now and into the future, including accommodating people's livelihood needs within the confined spaces available. The solutions should also be sustainable, economically, socially, culturally and environmentally.

Government Funding

The Nepali Government pledged monetary support to all homeowners whose houses collapsed, but proportional funds were not offered for houses that were partially damaged (Adhikary, 2016). As a result, it has been reported that many people demolished their houses for the government survey, even though they could have been repairable (Desai, 2015). In Bhattedande though, many people stated they demolished upper floors as a precautionary measure against further collapse during aftershocks (village discussions, 2016). In February 2016 (ten months after the earthquake), government inspectors had still not surveyed the damage to houses in Bhattedande even though there had been an 80% loss in the village. As people awaited government confirmation of reconstruction requirements, they had not begun to rebuild. Thus, although the government promise was made with good intentions, it had in essence disempowered people from undertaking their own recovery.

New Buildings and Technologies

Although all new buildings are required to be constructed in accordance with the national building code, which is currently under review, as yet no certification system has been put in place to ensure that this occurs (Adhikary, 2016). Nor is the financial assistance offered sufficient to meet the costs of improvement. In the city areas, where people can afford to rebuild without government assistance, reinforced concrete framed buildings have been re-erected quickly, again without proper oversight and often repeating the mistakes of the past (Adhikary, 2016).

Although the code provides rules of thumb for traditional construction, the new *Design Catalogue for Reconstruction of Earthquake Resistant Houses* developed since the earthquake by the Department of Urban Development and Building Construction (DUDBC, 2015) promotes modern construction and limits traditional construction to a single storey. This restriction on size fails to satisfactorily accommodate living and livelihood needs on the limited land available.

Many international companies have offered new manufactured products, ranging from steel frames to polystyrene wall panels. Nearly all require importation of materials and expertise from abroad and few have regard to the local social, economic and environmental conditions. Poverty, combined with the recent blockade of the Indian border (due to political unrest), has temporarily prevented the importation of many of these options. The homogeneity that these global alternatives create in the built environment fails to recognize the value and appropriateness of local solutions to local conditions.

Local Solutions

In remote rural areas, lack of access and minimal financial resources necessitate the adoption of local solutions that use the physical and human resources available. Even if communities had the money to afford cement and steel, these materials cannot be carried up the steep mountain paths. Therefore, where quality timber is not available, the immediate issue is finding alternatives for the traditional seismic timber bands. Solutions incorporating polypropylene geogrid bands (Adhikary, 2016), galvanised wire gabion bands (Langenbach, 2015) and wire containment (Desai, 2015 & 2016) have been developed and tested for seismic performance. These options, which incorporate local materials, knowledge and skills, provide far more affordable and sustainable alternatives that enable maintenance of local character and identity through retention of local architectural typologies. However, as yet, these solutions have not been approved under the national building code.

Capacity Development

As found in Bhattedande, many villages have lost both their traditional artesans and modern construction workers through the export of skilled labour to Asia and the Middle East where the pay is better (village discussions, 2016). Thus, reconstruction requires capacity development in both traditional and modern construction. Not only do traditional skills and knowledge need to be reinforced and strengthened, but also understanding of the highly technical nature of reinforced concrete construction: including the correct proportioning of cement, sand, graded aggregate and water; appropriate cover to steel to prevent corrosion; and the removal of air to ensure homogeneity and structural integrity (site evidence, Bhattedande, 2016).

Organisations such as CRAterre (International Centre on Earthen Architecture) have partnered with the Red Cross and local NGOs to develop simple guidelines that illustrate the key elements of earthquake resistant houses based on well-researched local materials and technologies (Forbes, 2015). CRAterre and the Nepal Vocational Academy (Panauti, 2016) have provided hands-on training for local builders and artesans to ensure they have the skills and knowledge needed for traditional reconstruction. NSET (National Society for Earthquake Technology-Nepal) has also provided construction training focused on meeting building code requirements (Forbes, 2015).

Testing over Time

Nepal's traditional housing typologies have developed through cyclical testing over time. Although those houses that were in good condition survived with little impact from the disaster, many of the houses that collapsed were found to be old, poorly maintained and suffering from decay. In comparison, the concrete houses that survived were relatively new. The performance of these houses over time has yet to be tested. Considering the vulnerability of steel to corrosion when exposed to water and air and the impact that this will have on the structural integrity of these buildings, the durability and long-term sustainability of this construction type and other alternate solutions must also be considered and monitored.

CONCLUSION

Unfortunately, the failure of traditional buildings in the recent earthquakes has been considered by the general populace as the failure of the materials used, rather than the failure of poor construction, poor maintenance or the changing built environment. Conversely, in the case of modern buildings, the failure has generally been attributed to greed, corruption and poor construction. The misunderstanding of causes of failure, particularly in relation to traditional building types, has lead to a general rejection of these typologies both locally and internationally. Correspondingly, there has been an accelerated take up of the imported modern technologies, which have not been locally tested over time.

The long-term impact of this for Nepal will be the loss of architectural diversity, cultural identity and diminished resilience through the loss of local knowledge and skills. It will also result in financial loss to the local tourist economy through the loss Nepal's unique character. The future failure of the modern buildings will also result in diminished resilience.

Major issues that still need to be addressed include: improving governance within the property and construction industries to ensure that buildings meet the required construction standards; improving drainage within urban areas to prevent flooding and reduce building decay; and building community awareness regarding the need for regular maintenance – buildings in good condition are far more resilient than those in poor condition.

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BUILDING CHRISTCHURCH'S WATER INFRASTRUCTURE BACK BETTER

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ABSTRACT

Christchurch's water infrastructure suffered significant damage during the 2010-2011 earthquake sequence. This case study reviews the methods used by the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) – who had to the role to rebuild the city's horizontal infrastructure – in rebuilding the city's water infrastructure back to either an improved or better condition which existed prior to the earthquakes.

The formal Build Back Better (BBB) framework, included within the Sendai Framework for Disaster Risk Reduction 2015-2030, conceptualised by Mannakkara and Wilkinson forms the structure of this research.
Overarching principles within this framework – Disaster Risk Reduction (DRR), Community Recovery and Implementation – together provided a holistic framework to guide post-disaster recovery efforts.

This paper aims to demonstrate how BBB can be practically applied during the rebuilding of communities to guide rebuilding efforts following natural disasters. The DRR principle is focused upon during this paper and includes sub-groups; Structural Resilience, Multi hazard based Land Use Planning and Early Warning and DRR education. Linkages from this principle to the Community Recovery and Implementation principles are also discussed, assisting to demonstrate the holistic nature of the BBB framework.

Performance related to the DRR principle has been assessed as "moderate". Key actions taken include the enforcement strict design and construction standards and closer attention to land condition and location. Opportunities for further improvement include the adopted of new technologies and design / construction methods.

Community Recovery considers the management of economic and social factors while Implementation considers the governance, legislation and regulation during the water infrastructure rebuild.

Key words: *Build Back Better, Christchurch, Disaster Risk Reduction, water infrastructure*

INTRODUCTION

Christchurch's water infrastructure suffered significant damage during the 2010 and 2011 earthquakes. Rebuilding the city's water infrastructure presented a significant challenge, which had never been seen before in New Zealand. Build Back Better (BBB) is a relative new post-disaster rebuild framework that takes a holistic, yet theoretical approach to rebuilding communities. This paper aims to;

Consider the steps taken to rebuild Christchurch's water infrastructure.
Understand where improvements in the city's water infrastructure have been made.
Understand if BBB is a practical framework to guide infrastructure rebuild efforts following a natural disaster.

Pre research situation

Initially developed and applied for the first time on a regional scale during the aftermath of the 2004 Indian Ocean Tsunami (IOT), BBB is a post-disaster recovery mechanism that aims to prevent and minimise damage in the event of future natural disasters in a holistic manner (Mannakkara and Wilkinson, 2014, Clinton, 2006). In the past many frameworks within the disaster preparedness and rebuilding sector have focused upon resilience, in preparation for future disaster events, but as suggested in the name of BBB, this concept considers resilience in a post-disaster situation (Mannnakkara and Wilkinson, 2014).

There has been a recent push to encourage the focus given towards Building Back Better. The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) includes "enhancing disaster preparedness for effective response, and to Build Back Better in recovery, rehabilitation and reconstruction" as one of its four priorities for the next 15 years (UNISDR, 2015). The SFDRR recognises that being able to effectively BBB also requires a degree of pre-disaster planning and awareness, therefore it is anticipated that BBB will obtain significantly more attention over the coming years (UNISDR, 2015).

Figure 1: Build Back Better conceptual model (Mannakkara and Wilkinson, 2014)

Wilkinson and Mannakkara established a conceptual model (Figure 1). This model has three high level sub-groups, each with two principles. All of the six principles are made up of a range of BBB factors, which were used to measure the practicality of BBB and assess the performance of the water infrastructure rebuild in Christchurch.

Table 1: BBB factors for Principle 1 – Structural Resilience (Mannakkara and Wilkinson, 2013).

Building Codes and Regulation
Enforce building codes and regulations using legislation Provide education on building regulation revisions prior to rebuilding to key stakeholders On-going regular inspections and retrofit programmes Incorporate traditional technologies
Cost and Time-related Factors
Arrange long-term funding to cover extra costs for structural improvements Provide incentives (e.g. tax reductions) to promote adoption of structural changes Provide transitional accommodation to relieve pressures on rebuilding
Quality
Arrange quality assurance inspections Provide incentives to attract skilled builders for reconstruction Provide professional supervision for owner-building Arrange rebuilding advisory service centres to support home-owners Facilitate the use of efficient and effective quality control methods*

Note: * Highlights new factors, refer to Results section.

Table 2: BBB factors for Principle 2 – Multi-hazard based Land-use Planning (Mannakkara and Wilkinson, 2012).

Risk based Zoning
Divide land (to be used for reconstruction) into risk zones based on multi-hazard assessments Determine appropriate land-uses based on risk zone maps AND relevant building regulations Provide education on risk reduction and revised land-use plans prior to rebuilding Implementation long-term risk management systems through information dissemination and inspections
Resettlement
Provide resettlement only for high-risk lands where rebuilding is not feasible Collect background information about household subject to resettlement

Identify potential low risk land sites close to the original settlement
Involve the community in choosing new land sites
Provide incentives for relocation (e.g. payment for relocation, employment opportunities)
Provide support for resettlement through counselling and advisory services
Consideration of ground condition during construction and design phases*

Note: * Highlights new factors, refer to Results section.

Prior to commencing the rebuild SCIRT conducted a detailed analysis of the damange sustained to water infrastructure across the city. This analysis revelaed that 48% of water infrasructure required renewal, a further 46% required some form of repair and the remaining 6% requiring no action (P14). This highlighted the significant job which confronted SCIRT and demonstrated the need for a structured and effective method be used to rebuild Chrtistchurch's water infrastructure within five years, the agreed fixed lifespan of SCIRT.

METHODOLOGY

A case study approach was deemed to be the most appropriate for this research. This was primarily due to BBB being a new concept and there being minimal case studies available that measure the performance of infrastructure rebuild efforts and the practical use of the holistic BBB framework.

Key research methods used included Semi-Structured Open-ended Interviews; document analysis; industry seminars; and data analysis. Interviews were held with fourten SCIRT representatives from various roles across the organisation, ranging from professional design engineers, on-site construction supervisors and other business support staff. Design engineers and on-site construction supervisors from each of the four design teams and and five construction, or "delivery" teams were interviewed. This interview approach enabled our research to gain a full appreciation of the process from project initiation through to construction and delivery. A summary of interview paticipants is provided below.

Table 3: Interview participants

Role within SCIRT	**Experience Levels**		**Participant Identification**
	Career Length	**Geographic Location**	
Delivery Team Project Coordinators	10 years (2) 20 years (2) 30+ years (1)	United Kingdom (1) Australia (1) and New Zealand (3)	P1 to P5

Delivery Team Site Supervisors	Under 10 years (2) 30+ years (1)	United Kingdom & Australia (1) New Zealand (2)	P6 to P8
Design Team Engineers	Under 10 years (2) 20 years (2)	United Kingdom (1) Australia (1) New Zealand (2)	P9 to P12
Senior Managers	20 years (1) 30+ years (1)	United Kingdom (1) New Zealand (1)	P13 and P14

Note: Numbers in brackets show the number of interview participants.

Supplementary research methods, including document review; industry seminar participation; and data analysis were used. These were used to inform an overall rating of how Christchurch's water infrastructure was rebuilt, using the BBB framework as the reference point. Although assessments have been based on often qualitiative information, ratings have been represented in a quantiative manner to help communciate levels of performance (refer to figures 3 and 4).

RESULTS

During this research, four themes related to Disaster Risk Reduction when rebuilding Christchurch's water infrastructure became apparent. These themes include;

Improved building codes and regulation
Adopting a quality construction and design process.
Robust construction planning and delivery processes.
Adopting a risk based design approach.

Observations related to each of these themes have been presented during the remainder of the results section.

Improved building codes and regulation

Three key documents (Table 4) were used by design and delivery teams throughout the rebuild.

Table 4: Construction and design standards used in the water infrastructure rebuild (P1-P5, P13 & P14).

Document Name	Came into effect	Description
Infrastructure Recovery Technical Standard and Guidelines (IRTSG)	Post-earthquakes	Provides the overall brief for rebuild projects associated with SCIRT

Construction Standard Specifications (CSS)	Pre-earthquakes – but has been adapted post-earthquakes	Guides construction of infrastructure within the CCC area
Infrastructure Design Guidelines (IDS)	Pre-earthquakes – but has been adapted post-earthquakes	Guides infrastructure design methods in the CCC area

Note: Both the CSS and IDS include sections to other infrastructure which is not related to water infrastructure.

These documents were either developed by, or in close consultation with CCC, the owner of Christchurch's water infrastructure. These standards are similar to the existing standards which were in place prior to the earthquakes, and were updated to include specific earthquake response items. These items focus on using more structural resilient materials and specifying construction methods (P6-P11).

Significant volumes of water infrastructure and land condition data were collected to evaluate the full extent of earthquake caused damage (P3, P6, P7 & P10-P14). This data has been collated by SCIRT and now provides the delivery teams, and CCC in future with more accurate and extensive data base of information to inform future water infrastructure capital and maintenance works (P13 & P14). Delivery team members interviewed expressed that this high volume of information is likely to be significantly more accurate and therefore useful than any other city in New Zealand, (P9) allowing engineers and contractors a greater understanding of the water infrastructure network and inform future works (P9-P12).

Adopting a quality construction and design process

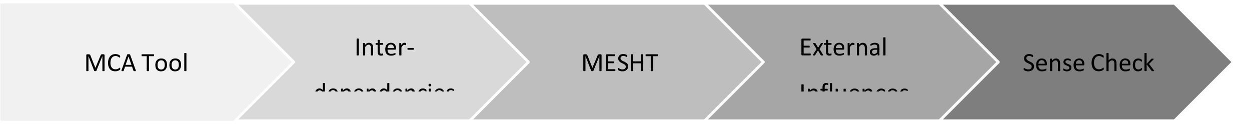
As stated in the previous section, consistent construction and design standards have been implemented throughout the rebuild. To ensure these are followed all designs go through a robust design processes, which culminates with approval from a chartered professional engineer (CPEng, or equivalent) (P2-P6 & P10-P12). In cases, where constructability factors inhibit all aspects of design standards to be included, approval must be sought from CCC prior to construction. This ensures that CCC are aware that the agreed standards cannot be met when considering reasonable constructability and cost implications, and that CCC is satisfied with the alternative design and method proposed (P6-P12).

Each delivery team has their own construction "Project Supervisors" who were responsible for ensuring that the design provided was constructed.

This role was important as the supervisors acted as the linkage between the designers and delivery teams, and helped clarify issues as they occurred (P3-P9). Designers and supervisors interviewed stated that having a dedicated resource to ensuring that construction was of the required standard and helped communication between design and onsite staff assist projects to be delivered of increased quality and in a timelier manner.

Robust construction planning and delivery processes

SCIRT used data collected in the early stages of rebuilding to identify trends in post-earthquake infrastructure condition. This led to the city's water infrastructure networks being divided into 56 catchments, which were then ranked in terms of condition (P13 & P14). These catchments were geographically based and it was decided that rebuilding efforts would occur in catchments – meaning that all projects in the catchment would be completed prior to moving on to the next area. This was largely decided to reduce public disruption and also reassure the public that a systematic approach to the rebuild was being undertaken (P14). Figure 2 demonstrates the five stage process use to prioritise projects and factors considered at each stage (P13 & P14).



Condition Criticality Servicability Ongoing maintenance	Hydraulic Proximity	Medical and Emergency Schools Hospitals Transportation	Social and Environmental Strategic plan requirements Political influence Other rebuild programmes

Figure 2: SCIRT rebuilding prioritisation processes (SCIRT, provided information (P14)).

Using the results generated, SCIRT was able to produce a full schedule of water infrastructure projects. This was key to schedule management and public engagement. This analysis is repeated each three months to ensure that any changes are included. Interviewees noted that schedules changes were infrequent (P13 & P14).

A full and clearly identified schedule of work at an early stage of the rebuild was key as it helped SCIRT management report rebuild progress to owner participants and other interested parties throughout programme delivery (P13 & P14). Early understanding programme progress was crucial for management as SCIRT was established for a fixed timeframe (five years) and with a fixed budget ($2 billion) (Auditor-General, 2013), and would help identify the need for any changes in programme delivery (if required) as early as possible (P13 & P14).

Adopting a risk based design approach

New methods used to rebuild Christchurch's water infrastructure have tended to established and known technologies which are more commonly used in other parts of New Zealand, or overseas (P6-P12). These include the use of Cured In Place Pipe (CIPP) lining and creating vacuum sections of the stormwater and wastewater networks. Both methods were rarely used in Christchurch prior to 2010 (P1-P12). Decisions related to construction method or to change the drainage systems (i.e. change from gravity to vacuum or pressurised) were made on a case by case basis, to ensure that the most suitable – from ongoing performance and "whole of life" cost perspectives effective – balancing both technical and cost factors – decision is made for the future performance of Christchurch's water infrastructure (P10 & P11). This includes considering the risks to the network from future earthquake events, a factor which received significant attention during the early stages of the rebuild as earthquakes were still occurring (P10 & P11).

As stated previously, significant volumes of data has been collated to inform the project schedule and update Christchurch's water infrastructure records. In parallel, large volumes of geotechnical data was being collected to inform a wide variety of rebuild activities (P9 & P11). SCIRT was one organisation which used this information regularly to ensure that suitable precautions could be designed into pipelines to mitigate impacts of future earthquakes where possible. Unfortunately some interviewees (P1-P3, P5 & P9-P13) expressed that this information was slow in being made available, which led to some earlier projects either suffering structural damage during aftershocks or being built with greater conservatism to cater for future ground shaking – both of which had time and cost implications on the programme.

As the rebuild has progressed, more accurate geotechnical information has been made available and consistent updating of the three technical standard (Table 4) have helped to ensure that the appropriate risk based elements are included in future Christchurch water infrastructure designs – both during and following the rebuild.

Performance against Build Back Better principles

During the research it was found that a number of the BBB factors (Tables 1 and 2) were not applicable for the rebuild of Christchurch's water infrastructure. Not applicable factors tended to relate to issues impacting the Christchurch rebuild as whole, including the need for rebuilding incentives (e.g. financial), worker accommodation and direct community involvement. This has led to the proposal of modified BBB model for rebuilding infrastructure, which is targeted to guide infrastructure network rebuilding efforts. This is often for utility infrastructure, including water; transportation; public housing / buildings; telecommunications; and power infrastructure. Factors in the modified principles covering Structural Resilience and Land use planning are included in Tables 1 and 2.

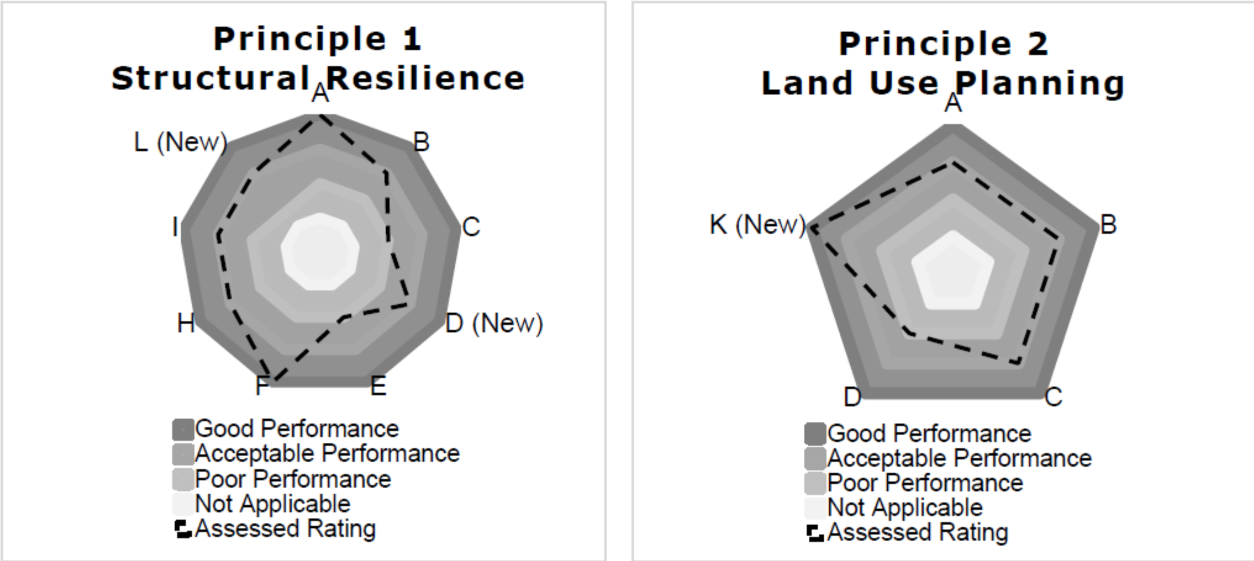


Figure 3: Christchurch water infrastructure rebuild performance related to the DRR principles of the BBB model.

An overall assessment of SCIRT performance rebuilding Christchurch's water infrastructure is provided in Figure 4. Performance against each of the factors from the proposed modified BBB model for rebuilding infrastructure is provided. New factors have been highlighted and can be identified using the identifiers in Tables 1 and 2.

The same assessment approach was taken for the remaining four principles of the conceptual BBB model (Figure 1). Following this, an overall assessment of how Christchurch's water infrastructure was rebuilt relative to each of the six BBB principles has been made and is presented in Figure 4.

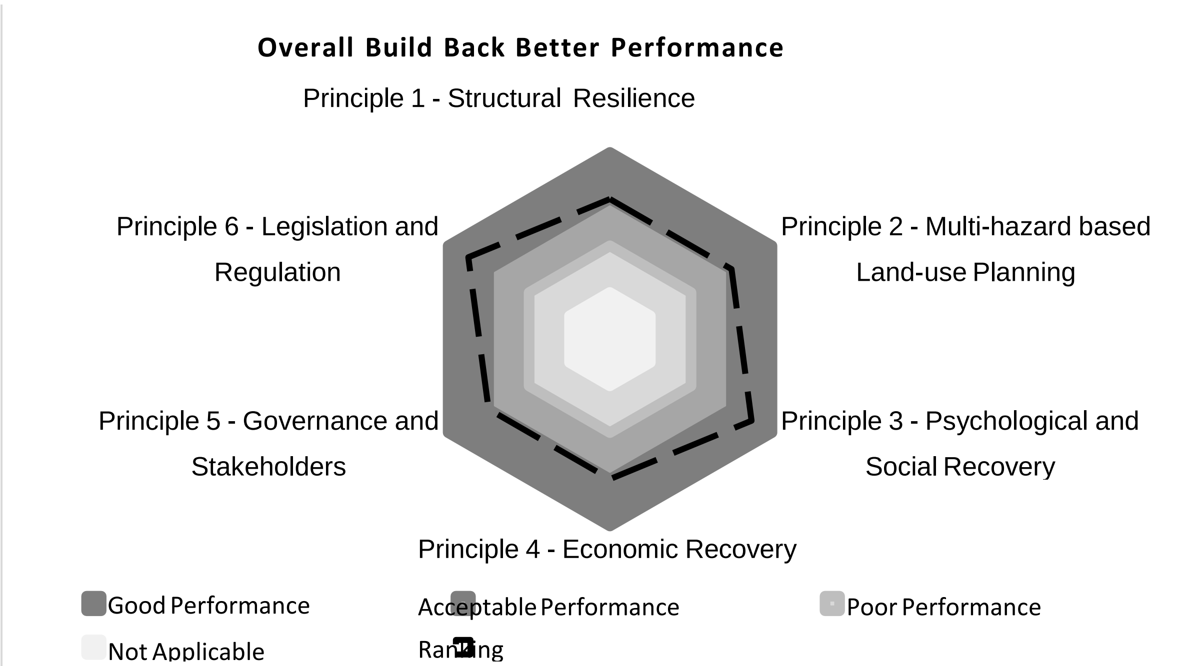


Figure 4: Overall assessment of Christchurch Water infrastructure rebuild as per all principles of the conceptual BBB model (Figure 1).

CONCLUSION

Overall SCIRT has taken many positives steps in improve Christchurch's water infrastructure from a DRR perspective following the 2010-2011 earthquakes. These include steps to improve building codes and regulations; Adopting a quality construction and delivery process; Robust construction planning and delivery processes; and Adopting a risk based design approach. In addition this case study has has highlighted the ability of the holistic BBB framework to guide post disaster rebuild efforts. Although initially established to cover all aspects of rebuilding, proposed modifications have been made to provide a more "purpose built" framework for rebuilding infrastructure networks. This framework can be further developed and refined by using this model to guide infrastructure network rebuilding efforts following a wide range of disasters in different parts of the world.

NOTE: Any views expressed in this paper are those held by the authors.

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MODELLING BUSINESS BEHAVIOURS FOLLOWING THE 2010-2011 CANTEBURY EARTHQUAKES

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ABSTRACT

There are a limited number of economic models specifically designed for infrastructure outage and disaster situations. The degree to which current models account for adaptive behaviours during these 'unusual' circumstances varies. In this paper, we present a model developed to represent business behaviour and recovery following an infrastructure disruption event.

This model was developed as part of the *Economics of Resilient Infrastructure*[6] project, and derived using business recovery data from the 2010-2011 Canterbury earthquakes. The business behaviours model is designed to integrate into a Computable General Equilibrium (CGE) economic model. The earthquake data showed that recovery trajectories follow a logarithmic pattern. A linear regression analysis, modelling the recovery of business operability (or ability to meet demand), showed that recovery was dependent on two variables: (1) overall level of impact experienced by the business and (2) their suppliers' ability to meet demand. However, given supply relationships are already represented in the CGE model, only overall impact was used as an input into the business behaviors model. The researchers are developing this model further so that it is fully transferrable to a range of infrastructure disruption and hazard events.

Key words: Business behaviours; Disaster recovery; Economic modeling; Infrastructure disruption; Spatial decision support system

INTRODUCTION

Increasingly costly and complex disaster events create a need for a greater understanding of the drivers of the economic impacts of disasters. Current economic models, however, often do not account adequately for the capacity of businesses to both mitigate the risk of losses pre-event and to adapt their operations to reduce losses.

[6] Funded by the Ministry of Business, Innovation and Employment, New Zealand

A number of authors have recently developed methods for adjusting for business/industry resilience within economic models. The models are based on a variety of economic modelling techniques, including input-output modelling (Haimes & Jiang, 2001; Haimes, Horowitz, Lambert, Santos, Lian, et al., 2005; Jonkeren & Giannopoulos, 2014), computable general equilibrium (A Rose & Liao, 2005; Adam Rose, Oladosu, & Liao, 2007; Adam Rose, 2004) and simulation modelling (Chang, Svekla, & Shinozuka, 2002; Chang, 2003). These models account for business or industry resilience through resiliency factors and/or inoperability functions.

Resiliency factors are static factors defined as "the percentage of production in an industry … that could still be produced in the event of total [infrastructure type] loss" (Chang et al., 2002, p. 292). Chang et al. made a major contribution to the literature by developing empirically derived resiliency factors for application in probabilistic simulation methodology. Resiliency factors have been adapted and applied to other economic models, for example (Chang, 2003; A Rose & Liao, 2005; Adam Rose & Guha, 2004; Adam Rose et al., 2007).

Inoperability functions are temporal functions that describe the impact of a disruption and trajectory back to full productivity. The impact and rate at which businesses regain productivity is influenced by the sector's dependence on infrastructure, risk management policies, and risk mitigation (Haimes, Horowitz, Lambert, Santos, Crowther, et al., 2005). Inoperability functions have recently been extended to account for factors such as inventories that can buffer the impact of some disruptions (Barker & Santos, 2010; Jonkeren & Giannopoulos, 2014). Generally inoperability functions are theoretically rather than empirically derived.

This research combines these two approaches and generates empirically derived, temporal operability curves (the inverse of inoperability) for application in a Computable General Equilibrium economic model. The research contributes to the Economics of Resilient Infrastructure project.

METHOD

Two and a half years after the February 2011 earthquake (July to December 2013), the authors sampled approximately 2,170 organisations across Greater Christchurch to understand the impact of, and recovery following, the earthquake. 541 organisations (response rate of 25%) responded to the survey, with broad representation of industry sector and ownership types. The survey sample slightly under-represented smaller and younger businesses as well as failed businesses (1% response rate as opposed to an annual average failure rate of 10%). For further details on the survey see (Brown, Seville, Stevenson, Giovinazzi, & Vargo, 2015; Brown, Stevenson, Giovinazzi, Seville, & Vargo, 2015; Seville, Stevenson, Brown, Giovinazzi, & Vargo, 2014).

ANALYSIS AND RESULTS

To generate operability curves, a step-wise linear regression was carried out using the Canterbury earthquake survey data. Error! Reference source not found. shows a conceptual diagram of the factors that contribute to an organisation's level of operability post-disruption and that are included in the analysis.

The dependent variable for the regression, 'operability' is based on the following survey question:

To what extent was your organisation able to meet the demand for your products and services? Immediately after the earthquakes Several months after the earthquakes A year on from the earthquakes Two years on from the earthquakes	Completely (80-100%) (1) Mostly (60-80%) (0.75) Partially (40-60%) (0.5) Limited (20-40%) (0.25) Unable (0-20%) (0)

The initial intent was to carry out the regression analysis at all four time steps noted in this question. However, at one year and two years on from the earthquakes, the majority of respondents were able to completely (80-100%) meet their demand. Therefore, due to the low data spread at these time steps, a regression analysis would not be feasible. Instead, the regression analysis focussed on immediately after the earthquakes (7 days) and several months after (90 days).

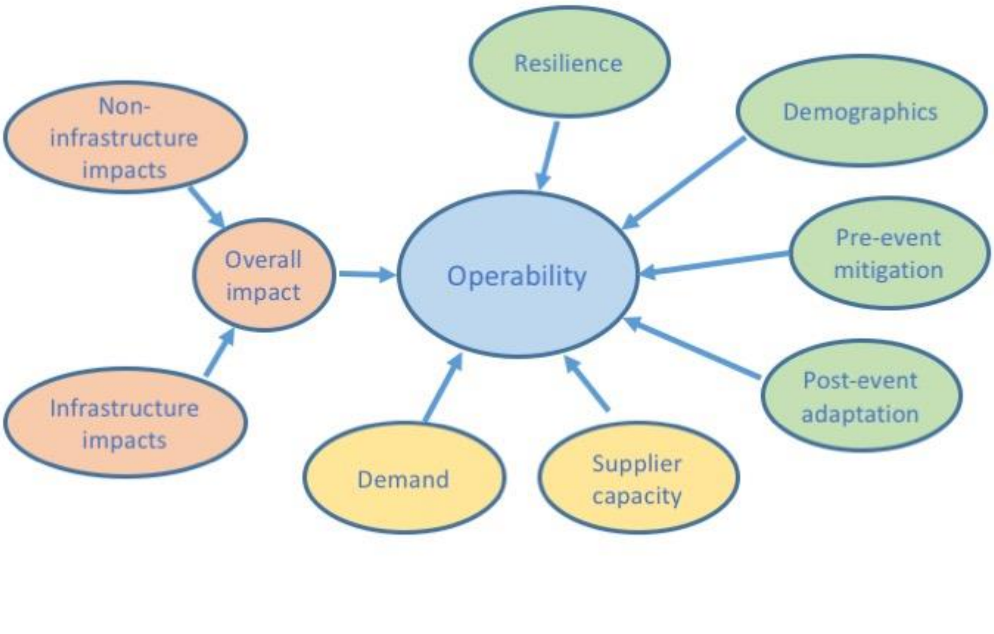

Figure 13 Schematic representation of factors affecting an organisation's post-disruption operability

The independent variables in the regression were constructed through aggregation of a number of survey questions. Questions were aggregated to: 1) reduce the number of variables in the regression and therefore improve the reliability of the model; and 2) where, necessary, account for additive impacts.

In particular, a single variable for 'overall disruption' was created. A factor analysis (Varimax rotation with Kaiser normalization) showed that the earthquake impacts fell into three categories: *non-infrastructure* (premises, neighbourhood and staff), *node infrastructure* (rail, airport, port, fuel) and *network infrastructure* (water, sewage, gas, electricity, phone, data, roads). Rather than aggregate all the impacts in each of these categories, the maximum disruption value within each of the disruption categories was taken. This assumption recognised that above some level of disruption, additional disruptions will not increase the material impact on an organisation. For example, once an organisation has no building, disruption to the neighbourhood is of little impact so it does not make sense to add or average these items. The overall disruption was then calculated taking the average of the top two of the three disruption categories. All the variables included in the regression analysis, and survey questions they were derived from, are shown in Table 17.The regression results for "immediately" and "several months after" the earthquakes were significant and are represented in Equation 1 ($R^2 = 0.166$, $p<0.005$) and Equation 2 ($R^2 = 0.051$, $p<0.005$), respectively[7]. The only two variables retained in the step-wise regression were overall disruption and suppliers' ability to meet demand.

$$\boldsymbol{Op_7 = 0.76 + 0.12 \times SA - 0.4 \times OD}$$ **Equation 1**

$$\boldsymbol{Op_{90} = 0.84 + 0.08 \times SA - 0.1 \times OD}$$ **Equation 2**

Where $\boldsymbol{Op_7}$ *is operability at 7 days;* $\boldsymbol{Op_{90}}$ *is operability at 90 days; SA is Suppliers ability to meet demand;* $\boldsymbol{OD}$ *is Overall Disruption*

However, the economic model that this business behaviour model is being applied to already has dynamic supplier-customer relationships defined. To avoid double counting, suppliers' ability to meet demand was removed from the analysis. The revised regression results indicate that overall disruption is the only statistically significant independent variable, see Equation 3 ($R^2 = 0.117$, $p<0.005$) and Equation 4 ($R^2 = 0.029$, $p<0.005$).

$$\boldsymbol{Op_7 = 1 - 0.4 \times OD}$$ **Equation 3**

$$\boldsymbol{Op_{90} = 1 - 0.1 \times OD}$$ **Equation 4**

Where $\boldsymbol{Op_7}$ *is operability at 7 days;* $\boldsymbol{Op_{90}}$ *is operability at 90 days;* $\boldsymbol{OD}$ *is Overall Disruption*

[7] The low R^2 values are due to the large variability of organisation nature, impact and recovery situations. However, the intent for this model is to generate a function that represents the average 'operability' within a sector (rather than predict a single business response).

Table 17 Dependent variables included in operability regression analysis.

Independent variable	Survey question	Response options	Description / Calculation
Non-infrastructure impacts	In the first three months following the 22 February 2011 earthquake, please indicate how disruptive the following factors were: PHYSICAL Difficulty Accessing IT Data. Structural damage to building(s) (integrity of building compromised) Non-Structural damage to building (fittings damaged e.g. windows or light fixtures) Machinery loss or damage Office equipment damage Damage to inventory or stock NEIGHBOURHOOD Damage to or closure of adjacent (next door) organisations or buildings Damage to local neighbourhood (e.g. other buildings in area, damage to pavements, etc) Difficulty accessing premises/site STAFF Health and safety issues for employees' Availability of staff Perceptions of building safety Changes in staff emotional wellbeing	Very disruptive (1) Moderately disruptive (0.66) Slightly disruptive (0.33) Not disruptive (0) N/A (excluded)	Average score within the three categories calculated. Cronbach's Alpha for each category of 0.84, 0.882 and 0.81, respectively. *Maximum impact carried through to overall disruption calculation.*
Infrastructure impacts - Network	With reference to the 22 February 2011 earthquake, how was your organisation disrupted by the loss of the following infrastructure services? Water supply Sewage Electricity Gas Phone networks (cell and landline) Data networks Road network	Very disrupted (1) Moderately disrupted (0.66) Slightly disrupted (0.33) Not disrupted (0)	*Maximum impact carried through to overall disruption calculation.*
Infrastructure impacts - Node	With reference to the 22 February 2011 earthquake, how was your organisation disrupted by the loss of the following infrastructure services? Rail Airport		*Maximum impact carried through to overall disruption calculation.*

	Port Fuel		
Overall disruption	Combination of non-infrastructure, node and network infrastructure impacts above.		Average of top two impact types
Resilience – planned	To what extent do you agree or disagree with the following statement from your organisation? Given how others depend on us, the way we plan for the unexpected is appropriate Our organisation is committed to practicing and testing its emergency plans to ensure they are effective We have a focus on being able to respond to the unexpected We build relationships with others we might have to work with in a crisis We have clearly defined priorities for what is important during and after a crisis We proactively monitor our industry to have an early warning of emerging issues	Strongly disagree (0) Moderately disagree (0.15) Slightly disagree (0.3) Negative side of neutral (0.45) Positive side of neutral (0.55) Slightly agree (0.7) Moderately agree (0.85) Strongly agree (1)	Average response across items Cronbach's alpha, α=0.874
Resilience - adapted	To what extent do you agree or disagree with the following statement from your organisation? There are few barriers stopping us working well with others Our organisation maintains sufficient resources to absorb some unexpected change People in our organisation are committed to working on a problem until it is resolved If key people were unavailable, there are always others who could fill their role There would be good leadership from within our organisation if we were struck by a crisis We are known for our ability to use knowledge in novel ways We can make tough decisions quickly		Average response across items. Cronbach's alpha, α=0.846
Feasibility of relocation	How feasible is it to relocate parts or all of your organisation's operations? (tick all that apply) The majority of my staff can work from home (1) It is relatively easy for us to set up a new location (1) We have multiple sites we can operate from (1) There are significant health/safety and regulation constraints affecting the locations we operate from (0) Our equipment is difficult to source, relocate and replace (0) Our business is quite location-specific, moving is not an option (0) We could potentially site-share with another organisation (1)	Yes No	Binary scale: responses split into those that can relocate (1) and those that cannot (0)
Level of mitigation	With reference to the 22 February earthquake, to what extent have the following factors helped mitigate the impact of the earthquakes on your organisation?	N/A (0) Not important (1)	Average response across items – higher value

	Backup/alternatives to water, sewerage, electricity, communications Backup-/alternatives to IT Relationships with customers Relationship with suppliers Relationships with business in our sector Relationship with business advisor/mentor Relationships with staff Relationship with banks or lenders Relationship with our neighbours Available cash or credit Spare resources (e.g. equipment or extra people) Insurance Business continuity, emergency management or disaster preparedness plan Backup or alternative site Practiced response to a disaster Emergency kit Well designed and well build buildings Other (please specify)	Slightly important (1) Moderately important (1) Very important (1).	means more mitigation.
Post-event adaptation	Has your organisation initiated new collaborations? Has your business adopted new technologies? Has your business changed operational processes? Has your business restructured? Has your business closed unprofitable lines?	Yes(1) No(0)	Average response across items – higher value means more adaptation.
Change in demand	Compared to before the September 2010 earthquake, how is the demand for your products and services? Immediately after the earthquakes Several months after the earthquakes A year on from the earthquakes Two years on from the earthquakes	Increased demand (1) About the same (0) Decreased demand (-1).	*As is. Time period matched to operability time period.*
Ability of suppliers to meet demand.	How well were your regular suppliers able to meet your organisation's needs after the earthquakes?	Incapable (0) Somewhat capable (1) Completely capable (2)	*As is.*

Ownership – individual proprietorship	How would you describe your organisation's ownership structure? (please tick all that apply) Individual Proprietorship/Self-employed	Yes(1) No(0)	*As is. Analysis indicated that this was the only ownership structure type that had a high correlation with operability.*
Number of FTE employees	Please estimate the number of employees now working in your organisation (including yourself if you are owner / operator)? Number of full time employees in Canterbury Number of part time employees in Canterbury	*Free text*	*Based on 1 x full time staff + 0.5 x part time staff.*
Number of locations outside Canterbury	How many sites or locations does your organisation currently operate from? Within Canterbury? Elsewhere within New Zealand? Outside New Zealand?	*Free text*	*Total outside Canterbury. Included as a proxy for organizational support outside affected region.*
Need to relocate following earthquakes	Did your organisation relocate your main sites due to the earthquakes?	Yes (1) No (0)	*As is. Included because qualitative research shows that relocation can have a major impact on recovery.*
Use of earthquake support subsidy	How has/is your organisation financing its recovery from the earthquakes? Earthquake wage subsidy	*Yes (1) No (0)*	*As is. Included because anecdotal evidence suggested this was a major contributor to organisation survival*

The survey results show that operability over time follows a logarithmic pattern. This is in line with the inoperability curves defined by Haimes et al. (2005). Therefore, taking the two static operability functions (Equation 3 and 4), a temporal operability function can be defined, see Equation 5.

$$\boldsymbol{Op(t) = 1 - 0.63 \times OD + 0.12 \times OD \times \ln(t)}$$ **Equation 5**

Where $Op(t)$ is Operability at anytime, t; $\boldsymbol{OD}$ *is Overall Disruption*

CONCLUSIONS

The analysis presented in this paper shows the generation of empirically derived operability curves. This research brings together two existing approaches to modelling business resilience and adaptation in economic models. Being empirically derived, it represents the actual average response of organisations to disruption, including for diverse adaptation measures such as: relocation, increased working hours, operational changes etc.. It also represents the impact and subsequent recovery temporally. This has an advantage in economic modelling (compared to static resiliency factors) as it allows for the economic model to experience an ongoing 'shock', which extends beyond the initial impact and decays over time.

While this analysis is presented based on a single disaster event, the researchers have begun to, and continue to, develop this operability model into a fully transferable model that can be applied to a number of different infrastructure and hazard disruption events, including infrastructure disruption functions (based on duration of infrastructure outage) and non-infrastructure disruption functions (based on physical hazard attributes e.g. MMI for earthquakes). For more on this research project go to http://www.naturalhazards.org.nz/NHRP/Hazard-themes/Societal-Resilience/EoRI.

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MULTI-HAZARD COASTAL RISK ASSESSMENT FOR BUILDING RESILIENCE- A CASE STUDY

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Coastal zones are of major importance due to their intrinsic environmental and socio-economic characteristics, mainly related with their high demographic densities and natural resources. This paper examines the regional scale coastal hazards risk assessment for Hawke Bay in New Zealand. A frame work for the quantitative estimation of present and future risks has been adopted for the study. The probabilistic risk assessment presents in this study in terms of losses and likelihood for coastal inundation, tsunami and erosion hazards. Fragility function have been applied to calculate potential damage costs to a given structure and its contents for a range of different inundation depths using synthetic vulnerability curves. Risk has been categorized in human, economic, social/cultural and environmental losses for each hazards for present and future. The results are shown in terms of effects on humans (fatalities and injuries), economic, social and cultural and environmental/ecological for study area. The tsunami hazard risk within the Hawke Bay region for the events modelled is significantly greater than the coastal inundation and coastal erosion hazard. Losses for coastal inundation are generally greater than for coastal erosion, but the range of values are of a similar order of magnitude for these two hazards.

KEY WORDS: Coastal risk, vulnerability, Multi-Hazard.

LAND USE PLANNING FOR RISK, RESILIENCE AND SUSTAINABILITY

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ABSTRACT

When New Zealand's Resource Management Act 1991 (RMA) was enacted, it did not include reference to resilience or risk – rather, it took a sustainable management approach to land use planning. Since then, resilience has become the 'in' thing, and natural hazard risks are now being given a priority in the RMA reforms. But what is resilience within a land use planning context? And how does resilience relate to sustainability and risk-based land use planning?

The land use recovery of Christchurch, New Zealand, provides a unique opportunity to explore these questions in a post-disaster environment. The red zoning of high risk land, categorising land into technical categories, and the risk-based replacement District Plan has highlighted the interrelationship between resilience, sustainable management, and risk-based planning. While a sustainable community should also be resilient, sometimes resilience-building does not always take sustainability into account.

This paper will explore these tensions, using the city of Christchurch as a case study to answer these questions. It will highlight the relationship between sustainability, resilience and risk, and provide a deeper understanding of the implications of planning for each. The paper will also outline what lessons have been learned from the Christchurch experience, and actions that need to occur to ensure that the integration of sustainability, resilience, and risk management.

Key words: Christchurch, land use planning, resilience, risk, sustainability.

INTRODUCTION

The term 'resilience' is increasingly being used in a multitude of contexts, from physical, psychological, ecological, social, city, community to individual resilience (Gallopin, 2006; Klein, Nicholls, & Thomalla, 2003; Manyena, 2006; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). In land use planning the term 'resilience planning' is used interchangeably with sustainability (Berke & Conroy, 2000; Godschalk, 2002; Houston, Kohlhase, & Suri, 2012; Tobin, 1999). But what does 'resilience' mean for land-use planning, and how does this relate to sustainability?

The paper provides an overview of the terms 'sustainability' and 'resilience' to ascertain the similarities and differences, and provides examples of how these terms are used in the New Zealand legislative setting. Looking at recovery, pre-event planning and insurance, this paper will discuss the relationship between sustainability and resilience, and use a case study of the 2010-11 Canterbury earthquakes to discuss 1) Is a resilient community a sustainable one? and 2) To be sustainable, does a community need to be resilient?

SUSTAINABILITY & RESILIENCE

Overview of Sustainability

The widely accepted definition of sustainability from the Brundtland Commission, is "… meets the needs of current generations without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987, p. 23).

Guiding principles in the Sendai Framework for Disaster Risk Reduction 2015–2030 state that "Disaster risk reduction is essential to achieve sustainable development" (United Nations, 2015, p. 9). Three key interacting elements underpin the concept of sustainable development: economic, environmental, and social (including cultural) well-beings (Berke & Conroy, 2000; Campbell, 1996; Lele, 1991).

Sustainable recovery from a natural hazard event ensures that existing risks are reduced and new risks are managed. The term 'holistic disaster recovery' from natural hazard events means that sustainability principles guide redevelopment.

Overview of Resilience

Resilience is more than just the ability to "bounce back" (cope). Recent literature suggests that resilience is an 'adaptive capacity' held by individuals and/or communities (Klein et al., 2003; Norris et al., 2008). While those at the periphery of an event may be able to "bounce back", those facing more catastrophic losses will have to adapt (Paton, Anderson, Becker, & Petersen, 2015). Paton and Johnston (2006) have defined resilience as the ability to adapt to the demands, challenges and changes encountered during and after a disaster and evolve with changing circumstances. Key contexts within which resilience must be considered include: emergency management, the environment, infrastructure, land use planning, building, insurance and engineering (Auckland Council, 2014; Queensland Reconstruction Authority, 2012).

Paton et al. (2013) suggest that planning, including land use planning, is an integral part of creating a resilient society and that it is important to involve citizens in the process. A community engagement strategy to determine levels of risk provides a robust, transparent and acceptable decision making framework (Saunders, Grace, & Beban, 2014).

A number of timeframes affect resilience (Schwab, Topping, Eadie, Deyle, & Smith, 1998): the period before a disaster; the period immediately following a disaster; and the recovery period from days to years afterward. Building resilience and long term sustainability after a disaster is challenging when recovery is protracted. For example: A natural hazard event occurs that requires some form of recovery. Insurance claims enable landowners to rebuild/repair their house; infrastructure is repaired. Another event occurs – more recovery is required. The landowner rebuilds/repairs with insurance. Infrastructure is repaired. Another event occurs. As the process continues you can start to see differences between short term resilience focussed on "bouncing back", and long term adaptive resilience and sustainability. Repeated events compound the situation, and short term measures (e.g., insurance, repairs) may not address the problem effectively.

Reconciling sustainability and resilience

Is a resilient community a sustainable one and visa versa? First we must understand what a resilient *and* sustainable community is (see Table 1).

Table 1. Explanations of sustainable and resilient communities in the land use planning context

Reference	Definition
Tobin, 1999, p. 13	Sustainable and resilient communities are defined as societies which are structurally organised to minimize the effects of disasters, and, at the same time, have the ability to recover quickly by restoring the socio-economic vitality of the community.
Berke et al., 2000, p. 104	Communities with a coherent land-use plan and hazard-mitigation strategy are able to build settlements that will be resistant to natural disasters, able to recover quickly from a natural event, and able to last for many years with little cost in dollars or lives to their inhabitants. These are resilient, sustainable communities.
UN Commission on Sustainable Development, 2002 (In Godschalk 2002, p. 3).	Sustainable development seeks to meet present needs without compromising the ability of future generations to meet their needs, but it cannot be successful without enabling societies to be resilient to natural hazards and ensuring that future development does not increase vulnerability.

Sustainability and resilience are interdependently linked. Godschalk (2002) suggests that "Sustainable development… cannot be successful without enabling societies to be resilient to natural hazards". The UN Sustainable Development Conference, 2012 named 17 sustainable development goals. Goal 11 states "Make cities and human settlements inclusive, safe, resilient and sustainable". This is supported by the aim to "increase … the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters … , develop and implement in line with the forthcoming Hyogo Framework holistic disaster risk management at all levels" (UN Division for Sustainable Development, 2014). The Sendai Framework now provides a framework to implement this goal (United Nations, 2015).

The New Zealand Treasury has produced a Higher Living Standards Framework (see Figure 2) in which risk management, sustainability, and resilience are key. Figure 2 reconciles the three concepts of resilience, sustainability and risk management implying that resilience should be focussed on short and long term adaptability, while sustainability should focus on 'future generations'. But sustainability and resilience goals can contradict each other if not managed as complementary outcomes (McPhearson, 2014).

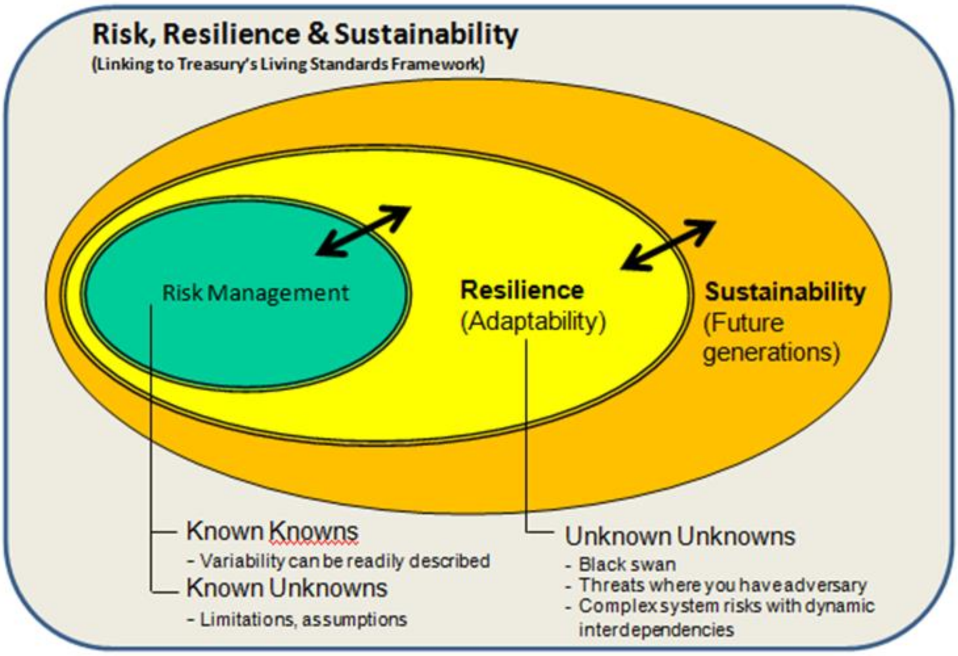

Figure 2: How resilience is related to both risk and sustainability (Blake, 2013, p. 6)

LEGISLATIVE FRAMEWORK FOR SUSTAINABILITY AND RESILIENCE IN NEW ZEALAND

Sustainability forms the philosophical base for New Zealand statutes that contribute to natural hazard management – the Resource Management Act 1991 (RMA); Civil Defence Emergency Management Act 2002 (CDEM Act); the Building Act 2004; and the Local Government Act 2002. While these four statutes refer to sustainability, only the RMA defines sustainable management. Other commonalities between the legislation include references to social, economic, cultural, environmental well-being, and health and safety. These well-beings are not defined within the legislation, allowing councils to determine their own measures. Health and safety is an RMA issue, and not just the responsibility of the Building Act and CDEM Act

The concept of resilience is advocated by only the CDEM Act. Administered by MCDEM, resilience is the core focus of the National Strategy, required under the CDEM Act. The Strategy's vision is "… to build a resilient and safer New Zealand with communities understanding and managing their hazards and risks" (MCDEM, 2008, p1). While the Strategy does not define resilience, it shows linked components of a Resilient New Zealand, being (p. 7):

Individuals looking after their families and loved ones;

Communities managing their hazards;

Businesses providing services to support the continued functioning of communities;

City, district and regional authorities ensuring the safety of their communities;

Emergency services providing critical services;

Central government ensuring the security and well-being of their citizens; and

Utilities providing essential services.

To assist in achieving resilience, the CDEM Act and National Plan focus on ensuring the "4R"s of reduction, readiness, response and recovery are addressed (CDEM Act, 2002; CDEM, 2006). Within the National CDEM Strategy, it is acknowledged that a sustainable management approach needs to be adopted, thus acknowledging any links between resilience and sustainability. The National Strategy is currently in the process of being updated.

The New Zealand Coastal Policy Statement (NZCPS) is required to achieve the purpose of the RMA in relation to the coastal environment of New Zealand (i.e., sustainable management). The term 'resilience' is not defined but is included once within the NZCPS, via Objective 1, which is "To safeguard the integrity, form, functioning and resilience of the coastal environment and sustain its ecosystems, including marine and intertidal areas, estuaries, dunes and land …" (Department of Conservation, 2010, p. 9).

CHRISTCHURCH – A RESILIENT AND SUSTAINABLE CITY?

The M7.1 Darfield earthquake occurred on 4 September 2010 and caused damage to the immediate Darfield area, Kaiapoi township, and the city of Christchurch. Building damage occurred from fault rupture, ground shaking and liquefaction.

On 22 February 2011 a shallow M6.3 aftershock – the Christchurch earthquake – occurred resulting in the collapse of a number of unreinforced masonry buildings, two multi-storey office buildings, and damage to other buildings. This aftershock resulted in 185 fatalities (New Zealand Police, 2012), and many serious injuries (Johnston et al., 2014). Much of the CBD was damaged and was cordoned off for months and years afterwards. Infrastructure was disrupted. Rock falls occurred in the Port Hills. Liquefaction and lateral spread was widespread with properties and streets affected and many residents displaced.

Aftershocks on 13 June and 23 December 2011 again caused liquefaction (Cubrinovski, Henderson, & Bradley, 2012), and there was a marked increase in flood events due to the changed ground levels from ground tilting and subsidence.

Recovery from the earthquakes

The recovery process began following the 2010 Darfield earthquake. People re-engaged with their social networks at a local level to help each other, and provided emotional support, meals, and clean-up assistance. Volunteer community members (e.g., Student Army, Farmy Army) cleared liquefaction material which was disposed of by the city services. Damaged buildings were identified, and decisions made to demolish or repair them. Local authorities held community discussions and started planning for the future. The region saw itself as resilient (Seville, Hawker, & Lyttle, 2011; Wood, Robins, & Hare, 2010), and people vowed to work together to recover.

However, despite progress on recovery following the Darfield earthquake, many of the resilient adaptations that people employed to "bounce back" (e.g., removal of liquefaction, repairs to buildings and infrastructure) were rendered useless by the impacts of the Christchurch earthquake, and were not able to be translated into a long term sustainable future.

In a land use planning sense, the destruction of the Christchurch CBD, and the liquefaction and rock falls had damaged a large portion of Christchurch (Environment Canterbury, 2013), meaning people were unable to return to their homes and workplaces. Every aftershock meant more liquefaction (Cubrinovski et al., 2012), and rock falls had either damaged homes, or had the potential to damage homes in the future, making many properties uninhabitable (CERA, 2014c). To ensure a sustainable future, new adaptive land use planning solutions were required to be implemented – it was not business as usual.

Examples from Christchurch of land-use planning that contribute to sustainability and resilience

Due to the amount of liquefaction and land instability that occurred in Christchurch – and the likelihood of continuing susceptibility to future events – planning initiatives were developed including the residential red-zone system, a recovery plan or 'Blueprint' for the CBD, and the use of insurance pay-outs to improve previous living or work situations.

Red and green zones were developed for residential properties. Red zones for the flat land subject to liquefaction, and for areas susceptible to cliff collapse and boulder roll; green zones were developed for areas considered to have low risk to life, and the land could be remediated.

Red zoning – a sustainable approach?

Areas in the flat land residential red zone had area-wide land and infrastructure damage, and an engineering solution to repair the land was considered to be uncertain, costly, and highly disruptive (CERA, 2014a). Residents received a pay-out for forfeiting their property in the red zone. Houses were removed from the site, and reinstatement of the land began.

Residential red zone criteria (CERA, 2014d) was as follows:

significant and extensive area wide land damage;

success of engineering solutions may be uncertain in terms of design, its success and possible commencement, given on-going seismic activity; and

any repair would be disruptive and protracted for landowners.

In the Port Hills, red zone areas were identified as those:

affected by cliff collapse and there were immediate risks to life, land remediation was not considered viable and infrastructure was difficult and costly to maintain; or

affected by rock roll and the risk to life was considered unacceptable, was unlikely to reach an acceptable level in a reasonable timeframe, and protective works to mitigate the life safety risk were not considered practicable (CERA, 2014a).

This zoning of residential land shows a sustainable management response to the land use recovery process. The sustainable approach was to retire the land until a time when it may be reinstated in the future.

Green zoning – a resilient response?

Green zones were used for residential land in both the Port Hills for land instability, and on the flat land for liquefaction. Flat green zone land was divided into 3 technical categories (CERA, 2014b):

Technical Category 1 (TC1, grey) – future land damage is unlikely. You can use standard foundations for concrete slabs or timber floors.

Technical Category 2 (TC2, yellow) – minor to moderate land damage is possible in future significant earthquakes. You can use standard timber piled foundations for houses with lightweight cladding and roofing and suspended timber floors or enhanced concrete foundations.

Technical Category 3 (TC3, blue) – moderate to significant land damage is possible in future large earthquakes. Site-specific geotechnical investigation and specific engineering foundation design is required.

In contrast to the red zone, the green zones allow for adaptive measures to be completed so that resilience and adaptive capacity is improved and property owners can continue to live in these locations.

CONCLUSION

Sustainability and resilience are not interchangeable concepts: a sustainable community should also be resilient; but a resilient community may not necessarily be sustainable in the long term. A resilient community should also be a sustainable, for two reasons: to meet legislative requirements; and to meet the needs of future generations - economically, socially, culturally, and environmentally. The ability to recover from an event, and in the process improve sustainable practices and adaptive capacity, is a positive outcome for communities.

Sustainability and resilience both aim to develop strong communities and create places that are enjoyable and safe to live in. However, some current definitions and frameworks focus on resilience as a short-term phenomenon (e.g., "bounce back"), and sustainability a long-term phenomenon. This can lead to unsustainable practices in the long term.

During the Canterbury earthquake sequence, the dynamics between resilience and sustainability were certainly evident. People considered themselves resilient and able to "bounce back" after the Darfield earthquake, but after the Christchurch earthquake people realised that a short-term view of resilience was not in fact sustainable in the long term. Projects such as the red and green zoning, Christchurch CBD recovery plan (CERA, 2012), and insurance initiatives were undertaken as a way of adapting and evolving to the catastrophic consequences that had unfolded.

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APPLICATION OF SCIENCE AND TECHNOLOGY IN THE SENDAI FRAMEWORK

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The Sendai Framework, a landmark international framework adopted in 2015, calls for a shift from managing disasters to managing risks. This requires a more holistic approach to risks and a stronger focus on risk-creation processes, and it presents opportunities to approach disaster risk reduction (DRR) as an integral part of sustainable development. The SFDRR was endorsed last March 2015. There has been much discussion on what the SFDRR encompasses, and it is obviously difficult to cover all aspects of DRR in short documents. There has been discussion what would be the next after the SFDRR. The journey started with the Yokohama Declaration (1994) and moved onto the Hyogo Framework (2005). Perhaps for the next 15 years it will be the SFDRR. Science has gone through a highly advanced stage but there is still more to go. Unfortunately much of the scientific information is never incorporated into the operational domain for decision-making, and very little has been incorporated down to the community level to respond to disaster risks. There is and will be uncertainty in scientific knowledge. Similarly uncertainty exists in all aspects of human decision-making. Thus there is no harm to applying uncertain scientific knowledge for decision-making. If the probability is 60%, the uncertainty is 40%. But by using 60% certainty, many disaster impacts could be avoided. In the law there is a concept of "foreseeability". It refers to actions for which the outcomes could and therefore should have been foreseen. Foreseeability is a qualitative expression of probability.

KEY WORDS: Science and Technology, Sendai Framework, resilience, early warning system.

COMMUNICATING UNCERTAINTY FOR FLOOD LOSS AND DAMAGE ASSESSMENT

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ABSTRACT

Uncertainties in flood loss and damage assessment models are inevitable. At a bare minimum, uncertainties reflect flaws in data accuracy and the simplification of a complex system that is inherent in any model or set of equations. The disaster management community recognizes the value of communicating these uncertainties to decision makers in order to better quantify disaster risk. While a common framework and standardized techniques does not yet exist to communicate uncertainties to decision makers, independent evaluations have been conducted and interest are growing. This research focuses on communication mechanisms to provide flood loss and damage information to end users based on flood modelled for future climate change and damage calculated using synthetic fragility function. A hybrid framework was developed for flood loss and damage uncertainty analysis and involvement of end users through questioner survey and focus group discussion. The proposed framework was applied to the study in a basic way to provide an impression about the relative uncertainty of key areas within the entire modelling and results communication processes. The findings demonstrated how the proposed uncertainty framework could be used to identify areas within the data management and transformation process that could benefit from further improvements. Furthermore, the results from the questionnaire and focus group discussions can be integrated to better communicate scientific results to end users. Based on these results, certain recommendations are highlighted. Uncertainties due to human errors and inferences were identified as the most significant contributors. Subsequent decisions based on modelled flood information could be greatly improved if uncertainties from these areas are minimized and the insights provided by end users are addressed.

INTRODUCTION

Over the long term, flood damages are mitigated through flood-risk management, which relies on estimates of the risk of flooding (Betty et al., 2015; U.S. Army Corps of Engineers (USACE), 1996; Olsen et al., 1998; Ganoulis, 2003; Takeuchi, 2001; Merz and Thieken, 2004). Estimates of flood risk have numerous sources of uncertainty. (Smith, 1981;

Krzysztofowicz and Davis, 1983; Wind et al., 1999; National Research Council, 2000; Green, 2003; Thieken et. al., 2005). The uncertainty could be categorized into two categories: Aleatory and epistemic. Aleatory uncertainties arise from natural variability. Aleatory uncertainties can be quantified with a range of robust, statistical methods. Uncertainties are characterized as epistemic, if the modeller sees a possibility to reduce them by gathering more data or by refining models Uncertainties are categorized as aleatory if the modeller does not foresee the possibility of reducing them. From a pragmatic standpoint, it is useful to categorize the uncertainties within a model, since it then becomes clear as to which uncertainties have the potential of being reduced. More importantly, epistemic uncertainties may introduce dependence between events, which may not be properly noted if their character is not correctly modelled (Kiureghian & Ditlevsen, 2007). Walker et al. (2003) explain that the nature of uncertainty can be categorised into epistemic uncertainty, i.e. the uncertainty due to imperfect knowledge or stochastic uncertainty or ontological uncertainty, i.e. uncertainty due to inherent variability, e.g. climate variability. Flood or any hazard modelling contain inherently uncertain quantities. Therefore an important part of building the model universe is modeling of these uncertainties or way to find a communication pathway to dealing with uncertainties (Merz et al., 2010).

Climate change-based uncertainties are attributed to a number of factors related to the inherent unpredictably such as incomplete knowledge about the climate system, and the limitations of existing models to generate projections (Stainforth, 2007). Uncertainty also exists in relation to the effects of strong natural variability of precipitation and discharge. Uncertainty is further confounded by the effects of land use changes (Kundzewicz, 2013). Climate change impacts would enhance vulnerabilities and to curtail these past and present flood models are to be compared, analyzed and upgraded (Surminski et al., 2012). Uncertainties relating to the transfer in spatial scale include those related to climate model downscaling. While global circulation models (GCMs) may provide credible quantitative estimates of future climate changes at continental or global scales, there are challenges to downscaling the results to support adaptation decisions at regional or local scales and dealing with uncertainties (Solomon et al., 2007).

In order to understand various approaches to uncertainty and model implications, they need to holistically analyze. An inherently high level of uncertainty is associated with damage assessments derived with parametric approaches (Baleca et al., 2013). While higher degrees of accuracy may be achieved with data-intensive physically based hydrologic-economic models, uncertainties are still associated with each step of the process (Morrs et. al., 2005). In particular, uncertainties exist in direct, indirect and long-term reversible damage estimates. Uncertainty in the development of a hydrologic model can stem from two sources: natural variability (stochastic) and knowledge uncertainty (epistemic). Natural variability can be due to temporal variability, spatial variability, and individual heterogeneity. Knowledge uncertainty focuses on the model development factors, parametric breadth and numerical accuracy of available data, and the type of model being used in relation to decision-making needs (Ahmad and Simonovic 2011, Merz et. al. 2010; De Groeve at. Al., 2014).

Uncertainties in predicting flood damage, however, present challenges to both insurance companies responsible for developing appropriate insurance programs (Dick 2006) and farmers who must decide whether to allocate financial resources to risk reduction or income optimization (Mechler et. al. 2008). Understanding uncertainties would greatly facilitate increasing the efficacy of agricultural insurance options. There is, and will be, uncertainty in scientific knowledge. The uncertainty inherent in scientific information is one of the reasons for failing to act on disaster warnings. People take chances in every decision-making process. Therefore, there is no harm to applying uncertain scientific knowledge for decision-making. If the probability is 60%, the uncertainty is 40%. But by using 60% certainty, many disaster impacts could be avoided. In Law, there is a concept of "foreseeability". It refers to actions for which the outcomes could and therefore should have been foreseen. Foreseeability is a qualitative expression of probability (Fakhruddin, 2016).

METHODOLOGY

A hybrid approach based on the combination of an update of the uncertainty classification framework described by Skeels et al. (2010) and the Pedigree parameter of the Numeral Unit Spread Assessment Pedigree (NUSAP) method described by Funtowicz et al. (1990) was proposed by Romão and Paupério (2014a,b) used for this study. The approach was presented by the authors at the Joint Research Centre of the European Commission's "Joint workshop of IRDR loss data and EU loss data experts" in May 2014.

A limited sample size (n = 10) was chosen to gather preliminary data about the flood impacts on farmers in the study area of Banghpa Inn and Wangnoi districts in Bangkok, Thailand. Respondents included rice growing farmers who worked on their own properties and those who worked on rented land. The respondents' ages ranged from 29 to 67 years old, with an average of 49 years. All participants received at least primary to secondary level education. The majority of the participants had lived on the farm since birth, with the shortest length of residence of 8 years. Based on the ages and the duration that the participants worked on the farms, it may be assumed that they have sufficient experience to make decisions to safeguard and optimize the returns of their labor. However, due to the partial or limited ownership of the farms and/or differential education levels, certain participants may not have ability or adequate knowledge to make significant changes related to the uncertainties facing agricultural production in the future.

Updated Uncertainty Classification Framework

The original framework (Skeels et al., 2010) was developed based on a movement away a generalized treatment of aleatory and epistemic uncertainties. The updated framework is established on a (modified) hierarchy and connectivity among six types of differentiated uncertainties including measurement, completeness, inferences, disagreement, credibility and human error. Romão and Paupério (2014) identified the inability to account for human error and proposed additional consideration for this type of uncertainty in the updated framework.

In general, the process used to solve a problem of interest can be described in three stages, where each stage is associated with i) a more advanced state of data processing and ii) one of the six types of uncertainties expressed in the stages (Figure 1). Uncertainties relating to disagreement, credibility, and human error are considered at all three stages which are data acquisition (measurement), data sorting and manipulation (completeness) and data transformation to address objectives (inference).

Figure 14 Six Types of Uncertainty and their relationships (Source: reproduced from Romão and Paupério, 2014)

Measurement considers both accuracy (i.e. extent of differences between measured and actual values; deficiencies in measurement techniques and epistemic factors) and precision (i.e. consistency of measured results, attributable to limitations in measurement technique and/or natural variations in the phenomena being measured).

Completeness considers three aspects: sampling (i.e. whether estimates can be generalized for the whole system; aleatoric uncertainty associated with random sampling and epistemic if samples are collected based on pre-defined criteria), missing values (i.e. values that are not present in the data, but would preferably be included; possibly due to the unavailability or the removal of erroneous values), and aggregation (i.e. an irreversible procedure that may result in loss of information and incomplete data).

Inferences assign meaning to data. Uncertainties arise from the inadequate representation of data properties or relationships, which prevent the accurate replication of the phenomena of interest. Three possible ways of making inferences include modeling, prediction, and extrapolation into the past.

Disagreement describes the inconsistencies between data sets describing the same phenomena, between repeated measurements, and between interpretations made with the same results.

Credibility describes confidence or doubt in sources of information, methods, tools, known conflicts of interest, concerns about performance, and/or biases.

Human error is a type of aleatoric uncertainty assumed to result from random events that is generally difficult to quantify, but may be more helpful to describe in detail with a categorized approach. Romão and Paupério (2014) identified the inability to account for human error and proposed additional consideration for this type of uncertainty in the updated framework.

The Pedigree Parameter of the Numeral Unit Spread Assessment Pedigree

The Pedigree parameter is a matrix where problem-specific criteria are assigned scores based on a customizable numerical scale (De Groeve et al., 2014). The matrix structure does not have any formal requirements; the rating scale, number and type of criteria are selected to reflect the needs of each problem. It was originally developed to characterize and assess the multidimensional uncertainty in science for policy. The NUSAP method provides a systematic framework for synthesizing qualitative and quantitative uncertainty assessments and the information is organized in a coherent and easily understandable way. Consequently, it can be applied to complex models of natural phenomena. The Pedigree parameter specifically evaluates the strength of relevant values by considering both the background by which it was produced and the status of the value following processing. This helps to focus research efforts on the most problematic or weakest model components. By providing an in-depth and comprehensive overview of the sources and nature of the uncertainties, the method serves as an effective way for all participants (i.e. scientists, stakeholders, policy and decision makers) to become more aware of their interaction with the data at different stages, thereby supporting a transparent and extended peer review process. The main disadvantage, however, is that it can be a time intensive procedure. Applying the NUSAP method to loss and damage assessments involves multiple stages (van Sluijs, J., 2010):

the initial examination of uncertainties and assumptions

decision to perform expert or stakeholder elicitation

the selection of experts

the choice of pedigree criteria

problem visualization with diagnostic diagrams

reporting and communicating findings

interpreting results and integration in the decision making process

In general, the process used to solve a problem of interest can be described in three stages, where each stage is associated with i) a more advanced state of data processing and ii) one of the five types of uncertainties expressed in the brackets. Uncertainties relating to disagreement, credibility, and human error are considered at all three stages.

Stage 1 : data acquisition (measurement)
Stage 2 : data sorting and manipulation (completeness)
Stage 3 : data transformation to address objectives (inference)

To determine disaster losses, the data acquired at the first stage can either be used as an indicator to represent actual loss or be applied as input for further processing (Romão and Paupério, 2014). Therefore, the degree of uncertainty is dependent on the extent of processing per stage. Additional approach was taken to gather information summarized in.
Supplementary information (S1): Uncertainty from target end users' perspective
Supplementary information (S2): Focus group discussion

Average Pedigree matrix scores are determined for each stage of the process. Based on the water level results from hydro-dynamic model, agriculture damages were future climate 2020 scenarios and compared.

FINDINGS AND DISCUSSIONS

The following provides guidance on the practical use of an adapted uncertainty classification framework (Romão and Paupério, 2014a) and describes the supplementary information that is expected to be derived from the field-based questionnaire. The proposed approach is summarized as follows by considering each stage from figure 1.

Stage 1: Uncertainty Relating to Data Collection

Stage 1 quantifies uncertainty related to the data collection effort and should be completed by representatives who were involved with that process. To provide a more comprehensive understanding of uncertainties relating to each set of input data used, one evaluation should be completed by the responsible representative for each data set involved. All of the evaluations completed for Stage 1 would then be averaged.

Alternatively, representatives who are aware of the data collection process can complete one evaluation to describe “averaged” uncertainties. This may be considered under time constraints or if those originally responsible for data collection are unavailable. To identify potential evaluators at this stage, we needed to identify the contact person responsible for collecting and distributing each primary data set used in the study.

So the assessments of uncertainties at Stages 1 through 3 of the flood damage assessment process were completed by four entities in the case study.

Stage 2: Uncertainty Relating to Data Organization and Manipulation

Stage 2 quantifies uncertainty related to the organization and manipulation of the data and should be completed by representatives that were involved with the organization and participated in that process. An example of Stage 2 output can be found in Table 3. To provide a more comprehensive understanding of uncertainties relating to the handling of each set of input data used, one evaluation should be completed for each data set by the responsible representative. All of the evaluations completed for Stage 2 would then be averaged.

Alternatively, representatives who are aware of the data organization and manipulation processes can complete one evaluation to describe “averaged” uncertainties. This may be considered under time constraints or if those originally responsible for data handling are unavailable. To identify potential evaluators at this stage, identify the contact person responsible for organizing and preparing the primary data so that it can be used in the subsequent modelling stage.

Stage 3: Uncertainty Relating to Data Processing to Realize Project Objectives

Stage 3 quantifies the uncertainty related to processing of the data to realize project objectives and should be completed by representatives that were involved with that process (i.e. modeling flood damages). An example of Stage 3 output can be found in Table 4. To provide a more comprehensive understanding of uncertainties, one evaluation should be completed for each person involved in the modeling process by using the diagnostic diagram of uncertainty scores in figure 2. Weights, totalling 1.00, can be assigned to data sets to reflect the relative significance to the modeling process. All of the evaluations completed for Stage 3 would then be averaged.

Alternatively, if time constraint is a factor, one evaluation to describe “averaged” uncertainties can be considered. To identify potential evaluators at this stage, there is a need to identify the contact person responsible for processing the data (i.e. involved in physical modelling, preparing the flood vulnerability index and economic models).

For each of the stages, uncertainty scores range from 1.0 (high uncertainty) to 5.0 (low uncertainty). It can be observed that in all three stages, human error is consistently identified as the most significant evaluation criteria contributing to uncertainty in the flood damage assessment process. At Stage 3, inference (i.e. the manner in which meaning is assigned to data or the way that data is interpreted) was also identified as a source.

The range of average scores varies for each stage. Scores at Stage 3 were the lowest, implying that the levels of uncertainty associated with relating data processes to realizing project objectives are notably higher than at the first two stages.

Stage 1: 3.3 to 4.0

Stage 2: 3.3 to 4.0

Stage 3: 3.0 to 3.7

This assessment reveals that the uncertainties associated with the first three stages of the data acquisition, processing, and inference are consistently attributed to human error. Furthermore, the interpretation of the modelled data at the final stage should also be re-examined to ensure that all assumptions and generalizations are valid. Elimination of these two sources of uncertainty would improve the credibility of the information presented to decision makers.

CONCLUSION

The findings demonstrated how the proposed uncertainty framework could be used to identify areas within the data management and transformation process that could benefit from further improvements. Furthermore, the results from the questionnaire and focus group discussions can be integrated to better communicate scientific results to end users. Based on these results, certain recommendations are highlighted.

A formal procedure should be developed to select key experts to perform the uncertainty assessments. Selections criteria could include educational background, impartiality and scope of involvement in project. It would also be beneficial to consider developing criteria for evaluation matrices with groups or experts and/ or stakeholders, so that areas of concern are clearly represented and can be directly addressed. The example provided in the study by Warmink et al. (2011) can be consulted for further guidance.

In addition to communicating uncertainty information, it may also be useful to investigate different modelling approaches to reduce known uncertainties (i.e. whether the prediction of loss and damages by physical modelling is the best approach). For example, Merz et al. (2013) presented a study that explores a potential alternative to reduce known uncertainties by conducting a multi-variate flood damage assessment.

In summary, the proposed framework was applied to the study in a basic way to provide an impression about the relative uncertainty of key areas within the entire modelling and results communication processes. Uncertainties due to human errors and inferences were identified as the most significant contributors. Subsequent decisions based on modelled flood information could be greatly improved if uncertainties from these areas are minimized and the insights provided by end users are addressed.

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RESILIENT COMMUNITIES: IMPLICATIONS FOR PROFESSIONALS

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ABSTRACT

As a result of societal changes like citizen empowerment and increasing attention for strengthening community resilience, relationships between citizens and professional responders in crisis management are changing. Citizens actively deal with crises themselves, implying adjustments to professional procedures. To provide professionals with support to understand the actual resilience of a community we developed a dashboard that provides insight into both the vulnerability of a selected community (for example elderly) and capacities. Capacities were based on indicators of resilience adapted from the multi-level Community Engagement Theory of Douglas Paton.

We discussed this dashboard with professionals in interviews and focus groups. The results showed that professionals mostly wanted to know the location of less self-reliant inhabitants (vulnerability) and key persons and characteristics of social networks (capacities). Professionals were most sceptical with regard to the reliability of the data. Ideally, it should be based on existing data bases, but at the same time, not all relevant information is registered and this information is quite general.

Our study confirms that having access to information about the level of resilience of communities seems to have a great potential in supporting professional responders in crisis management. Yet knowledge about communities' levels of resilience or sharing information is not enough and comes with limitations. What is more important is that structural collaboration between citizen communities and professionals is facilitated. This collaboration should already start in the preparation phase and continues throughout all phases in crisis management.

Key words: community resilience, indicators, platform, cooperation, professionals

INTRODUCTION

In the past decades, the world has seen a substantial increase in both occurrence and impact of disasters. Current developments such as climate change, urbanisation and extensive digitalization of critical infrastructure will further deepen the effects of natural hazards and human-induced threats. These developments necessitate a new emphasis on community resilience: the capacity of citizen communities to be more self-reliant, and less reliant on government help. This understanding has been entrenched in many current regional or global disaster risk reduction programmes, such as the Sendai Framework (UNISDR, 2015) or the Rockefeller Foundation's 100 Resilient Cities Program.

The political will for community resilience initiatives can often be found in response to a recent crisis or disaster within the affected region. This can prompt an identification of high-risk areas which require resilience capacity building in order to mitigate future risk. On the other hand, regions that have not experienced any significant disaster also need to adopt the notion that it is necessary to address society's vulnerabilities and build capabilities across the community to cope with possible shocks and stresses.

A resilient society is a society in which individuals, groups and communities are able to cope with threats and disturbances caused by social, economic, and physical changes (Adger 2000; FAO 2010). This can be understood more broadly in relation to general changes, but more often societal resilience is defined in terms of resilience towards disasters: the process of preventing an event escalating into a disaster therefore requiring the ability to prepare, the capacity to cope with the impact of disasters when they occur and the capacity to implement recovery activities in such a way that the societal disruptions are minimized (Renschler et al. 2010). Resilient communities are considered to be able to respond to changes within their specific physical and social environment positively and proactively, with a focus on the continuity of it's essential functions despite what kind of stress or shock it is confronted with. Different stresses will demonstrate different degrees of resilience within communities, based on the specific resilience capacities the community has to cope with an respond to that particular stress (Kelly 2004).

Ever since the adoption of the Hyogo Framework for Action in 2005 (UNISDR 2005), there has been a shift within international disaster resilience discourse. Where once the main goal was that of hazard planning and disaster risk reduction, it has moved towards focusing more on building community resilience. The widespread adoption of the 'resilience' discourse (e.g. Duijnhoven & Neef 2014; Norris et al., 2008; Woods & Hollnagel,

2006) marks a notable shift from a state-centred approach to risk and safety towards an integrated approach whereby the activated community (including all different stakeholders across the community, including citizens) takes responsibility for building and strengthening its capacities to cope with sudden shocks and long term stresses or transformations. Such a community-centred approach is in line with other wide-spread transformations in recent times whereby community-centred governance has gained ground in over centralized, state-led policies (e.g. Bailey & Pill, 2011). Neighbourhood programs, aimed at increasing inclusion, empowerment and self-reliance and stimulating communities to take-up responsibility and improve quality of life. In addition, technological developments and societal changes have given rise to new forms of communication among citizens and between citizens and professional organizations. Social media is everywhere and also plays an important role with regard to risk and crisis management.

As a result of these and other developments, increased community resilience and community empowerment are changing the relations between citizens and professional responders in crisis management. This is more and more acknowledged among crisis management professionals as well as researchers and there is an increase in research on how to enhance and strengthen citizens' self-reliance in crises. In this paper we discuss the changing landscape of crisis management and present some results of a European project in which new ways of supporting professionals in crisis management have been tested.

CITIZEN PARTICIPATION IN CRISIS MANAGEMENT

Participation of the public in crisis management is not a new phenomenon. In fact, it is an essential aspect of disaster response. Citizens are typically the first to arrive at the scene of an incident, and often play a vital role in the early, chaotic stages of crisis response. Many disaster reports recount stories of citizens that spontaneously start caring for victims, providing transport, or performing other tasks, as soon as they are confronted with a crisis (e.g. Grimm et al., 2014; Helsloot & Ruitenberg, 2004; Milliken & Linton, 2015; Prati et al., 2012). Such citizen actions come undirected and spontaneous, and stem from fundamental inter-human interest, and is well studied from a sociological perspective (for instance Drabek & McEntire, 2003; Barraket et al, 2013).

Ideally, professional responders make use of the local and situational knowledge of the public at the scene and fully utilize the capacities of those citizens that are present. In practice, however, there is often a lack of standing operational procedures or practical knowledge among professional responders on how to actually collaborate with the public at the scene. In a Dutch study investigating how professionals would react to such citizen activities it was for example observed that five teams (17%) sent citizens away immediately, five teams allowed them to stay at the scene and the rest of the teams sent (part of) the citizens away at a later point in time (Kerstholt et al. 2015). This study illustrated the lack of guidelines professionals have in dealing with citizens at the scene.

If citizens become more pro-active during crises, the responsibilities and general attitude of professional responders need to be re-evaluated, and a new balance needs to be sought between the responsibilities of government parties and the inevitable actions of citizen parties. Each crisis is unique and will involve different stakeholders in each occasion. Therefore, it is impossible to know in advance the level and type of citizen participation. Nor can responders be certain about available citizen knowledge and capacities, nor can they be certain how the citizen population will behave. Citizen behaviour in response to a disaster will depend greatly on the risks and dangers involved. The type and size of the crisis are also factors that need to be considered when deciding how to respond to the situation, including the citizens at the scene.

THE COMMUNITY ENGAGEMENT THEORY

To facilitate more effective collaboration between professional responders and the public in crises, we argue that it is important for professional responders to have more insight into the level of resilience of the affected communities. What types of capacities are available in the community and how can these be effectively used? What kind of vulnerabilities characterize the community and what needs to be done to mitigate these? In the European project DRIVER, we developed a dashboard that provides insight into both the vulnerabilities of a selected community (for example elderly) and capacities. The idea behind this dashboard is that it could be used to provide professionals with support to understand the resilience of a specific community.

The dashboard is based on a set of indicators to measure both the vulnerabilities and capacities of a community. For the vulnerabilities we use indicators such as the amount of elderly citizens, citizens with special needs and the presence of hospitals or care facilities. Capacities were based on indicators of resilience adapted from the multi-level Community Engagement Theory of Douglas Paton (Paton, 2008; 2013; Paton et al., 2014).

The Community Engagement Theory (CET) is a multi-level model, operating on three levels:

Individual level

Outcome expectancy (or response efficacy): the belief an individual has in the effectiveness of specific behaviours in preparing for disaster. Negative outcome expectancy refers to the belief that the disaster or crisis is too “catastrophic” for personal actions to make a difference to safety, while positive outcome expectancy refers to a belief that their actions can make a difference.

Community level

Community participation: interactions with others in regular social contexts. Through discussion with others information is exchanged on risks and effective responses.

Collective efficacy: community members’ assessment of their collective capabilities and resources needs and their ability to formulate plans to use resources to meet challenges.

Place attachment: identification with a neighbourhood – including attachment to the physical place as well as attachment to its members.

Institutional level

Empowerment: belief that one has influence on their own environment and institutional policies.

Trust: belief that the relationship with risk management agencies is fair and empowering.

Intentions: indication that one is going to conduct a particular behavior.

These indicators are measured through a survey that can be used either pre-event, post event or both.

The theory is community-led and predominantly focuses on the decision-making processes regarding the uncertainty of community resilience and has been developed to examine the factors that influence how people change and adapt to in order to become more resilient. It measures the interpretive processes that occur at the individual, community and societal level of resilience and how they affect a community’s decision-making to become more resilient/increase capacity. For communities to increase their resilience, they must engage in disaster risk reduction and preparedness activities through the development of resilience behaviours such as implementing household emergency plans or collaborating with fellow community members and local agencies to address local problems. (Paton 2013).

Traditional ways to engage communities such as financial assistance provision or resilience information dissemination have shown to have little influence on preparedness (Perry and Lindell 2008). CET seeks to address this by considering preparedness as a decision making process where “uncertainty” acts as the variable. CET addresses the decision making process of each individual within the community’s response to risk. This universality of the decision making variable provides a cross cultural overlap, operating at the psychosocial level of resilience present in everyone regardless of cultural differences, access to finance, differing resources and organizational capacities.

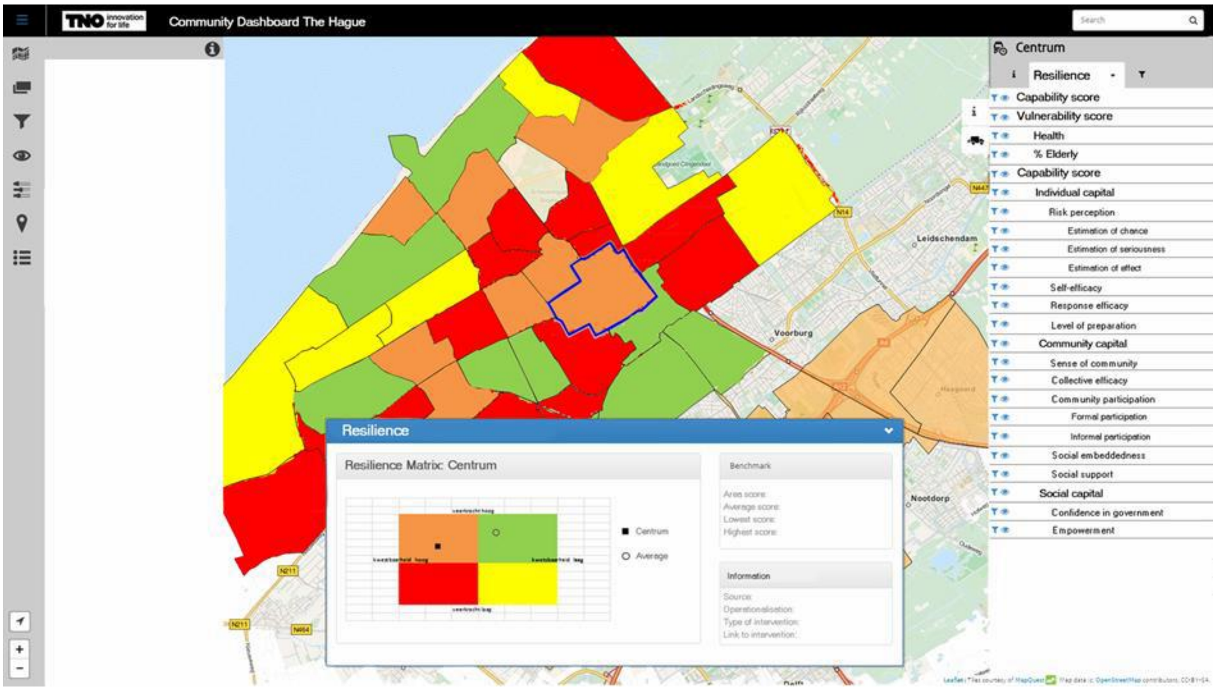
CET is considered an "all hazards" approach, validated across a range of communities and within different cultures using structural equation modelling (SEM) analysis. The theory has been validated in 'developed, western' countries that have frequent experience of disaster (e.g. New Zealand and Australia), but also within small to larger communities and radically different cultural contexts (e.g. Taiwan). The theory has been validated in both urban individualist (e.g. Christchurch, New Zealand) and rural collectivist (e.g. Taiwan) communities, showing valid cross-cultural equivalence, necessary for testing within pan-European contexts (Eiser et al., 2012).

CET draws upon some of the psycho-social concepts of community resilience, consistent with emerging community resilience literature that puts "pro-active human agency" at the forefront of community resilience (Skerrat & Steiner 2013; Paton, 2008). This is in contrast to the more reactive, "bounce-back" nature of more traditional resilience literature.

COMMUNITY RESILIENCE DASHBOARD

In order to come to a more effective collaboration between professional responders and the public in crises, professionals could work on better tailoring their interactions with affected communities to the specific needs and capacities that are available within these communities. We developed a dashboard to facilitate this. The idea behind the dashboard is that by providing professional responders with information about the level of resilience of a community, they may be better able to align their approach (response activities) to the situation at hand.

For the development of the community resilience dashboard we adopted the original CET survey (Paton, 2008; Paton et al., 2014) and administered it among citizens of The Hague, the Netherlands with regard to their preparedness against floodings. A demo-version of the dashboard (see figure) provides a resilience profile of specific communities. The profiles are based on indicators for the two main dimensions of resilience capacities and vulnerabilities. The indicators for resilience capacities are drawn from the CET, and the vulnerability is expressed in a set of indicators taken from existing census registrations. The first view in the demo-version shows a position of a community on the resilience matrix (the two dimensions) to see in one glance what the level of resilience is (the combination of high/low capacities and high/low vulnerabilities).



For more in depth analysis of the resilience profiles, users may browse each of the underlying factors in order to see what the specific factors are that influence the actual position in the matrix. This information can provide useful input for determining or adjusting the course of action of professional responders when preparing for or responding to an event in that community.

PRACTICAL USEFULNESS OF THE INSTRUMENT

The information in the dashboard of the demo tool offers clues for determining courses of action for professionals in anticipating and maximizing the resilience capacities of communities, both in training situations as well as operational situations. We discussed potential of the demo-version with a multidisciplinary team of professional responders in The Hague. In general they were positive about the underlying idea of bringing together useful information about the level of resilience of different communities to enhance their assessment of a crisis situation. The idea is in line with their ambitions to make better use of existing information to facilitate and stimulate effective collaboration with citizens and groups or organizations in affected communities and to better utilize the range of capacities that are present in these communities.

The respondents saw a lot of benefits of using such a dashboard during the pre-event phases. They argued that it could contribute to a better collaboration, starting in the preparation phase, for instance by building stronger networks between existing community networks and the professionals which saves time during a crisis. The use of a dashboard like this during the response phase is more complicated. In order to base part of the decisions about courses of action on the information in a dashboard, it is essential that the data is correct and updated dynamically. Crisis situations are always unique and it is dangerous to assume to know what can be expected based on more or less static information that is drawn from external sources or a periodic survey. Nevertheless, certain information can contribute to the assessment and sensemaking processes. For instance if there have been several incidents in a community related to tensions between different ethnic groups, this may indicate a relatively small event may escalate. An important conclusion is that even though a lot of data may be available to include in such a tool, it is important not to try to add too much details because that increases the possibility of erroneous or dated information. Moreover, it will never be the sole basis for a decision to decrease response efforts but at best only to increase certain specialist response efforts or to contact specific key contacts within the community to facilitate better collaboration and aligning interpretations of the situation.

CONCLUSION: FROM SELF-RELIANCE TO COLLABORATIVE RELIANCE

The increasing acknowledgement of the importance of strengthening community resilience is part of a broader transition in disaster management. It is recognized that preparation is a key factor when it comes to building resilience capacities. Preparation relates to risk awareness and actions within communities (citizens preparing for specific risks) but is also related to relations between the public and professional responders. While professional responders have a long tradition in training and preparing for response procedures in crisis situations, they generally do not prepare for collaboration with (resilient) citizens. So if citizens are stimulated more and more to become resilient and prepare for disasters, naturally professionals need to prepare for interacting with resilient communities.

Our study confirms that having access to information about the level of resilience of communities seems to have a great potential in supporting professional responders in crisis management. Yet knowledge about communities' levels of resilience or sharing information is not enough and comes with limitations (for instance regarding information reliability and accuracy in a dynamic crisis context). What is more important is that structural collaboration between citizen communities and professionals is facilitated. This collaboration should already start in the preparation phase and continues throughout all phases in crisis management.

So what we argue is that there is a need for a new foundational vision on crisis management that stresses 'collaborative reliance': a state wherein there are collaborations between professionals and citizen communities that are based upon maximizing capacities and minimizing strict operating procedures. A situation in which collaboration is set up in a dynamic, ad-hoc and flexible manner. As we see it, collaborative-reliance is not about creating formal, static collaboration agreements or rigid procedures. It is about creating conditions that encourage society-wide collaboration in disaster management and that is based on a mutual understanding of capacities, limitations and ambitions across communities.

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STRENGTHENING COMMUNITY RESILIENCE: A TOOLKIT

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ABSTRACT

While community resilience is said to have gained a lot of traction politically and given credence by disaster management professionals, this perception is not always shared by the individual members of communities. One solution to addressing the difficulty of individuals 'conceptualising' the benefits of resilience can be through the use of community workshops as a method of facilitating resilience awareness. Participatory workshops can be created to facilitate a "bottom-up" approach, with the aims of raising awareness and increasing the likelihood of resilient behaviours being adopted.

Within the European project 'DRIVER' we have tested CART (Community Advancing Resilience Toolkit) as a means to increase resilience. This framework has an added benefit of bringing community members together regarding resilience, increasing their awareness of resilience and improving community cohesion through the exchange of ideas throughout the process. The methodology employs the use of a range of participatory methods including an assessment survey, key informant interviews, data collection framework, community conversations, neighbourhood infrastructure maps, community ecological maps, stakeholder analysis, SWOT analysis, capacity and vulnerability assessment.

Eight workshops were held in Scotland pairing the CART toolkit's framework with recent British Red Cross resilience thinking in order to raise the awareness of resilience among a broad range of rural and urban communities. The overall result is that members of communities became more aware of their own vulnerabilities and capabilities, both at the individual and collective level, encouraging action as to increase their resilience.

Key words: community resilience, strengthening resilience, measurement, awareness raising, participatory methods

INTRODUCTION

In this paper we discuss the concept of resilience from the perspective of communities. The concept of resilience in the context of disaster risk reduction has gained a lot of traction politically and given credence by disaster management professionals, including a recognition of the importance of community resilience as an essential focal point in strengthening the resilience against a complex range of uncertain and sometimes unknown threats. Yet, the widespread adoption of a resilience perspective towards disaster risk reduction in professional circles has not spread equally among the public, i.e. the individual members of communities. Among citizen communities, resilience often becomes a topic of concern only after a crisis, when they have been confronted with disaster and are aware of some of the vulnerabilities in their community. For communities that have not experienced serious disasters, the perception of risk and vulnerabilities is not always present, and for them the concept of resilience does not have a strong meaning or sense of urgency. In addition, a lower sense of urgency with regard to disaster preparation or community resilience may be related to citizens' views on the state's role in disaster risk reduction and crisis management. Individuals can therefore find it difficult at times to appreciate the range and implications of consequences in the event of a disaster and the benefits of community resilience (Paton et al., 2014).

One solution to address the difficulty of individuals 'conceptualising' the benefits of resilience can be through the use of community workshops as a method of facilitating an increase of communal resilience awareness.

Within the European project DRIVER, we address the issue of community resilience and in particular seek to understand how members of a community can become activated through increased awareness about the resilience of their particular community. The overall aim of the project is to evaluate emerging solutions in crisis management and resilience. In order to evaluate existing approaches towards enhancing community resilience we have reviewed a selection of existing tools and frameworks that address the topic community resilience. In this paper, we discuss some of the characteristics of different available tools and discuss the preliminary results of our tests with one of the tools.

ENHANCING COMMUNITY RESILIENCE: A RANGE OF APPROACHES

The concept of resilience has received a lot of attention in recent years, yet the concept itself remains subject to debate and diverging interpretations (e.g. Cutter et al., 2010, Duijnhoven & Neef, 2016; Shaw & Maythorne 2013). It is used in various disciplines and fields, leading to a variety of definitions and operationalisations and a broad range of resilience enhancement frameworks (Duijnhoven and Neef 2014; Ostadtaghizadeh et al., 2015). Community-oriented approaches aim to facilitate self-assessment of resilience in communities (both communities of place and communities of interests such as a specific sector) by bringing together different stakeholders to identify critical functions, vulnerabilities and to develop specific enhancement activities. Some of the community oriented approaches aim to increase awareness within a community and help to identify concrete actions to enhance resilience, whilst others are primarily aimed at measuring the level of resilience of communities and understanding the determining factors of community resilience. These aims show a close relation to the way resilience is measured and relevant data are gathered. On the one end of the spectrum there are the participatory ways of collection of qualitative data. The methods are often applied in frameworks aiming at creating awareness of risks and hazards and shared responsibilities of stakeholders as a basis for enhancing community resilience. These frameworks take resilience as an on-going process at its starting point. At the other end of the spectrum community resilience can be measured quantitatively, either by specific surveys or by administrative statistics. The results of these measurements are mostly serving governance purposes by making comparisons between communities, cities, regions, etc. Between these two extremes there are a number of 'hybrid' frameworks that take a 'mixed methods' approach towards data collection to measure community resilience, based on their specific objectives.

Recently, Ostadtaghizadeh et al. (2015) conducted a comprehensive review of assessment tools available for evaluating community disaster resilience, using international electronic databases including Scopus and ISI Web of Science. As noted by Ostadtaghizadeh, et al. (2015) most studies on available tools are based on an analysis of community characteristics rather than on how to measure the level of community resilience, based on theoretically grounded and valid indicators. These characteristics relate to the level of communities' preparation and response. The research on community resilience is not very mature in that sense.

For our analysis, we have selected one specific tool to evaluate its usefulness and usability. Some of the approaches we reviewed originated from government/NGO initiatives that were meant to raise awareness and to identify possibilities for enhancing community resilience. These are based on theoretical insights, but they are not scientifically tested or validated. This means that there is not a lot of (systematic) information available about their validity or generalizability. This does not mean that these are not useful tools, but it is difficult to judge this on the basis of the information that is available. Two approaches Disaster Resilience Of Place, DROP (Cutter, 2008), and Community Advancing Resilience Toolkit, CART (Pfefferbaum et al., 2013), seem to have a more explicit theoretical grounding and there are a number of publications available about the tools and underlying models. Looking at these two tools, the theoretical model that is the basis for DROP has been discussed rather extensively in academic journals (e.g. Cutter et al., 2008; Cutter et al. 2010), but there is less information about its empirical application, whereas CART offers a broad, more community participation oriented set of tools, and there is also a number of articles available about its application in different contexts (e.g. Pfefferbaum et al., 2015; 2016). Based on these considerations, we have selected CART by Pfefferbaum et al. (2013) as the tool to use in our project.

APPLYING THE COMMUNITIES ADVANCING RESILIENCE TOOLKIT

The Community Advancing Resilience Toolkit (Pfefferbaum et al., 2013), uses a combination of several participatory data gathering methods to create a toolkit that can support communities in gaining information on the level of resilience capabilities in their community. The CART framework is used mainly by community organisations and as such can be considered a "bottom-up" approach to community resilience. The framework has an added benefit of bringing community members together to collectively discuss the topic of resilience in relation to their local situation, increasing their awareness of resilience and improving community cohesion through the exchange of ideas throughout the process. The CART framework helps users to collect community information following a process whereby the community generates an initial profile of their community, refines the profile, develops a plan and implements the plan. The process is iterative and communities use the following tools throughout the process: (i) assessment survey; (ii) key informant interviews; (iii) data collection framework; (iv) neighbourhood maps; (v) ecological maps; (vi) stakeholder analysis; (vii) SWOT analysis; (viii) capacity and vulnerability assessment.

CART is a comprehensive "bottom-up approach". The toolkit and is organised within a modular set-up allowing for the selection of specific, relevant tools to the community involved. CART's range of participatory instruments within the toolkit allow the community to reflect upon its capacities and identify actions aimed at improving certain specific capacities or addressing areas that are lacking to improve the resilience of the community. Four domains are distinguished: (i) Connection and Caring (participation, relatedness, shared values, support systems, fairness, hope); (ii) Resources (natural, physical, human, financial and social resources); (iii) Transformative potential (identify and frame collective experiences, data collection, analysis, planning, skill building to create the potential for community charge); (iv) Disaster Management (disaster prevention, mitigation, preparedness, response and recovery).

In our project we have applied CART in eight different Scottish communities with the aim to evaluate its usefulness and usability as an instrument to activate communities and increase resilience. The communities were selected by the British Red Cross and included four rural and four urban communities. The BRC facilitated and moderated the workshops with the communities.

RESULTS

All participants of the workshops indicated that they found participation interesting and inspiring. Most of them said they were planning to take concrete actions to prepare themselves and their community for crises as a result of the workshop.

In order to measure the effectiveness of the workshops in increasing awareness about community resilience and activation of participants, we administered a short survey at three different times: before the workshop, directly after the workshop and one month after the workshop. The questions in this short survey addressed the awareness of the participants about the vulnerability of their community, their opinions about the resilience of their community (capabilities to deal with a crisis), and whether or not they are prepared for a crisis.

The results of the surveys show that the members of communities who participated in the workshops became more aware of their vulnerabilities. Figure 1 shows the mean scores of the question: 'Do you think that your community is vulnerable to a crisis?'

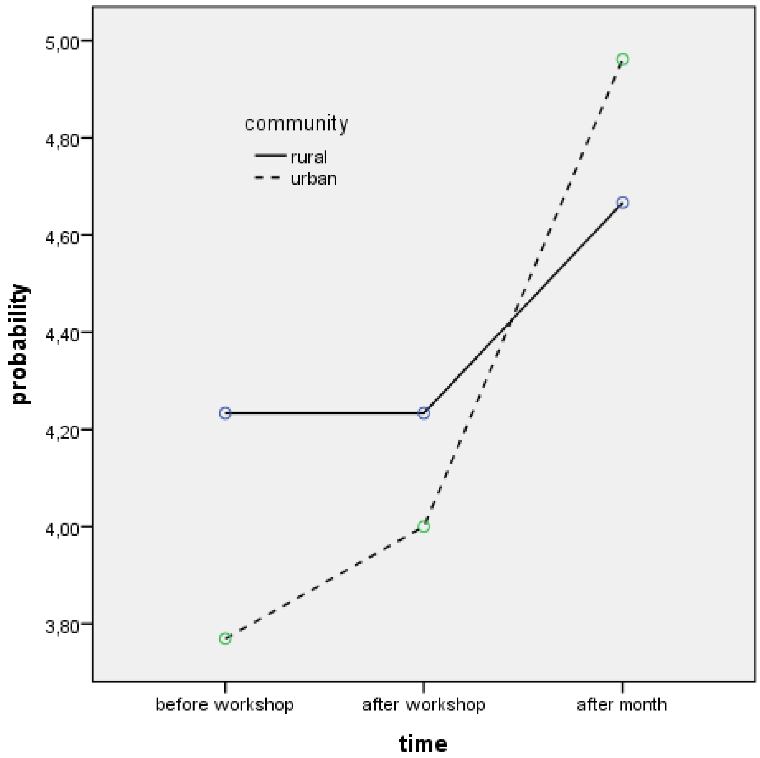

Figure 1: assessment of vulnerability as a function of time (pre, post and after month) and community (rural and urban)

There is an overall effect of time ($F(2,108)=7,21$; $p=.001$, no overall difference between communities ($F(1,54)<1$) and no interaction between time and community ($F(2,108)=1,41$; $p=.25$). The time effect is not due to a difference between the scores between pre and post workshop ($F(1,67)<1$), but to a difference between post workshop and after a month ($F(1,54)=7.61$, $p=.008$). This means that in the month after the workshop both rural and urban communities became more aware of the vulnerability of their community.

Furthermore, the results of the survey indicate that participants became more aware of their community's capabilities to deal with a disaster, both at the individual level as well as at the collective (community) level. It seems however, that this awareness of capabilities decreases over time (based on the survey one month after participation in the workshop). Figure 2 shows the results for the question ‘Do you have the feeling that your community is capable of dealing with a crisis?’.

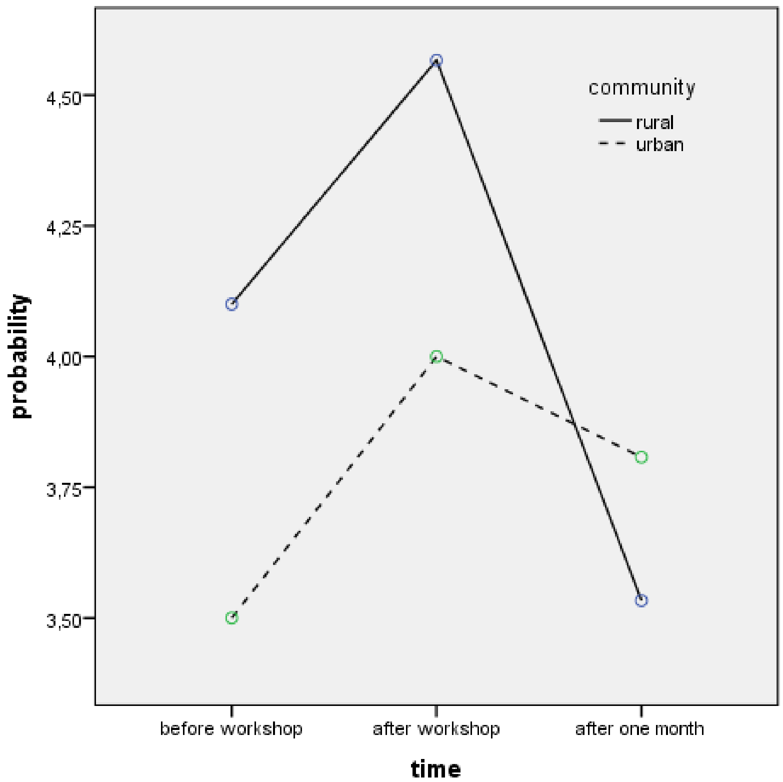

Figure 2: assessment of community capability as a function of time (pre, post and after month) and community (rural and urban)

It shows that there is a time effect ($F(2,108)=5.41$, $p=.004$), no main effect of community ($F(1,54)=2.04$, $p=.16$) and a significant interaction ($F(2,108)=3.42$, $p=.036$). In order to explain the interaction effect we conducted separate analyses for the different types of communities. The results show that there is only an effect of the intervention for rural communities ($F(2,28)=11.65$, $p<.0001$) and not for urban communities ($F(2,24)=1.51$, $p=.24$). For rural communities there is a significant increase between pre and post measurement $F(1,41)=9.29$, $p=.004$) and a significant decrease between the scores that were taken directly after the workshop and after a month ($F(1,29)=16,31$, $p<.0001$).

A month after the workshops we also asked participants about any behavioral adaptations: 1) whether they thought about risks and resources of their community; 2) whether they discussed what they had learned at the workshop with other members of the community; 3) whether they gathered additional information about their community’s resilience and 4) whether they had made any preparatory actions with regard to risks. Table 1 shows the mean scores on these questions for both rural and urban communities.

	rural	urban	p-value
Thinking	4.43	4.73	.12
Discussing	3.77	4.31	.14
Information	3.97	4.39	.20
Actions	3.70	4.65	.007

Table 1: mean scores and p-values for the behavioral responses after workshop

The answers could be given on 6-points scales. As can be seen in Table 1 the mean scores were between 3 and 5, with '3' meaning rarely, '4' occasionally and '5' frequently. The scores of the urban communities are overall somewhat higher than of the rural communities, but only for the preparatory actions a significant difference was found between the two types of communities (thinking: $F(1,54)=2.51$; $p=.12$, discussing: $F(1,54)=2.27$, $p=.14$, information $F(1,54)=1.66$, $p=.20$ and actions $F(1,54)=7.76$, $p=.007$). This means that all communities occasionally thought, discussed and gathered information about risks and resources in their community. But the urban communities took significantly more preparatory actions than the rural communities in the month following the workshop.

Interestingly, with regard to both the vulnerabilities and capabilities rural communities seem have higher awareness about it. The urban communities, on the other hand, seem to show an increase in the extent to which they feel prepared for a crisis after participating in the workshops, both at the individual level and at the level of their community.

CONCLUSIONS

The results of our study indicate that participating in a resilience awareness workshop using CART is effective in increasing awareness of vulnerabilities and capabilities. In particular for urban areas, where it seems there is less awareness to start with, the results show an effect in the assessment of the level of preparedness for themselves and their communities. The differences between urban and rural communities may be explained by the fact that many rural areas in Scotland are more prone to certain risks, such as flooding, making members of these communities more aware of this vulnerability, and more prepared as well. With regard to the higher level of preparedness as reported by rural communities, this may have to do with the more isolated location of many rural communities, with less professional response or other help close by, such smaller, tight-knit communities are often more used to helping each other out in times of crisis and being more self-reliant.

Based on these results it seems that CART is an effective toolkit to be used by communities for enhancing awareness about resilience. In order to test whether the application leads to sustained awareness and/or concrete actions within these communities further research, after more time, is needed.

ACKNOWLEDGEMENT

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FRAMEWORKS FOR UNDERSTAND THE LONG-TERM ECONOMIC CONSEQUENCES OF DISASTERS

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The long-term economic impact of disasters is debated among scholars. Several factors should be taken into consideration, including the type and severity of natural disaster, the underlying wealth of the economy, and the total area of country impacted. Additionally, the way that researchers choose to define long-term impact, look at direct and indirect damage, and the availability of data also matters. Regardless, there is still no clear consensus concerning the long-term economic consequences of disasters. A common way to determine this impact is to compare the economy post disaster to the level it was at prior to the disaster. This approach can be useful when comparing the impact in the short-term; however when analyzing the long-term impact it becomes problematic. Economies are constantly changing, and over long periods of time these changes will accumulate. Therefore one of the biggest challenges is to estimate what the level the economy would be at had the disaster not occurred. The ways in which researchers go about doing this can have a large impact on their conclusions. Several authors have found very little to no impact, of natural disasters in the long-term, especially when using country level data. There have been some notable exceptions. Poor countries as well as small island nations have been found to be less resilient in the long-term. Studies using data collected at regional or city level have found a much more nuanced set of results.

KEY WORDS: Economic impact, long-run, long-term growth, recovery, socio-economic

A SYSTEMATIC METHOD OF PLANNING EMERGENCY EXERCISES TO ENHANCE HEALTHCARE RESILIENCE

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ABSTRACT

Background and Purpose: Authors' research group is developing an Area Disaster Resilience Management System Model for Healthcare (ADRMS-H), which is composed of the municipality and healthcare-related organizations, to enhance the healthcare resilience of a community. To operating ADRMS-H effectively, we must execute emergency exercises and rotate PDCA cycle. However, a systematic method of preparing long-term plan of emergency exercises and executing them systematically has not been established yet. The purpose of this study is to propose a systematic method of planning emergency exercises for healthcare. **Approach**: At first, we enumerate emergency works at the time of disaster and classify them based on the seven principles of disaster coping. Next we break down the purposes specified in the ISO 22398 into detailed purposes by considering healthcare characteristics and systematize them. Based on this analysis, we propose a method of selecting individual exercise project and making annual plan of the exercises.

Findings: We extracted 118 emergency works and made a system diagram of the same. We made correlation matrix between emergency works and working teams as well. We can decide the exercises to be executed and the team to be selected by the diagram and the matrix. Furthermore, we clarified 31 concrete purposes of the emergency exercises by considering healthcare characteristics. Based on the results, we proposed a systematic method of preparing long-term plan of emergency exercises and executing them systematically. We applied the proposed method to the core hospital of ADRMS-H and verified its effectiveness as well.

Keywords: ADRMS-H, Emergency Works, Healthcare Resilience

INTRODUCTION

Japan faces a high risk of natural disasters, such as earthquakes, during which it is essential that countermeasures are taken to secure business continuity. During the 2011 Great East Japan Earthquake and the 2016 Kumamoto Earthquake, Japan found that a failure in its healthcare infrastructure hindered its social and industrial activities and created social dysfunction.

To create a safe and secure society in the midst of natural disaster, we must take countermeasures to enhance area resilience for healthcare. We define the area resilience for healthcare as the "ability of healthcare-related organizations in the area, to operate both normal medical care and disaster medical care continuously, to maintain status and condition, to recover quickly, and to improve as appropriate."

The authors' research group is developing an Area Disaster Resilience Management System Model for Healthcare (ADRMS-H), which is composed of the municipality and healthcare-related organizations, to enhance the healthcare resilience of a community. To operate ADRMS-H effectively, we must execute emergency exercises and engage the Plan-Do-Check-Act (PDCA) cycle. However, a systematic method of preparing and executing a long-term plan of emergency exercises has not been established. The purpose of this study is to propose a systematic method of planning emergency exercises for healthcare.

In this study, the target area is the city of Kawaguchi, which is located in the southeast of Saitama Prefecture, north of Tokyo, and has a population of around 600,000 people. Possible natural disasters around this area include a northern Tokyo Bay earthquake, the Kanto earthquake, etc. The core medical organization is the Kawaguchi Municipal Medical Center (KMMC), an acute care hospital with 539 beds and the core disaster-based hospital, a designation which is given to only one hospital in each prefecture. In this paper, we take up exercises in KMMC as an example.

APPROACH

ISO 22398, Societal Security - Guidelines for Exercises, has been published [ISO, 2013]. However, since the guideline has some problems, such as "it does not show which work should be a target of exercises" and "the objective of exercises are abstract," we cannot plan exercises concretely. First, to clarify the target activities, we enumerate activities during disaster by referring to healthcare literature, such as disaster procedure manuals. Next, we classify the works based on seven principles of initial response: command and control, safety, communication, assessment, triage, treatment, and transport (CSCATTT) [Carley, 2005].

Furthermore, we break down and systematize the objectives of exercises shown in ISO 22398 by considering healthcare characteristics. In summary, according to the above analysis, we propose a method of planning exercises that creates an annual exercise plan and selects a specific exercise for each year.

ENUMERATION AND CLASSIFICATION OF WORKS DURING DISASTER

To organize activities during disaster, we enumerated them. We investigated disaster procedure manuals [Hokkaido, 2010; Saitama, 2014a] and business continuity plans (BCP) of hospitals [Saitama, 2014b; Kochi, 2013; Tokyo, 2012], and related literature [InterRisk, 2013]. Initial activities are described in the disaster procedure manuals, while initial and subsequent activities are described in the BCPs. In total, we extracted 118 activities that occur during a disaster.

Next, we classified the activities as follows. Since medical needs, such as the occurrence of illnesses and wounds, increases during a disaster [Yoshinaga, 1996], many new tasks must be implemented. In this paper, we call them "disaster response works." On the other hand, tasks done during normal work, especially healthcare for hospitalized patients must be performed continuously. The procedures of the works have been determined, however, there might be a case in which the procedures must be modified due to the disaster. We call these activities "normal works during disaster." Since the characteristics of these works differ greatly, we then divide activities that must be accomplished during a disaster into disaster response works and normal works during disaster.

Medical works are divided into medical care and support services, such as setting up infrastructure and securing lifelines. The importance of support services increases during a disaster. Thus, we divided both disaster response works and normal medical works during disaster into medical care and support services. For disaster response works, we then classified medical care into "triage," "treatment," and "transport" and support services into "command and control," "safety," "communication," and "assessment" based on seven principles of initial disaster activities, CSCATTT. We defined these activities as primary works.

Furthermore, in the normal works during disaster, there are some tasks that are performed in a manner differing from normal circumstances due to the cessation of lifelines and the lack of material and human resources. These activities must be the target tasks to be exercised preferentially. We then classified these tasks into substituted work, reduced work, and temporarily interrupted work. The substituted work are tasks for which an alternative method should be determined. The reduced work are the activities for which, although the amount of the work must be reduced, the procedure does not differ from the norm. The temporarily interrupted work are tasks for which the priority is low and can be ceased temporarily.

In summary, we classified 118 works into the above categories and created a systematic diagram and table of disaster medicine works. Figure 1 shows a systematic diagram of disaster medicine works, and Table 1 shows a table of disaster medicine works.

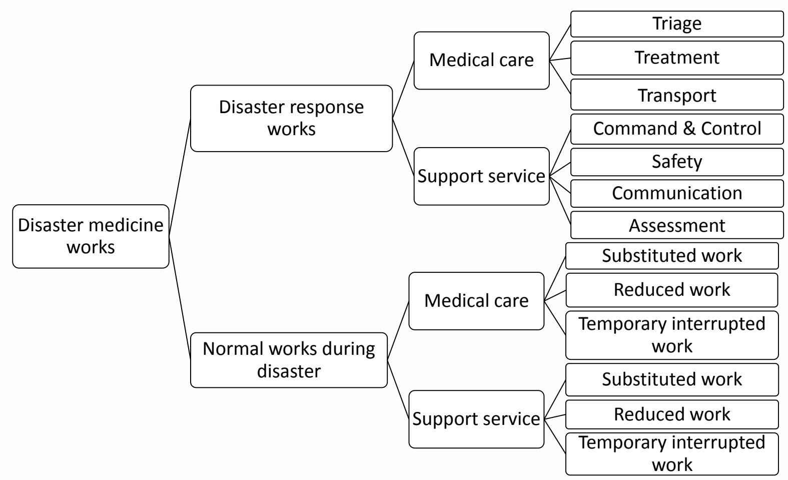

Fig.1 Systematic Diagram of Disaster Medicine Works

Table 1 Disaster Medicine Works (Partial)

Category			Primary work	Secondary work
Disaster response works	Medical care		Triage	Distribute necessary goods
				Conduct triage
			Treatment	Distribute necessary goods
				Reception at each aid station
				Care of patients who need emergency medicine
				Prescribe/prepare medicine
				Conduct emergency test
				Conduct emergency operation
				Conduct emergency radiograph test
				Perform an autopsy
			Transport	Determine patients to be transported
				Transport bodies of the deceased to family
				Coordinate with DMAT (DMAT arrived)
				Transport patients (DMAT not
Normal works during disaster	Support services	Temporarily interrupted work	External communication management	area citizens
				Information sharing control with partners
			Medical cooperation management	
			Purchase management	Purchase control of books
			Outsource management	Outsourced test control
				Dispatching personnel control
			Development/management of clinical technology standard	
			Procedure manuals management	
			Investment management	
			Finance management	
			Profit management	
			Food supply management	Food procurement control
				Cooking control
				Meal service/cleaning control
				Dish washing control

The target works of exercises are comprehensively shown in the Table 1. Hospitals can use the table for planning exercises.

ORGANIZING OBJECTIVES OF EXERCISES

To make an annual exercise plan and to achieve long-term objectives, it is necessary for hospitals to set concrete and achievable objectives for each exercise. The following are the objectives shown in ISO 22398:

Validating policies, plans, procedures, training, equipment, and inter-organizational agreements.

Clarifying and training personnel in roles and responsibilities.

Identifying gaps in resources.

Improving inter-organizational coordination and communication.

A controlled opportunity to practice improvisation.

Improving individual performance and identifying opportunities for improvement.

Since the objectives are abstract, it is hard for hospitals to set a concrete objective for an exercise. We then broke down the objectives. We explain the method by taking objective 2 as an example.

Objective 2 involves two sub-objectives, which are "clarifying personnel" and "training personnel." First we break the objective down into 2-1, "clarifying personnel in roles and responsibilities," and 2-2, "training personnel in roles and responsibilities."

As in 2-1 working groups are formed and each group performs disaster medicine works during a disaster, the personnel who form the group must be clarified. Furthermore, taking into consideration the case that personnel cannot be secured because of a cut-off road, substitutional personnel must be identified. Thus, 2-1 is divided into "clarification of personnel forming working groups" and "clarification of substitutional personnel forming working groups."

Training in 2-2 is defined "activities designed to facilitate the learning and development of knowledge, skills, and abilities and to improve the performance of specific tasks or roles." Ways to acquire knowledge and skills are different. For example, knowledge can be acquired through a lecture, however skills can be acquired by physical exercises. We then divide 2-2 into "teaching knowledge for personnel forming working groups" and "training skills for personnel forming working groups."

In the same way, we broke down all of the objectives. The results are shown in Table 2.

Table 2 Objectives of Exercises (Partial)

Category	Exercise objectives indicated by ISO 22398		Exercise objectives in hospital
	Primary objectives	Secondary objectives	
Assessing/Improving plan	1) Validating policies, plans, procedures, training, equipment, and inter-organizational agreements	1-1) Validating policies	1-1-1) Confirming that business continuity policy is consistent with business continuity objectives
		1-2) Validating plans	1-2-1) Confirming that business continuity plan is consistent with business continuity objectives
		1-3) Validating procedures	1-3-1) Confirming that incident response procedures are consistent with business continuity objectives
			1-3-2) Confirming that the communication procedures are consistent with business continuity objectives
			1-3-3) Confirming that safety/welfare procedures are consistent with business continuity objectives
			1-3-4) Confirming that rescue/security procedures are consistent with business continuity objectives
			1-3-5) Confirming that procedures for resuming business activity are consistent with business continuity objectives
			1-3-6) Confirming that recovery procedures for information and communication technology systems are consistent with business continuity objectives
		1-4) Validating training	1-4-1) Confirming that training is consistent with business continuity objectives
		1-5) Validating equipment	1-5-1) Confirming that medical equipment is consistent with business continuity objectives
		1-6) Validating inter-organizational agreements	1-6-1) Confirming that agreements with external organization (prefecture, DMAT etc.) are consistent with business continuity objectives
			1-6-2) Confirming that agreements with internal organization (working group, department etc.) are
Improving individual performance	2) Clarifying and training personnel in roles and responsibilities	2-2) Training personnel in roles and responsibilities	2-2-1) Knowledge education for the members of disaster working group
			2-2-2) Skill education for the members of disaster working group
	5) A controlled opportunity to practice improvisation	5-1) A controlled opportunity to practice improvisation	5-1-1) Opportunity to practice responses (mainly with judgement) that can not be proceduralized
	6) Improving individual performance and identifying opportunities for improvement	6-1) Improving individual performance	6-1-1) Improving individual quantitative results obtained by exercises
			6-1-2) Improving individual qualitative results obtained by the exercises
		6-2) Identifying opportunities for improving individual performance	6-2-1) Identifying opportunities for improving individual performance by quantitative results obtained by exercises
			6-2-2) Identifying opportunities for improving individual performance by qualitative results obtained by exercises

PROPOSAL OF SYSTEMATIC WAY FOR PLANNING EXERCISES

We propose a method of making an exercise plan systematically based on the results in sections 3 and 4.

Step 1: Determine target disaster medicine works

Clarify the activities for which procedure manuals are prepared, and are planned to be prepared. As the procedure manuals are part of the BCP, we can determine the target works for improving the BCP by understanding the status of the procedure manuals.

Step 2: Formulate an annual exercise plan

(2-1) Determine an annual exercise objective

Examine necessity of exercises and determine an annual exercise objective.

(2-2) Select target disaster medicine works for this year

Select target disaster medicine works for this year from the activities determined in step 1 to achieve the annual exercise objective determined in (2-1). We can select more than two activities for one exercise. For example, we can select both "establish disaster response headquarters" and "operate disaster response headquarters" as the target works, and perform a series of exercises to test the disaster response headquarters.

(2-3) Determine the exercise objective, type, and method

Determine the exercise objective of each activity selected in (2-2) by referring to Table 2. For works for which the procedure manual is newly prepared or revised, the objective should be "assessing and improving the plan." For works for which the procedure manual has already been revised and improved, the objective should be "improving individual performance."

Determine exercise type and method. Sample types and methods are found in ISO 22398.

Step 3: Make a plan for an individual exercise and conduct it

Make a plan for an individual exercise based on the annual exercise plan and conduct it.

By using the steps above, it is possible for hospitals to make an annual exercise plan and to conduct exercises effectively.

VERIFICATION

We applied the proposed method to KMMC. We attempted to make an exercise plan in collaboration with members of the disaster response committee.

Step 1: We determined the status of completion of the procedure manuals in KMMC by using Table 1. It was found there were 11 works for which the procedure manuals had already been prepared or were being prepared.

Step 2: We evaluated annual exercise objectives. We recognized that improvements in the disaster response headquarters were needed to respond disaster more efficiently and decided that the annual exercise objective would be: “all members of the disaster response headquarters can gather information, assess the hospital situation with standardized criteria, and can give appropriate directions.” We selected 8 activities, related to disaster response headquarters, from the 11 works identified in step 1.

Next, we examined the exercise objective and exercise type/method for each activity by referring to Tables 1 and 2. Taking into account the low-level of progress in establishing the BCP, we determined the majority of the exercises should be discussion-based and review of the procedure manuals. We were able to make an annual exercise plan.

Step 3: In the annual plan, it was decided to select one exercise, make a plan, and conduct it. The details of the exercise were as follows.

Title: Assessment of situation in the disaster response headquarters Content: Decide directions of the headquarters against injects*. Necessary knowledge is given by e-learning. (*injects: scripted piece of information inserted into an exercise designed to elicit a response and facilitate the flow of the exercise (ISO 22398)) Target personnel: 12 members of the headquarters (3 groups, 4 people/group) Objectives: 1-3-1) Validation of procedure manuals for the headquarters 2-2-1) The members acquire basic knowledge Method: Tabletop exercise

To conduct the tabletop exercise, it was necessary to prepare scenarios. We determined 29 actions that should be taken by the headquarters based on the procedure manuals for operating the disaster headquarters. We examined the situations needing a response and decided upon 37 injects.

After conducting the exercise, we compared the actions taken by each team. As a result, we clarified different actions among the teams, and the omission and mistakes present in the procedure manuals. We then could revise the manuals based on these results.

In summary, we can say that, by using the proposed method, we can rotate through the PDCA cycle, that is, we can enact countermeasures acquired from conducting exercise in the BCP.

DISCUSSION

There is no academic paper that addresses a systematic method of planning emergency exercises. Although empirical guidelines have been published by governments and municipalities, a systematic method has not been proposed.

Saito, et al. [Saito, 2013] proposed an exercise planning table for disaster response headquarters. The table makes it possible to grasp the availability of disaster responses and to set objectives of exercises, with the scope and scale appropriate for each task. However, the target works are limited to disaster response headquarters. Terumoto, et al. [Terumoto, 2011] designed and conducted a training program for municipal personnel who are in charge of disaster response. However, the objective of the program was the acquisition of disaster-response knowledge in a government office, and as such, the target works are limited.

To plan emergency exercises systematically, the activities in disaster response must be organized comprehensively, and what is evaluated in each exercise, that is the objective, must be defined precisely. Carley, et al. [Carley, 2005] described the activities in disaster response in the form of CSCATTT; however, the activities were not detailed. Moreover, the discussion did not include normal works in disaster. ISO 22398 provides a rough classification of exercise objectives. However, to link the objectives to the exercises, we must clarify the meaning of the objectives in the detailed activities. This clarification is provided in sections 3 and 4 of this paper. Thus, we propose a new method of deploying disaster activities and deploying exercise objectives relating to these activities. This is an original academic result, and the concept can be applied to other industries.

The proposed method makes it possible to see the relationships between individual exercises and to confirm the position of the exercises in the annual plan. As a result, we can achieve the annual exercise objective efficiently. This will enhance healthcare resilience in a disaster.

To conduct an exercise practically, we must determine a type/method of exercise. The Department of Homeland Security [Department, 2013], and the Business Continuity Institute [Business, 2013] describes the characteristics of various types/methods of exercises. If the relationship among the types/methods, the target activities, and objectives which are described in this paper are clarified, we can establish a systematic method of planning emergency exercises in the future.

CONCLUSIONS AND FUTURE ISSUES

In this paper, we organized disaster medicine works, proposing a systematic diagram and table for reference. Furthermore we classified exercise objectives, organizing them into a table. Based on these results, we proposed a systematic method of planning emergency exercises. We then applied the method to KMMC, which is a core disaster hospital in the ADRMS-H, prepared an annual plan, conducted an exercise, and verified the effectiveness of the proposed method. We can reflect countermeasures acquired from conducting exercise in the BCP by using this method. This leads to a rotating PDCA cycle for ADRMS-H.

The versatility of the systematic diagram, the table of disaster medicine works, and the table of exercise objectives have not been verified. In creating an exercise plan, it would be useful to have the relationships between the type/method of exercises and the exercise objectives organized. Moreover, the method of assessment for exercises has not been established. These are issues for the future.

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SUSTAINABILITY IN THE CONTEXT OF RESILIENCE AND CAPACITY BUILDING STRATEGIES

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ABSTRACT

Sustainability, resilience and capacity building should not be considered as isolated concepts but they should go hand-in-hand to offer a better habitat for the human being. Modern societies are facing increased risks of natural disasters due to rapid climate change. Examples of climate change effect include increased global mean temperature, mean sea-level rise, and frequent extreme hydrological events, e.g., floods and droughts. The importance of resilience and capacity building is well-established in order to enhance the security of communities, infrastructure and associated critical facilities in face of such extreme events. Improving resilience includes building capacities, redundancies, robustness (pre-disaster) and rapid recovery of systems (post disaster). While selecting various alternate strategies for capacity building to enhance resilience, strategic decision-makers and planners need to consider the sustainability aspects of the strategies. *Sustainable resilience-enhancing strategies* are thus, referred to those strategies that contribute indefinitely to the development and well-being of both the consumers and infrastructure whilst not overdrawing natural resources or over-burdening the environment in an irreversible manner. Strategic-decision-making for resilience enhancements thus should consider strategies/options that not only enhance resilience but also contribute to sustainable development of the society and infrastructure. This paper presents a conceptual framework for an integrated decision support system that considers all the three aspects, i.e., sustainability, resilience, and capacity building properties of the strategies in the decision making process.

Key words: Resilience, Sustainability, Capacity building, Strategic-decision-making

INTRODUCTION

Resilience planning, capacity building as well as sustainability planning are rooted in the designing and implementation of different types of strategies.

Resilience of a system is defined as the property that incorporates resistivity, absorptivity, adaptability and ability to recover timely from potentially disruptive or historically unprecedented hazards caused by natural, technological or man-made disasters (UNISDR 2007). In the United States, President Barack Obama signed a

Presidential Policy Directive (PPD)-21 on February 12, 2013 and called for national unity to enhance the resilience of critical infrastructures in order to strengthen and maintain proper functioning and security of the critical infrastructures for sustaining nation's security, economic prosperity and well-being of the public (The White House 2012). Recently, there is an influx of research studies that are focusing on the importance of the resilience enhancement of infrastructures (Berkeley III and Wallace 2010; Bruneau et al. 2003; Chang and Shinozuka 2004; Filippini and Silva 2014; Maliszewski and Perrings 2012; Moteff 2012; Pant et al. 2014; Petit et al. 2012; Sinclair 2009). Although several definitions of resilience are coined by various research groups and attempts are being made to use the concept of resilience in enhancing the security of any system, but still from an operational perspective, there are various issues regarding application of this concept. In this research, resilience refers to resilience of a system which includes infrastructure, societies, communities or organizations.

Capacity building is one of the important pillars of resilience enhancement. Capacity is referred to as the ability to absorb any type of disruptions and it also includes a margin of ability to resist, absorb or recover rapidly from the disruptions larger than what was anticipated (Scott 2010). Capacity building considers physical and functional redundancies so that the community or infrastructure might have alternative ways to survive in a post disaster situation (Scott 2010). UNISDR defines capacity as the *"combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals"* (UNISDR 2009). The UNISDR definition of capacity can be also applied to infrastructure and physical means, institutions, societal coping abilities, as well as human knowledge, skills and collective attributes such as social relationships, leadership and management (UNISDR 2009). Identification of the capacity gap with respect to the established social and economic goals, and mitigating that gap is extremely essential for resilience enhancement of both communities and infrastructure. Deshmukh & Hastak (2014a, 2014b) proposed decision support systems to identify the existing gaps in capacities of infrastructure. The authors suggested a novel methodology to select optimal strategies for capacity building of the infrastructure for improving community resilience both under the ex-ante and post disaster scenarios.

*Sustainable development or sustainability***,** as defined by the Brundtland Commission in 1987, is given by *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (UNISDR 2009). In this paper, we propose that the strategy selection for capacity building should not only be guided by resilience enhancement characteristics but also be assessed based on the sustainability aspects. This is essential because the time continuous effects of any strategy on the economy, environment and society is addressed by the concept of sustainability and their effects are distributed over the lifecycle of the infrastructure (Bocchini et al. 2014).

The major issue of implementing the combined concepts of sustainability with resilience and capacity building lies in the fact that these are relatively nascent concepts and there is a lack of common understanding of these terms among the stakeholders. In general, there might be two approaches for strategy selection:

Select a portfolio of strategies for sustainable development and check if they satisfy the resilience characteristics of robustness, resistivity and rapid recovery under any disaster scenario;

Select a portfolio of strategies for mitigating the capacity gap and build resilience to secure the communities or infrastructure in face of a disaster and then check if they contribute to sustainable development of the society.

In this research, we are proposing the concept based on the second approach.

LITERATURE REVIEW

Several studies have focused on the isolated concepts of resilience and sustainability, but a very few have looked into an integrated philosophy of resilience and sustainability. Bagheri & Hjorth (2007) illustrated a process based sustainable development of urban water system using the systems dynamics approach. The authors argued that the most suitable strategy for sustainable development includes a dynamic social learning process involving the stakeholders and planners instead of traditional approaches of strategy making to satisfy fixed goals. Ahern (2011) discussed the different strategies in the context of resilience building and the sustainability science from the perspective of urban cities. In this paper, author integrates the concept of resilience, i.e., anticipating the failure and preparing for the worst into the traditional concept of sustainability that envisions durability and stability, which once achieved could persist for generations. The proposed five urban planning strategies for building resilience include multi-functionality, redundancy and modularization, bio and social diversity, multi-scale networks and connectivity, and adaptive planning and design. Bocchini et al. (2014) proposed a conceptual integrated approach of considering the resilience and sustainability for the civil infrastructure systems within the framework for traditional risk assessment. Fiksel (2003) proposed a generalized approach for sustainable systems design where resilience was considered for both the individual engineered systems and also the system-of-systems. Fiksel (2006) claimed that there is a need to understand the dynamic, adaptive behaviour of complex systems as well as their resilience characteristics while designing the sustainable systems. Rahimi & Madni (2014) also proposed the concept of including resilience engineering (RE) in the development of sustainable engineered systems (SES). Folke et al. (2002) used the concept of resilience to understand how to enhance the adaptive capacity and sustain that in context of the rapidly changing socio-ecological systems. Pearce, Hastak, & Vanegas (1995) proposed a methodology to evaluate the construction materials based on sustainability and developed a conceptual decision support system to help in the process of those materials selection and specification process. Curz, Kim, & Cha (2012) proposed sustainability rating systems based on environmental assessment tools to evaluate and compare different transportation projects or programs over their life-cycle.

Recently, since 2012 the United Nations introduced the concept of Sustainable Development Goals (SDGs) and developed a 2030 Agenda for sustainable development of the Universe. The 17 SDGs and 169 targets proposed by the United Nations attempts to eradicate poverty of people, protect the planet from degradation, offer prosperity to human beings' life, foster peace and mobilize global partnerships in the process (United Nations 2015).

Thus, it is evident that there are various perspectives of considering the concepts of resilience and sustainability in the context of infrastructure and other engineered systems, socio-ecological systems, construction methods and material selection, transportation, and others. In this paper, we will consider resilience and sustainability within the same framework for capacity building of communities or infrastructure in face of a disaster. In the following section, we present the conceptual framework for our research.

CONCEPTUAL FRAMEWORK

Sustainability is an extremely important concept that is being used in different disciplines such as ecological and environmental sciences, sociology, engineering, designing and planning of built environment, and others. The three pillars of sustainability, i.e., economy, society and the environment are highly interrelated. The interrelationship in terms of resource flow within the systems taxonomy is shown in Figure 1.

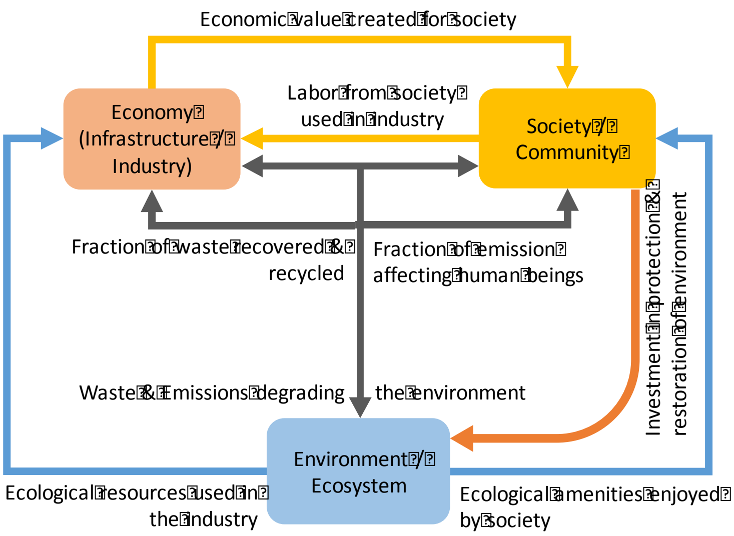

Figure 1. Systems taxonomy with resource flow (EPA 2012)

However, the application of sustainability in the context of resilience planning and capacity building for disaster risk reduction is a comparatively new concept. In the modern times of increasing global warming and climate change, it is extremely important to consider the effects of the implementation of any strategic decisions on the economy, society and environment/ecology. The effects might be direct/indirect and might be realized immediately or within a short-term or long-term period. Moreover, these effects must be assessed for all the involved processes throughout the entire life-cycle of the strategies. Figure 2 shows a framework for the conceptual decision support system to identify the *sustainable resilience enhancing strategies* based on:

setting a resilience goal
identifying the capacity gap
developing portfolio of capacity building strategies and
perform sustainability assessment for each of the candidate strategies

The methodology for setting the resilience goal, identifying the capacity building strategies, and developing portfolio of candidate strategies that meet the benefit-cost criteria has been developed by Deshmukh & Hastak (2014a, 2014b). In this paper, the method of selecting capacity building strategies is extended by integrating the sustainability aspect into the decision making process. Sustainability assessment is based on analysing and evaluating the impacts of the proposed strategy on the society, economy and environment throughout the life-cycle. The conventional phases of the life cycle include material flow and services, related raw materials extraction, all related processes, inputs, equipment required for the implementation of the strategy, related manufacturing and fabrication processes if needed, distribution of the product and all the relevant rehabilitation, recycle and disposal processes (Bakshi and Fiksel 2003).

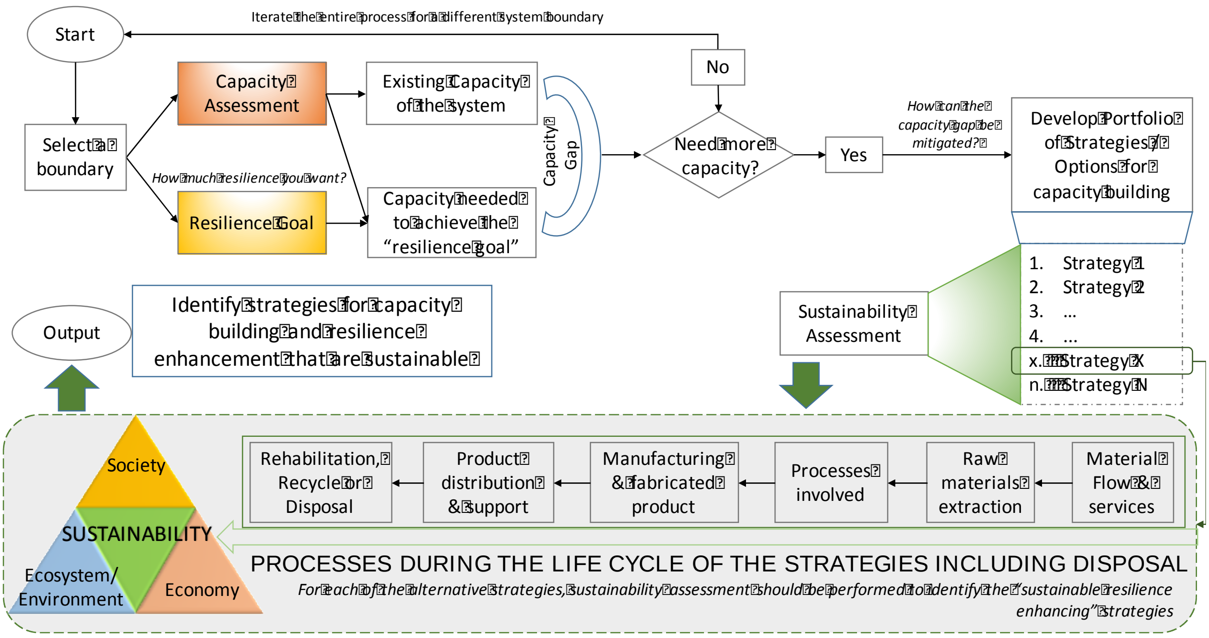

Figure 2. Conceptual framework for integrated decision support system to identify sustainable resilience enhancing strategies

The *capacity building strategy* can be referred to as the "product" in this case.

Table 1. Conventional Sustainable Performance Indicator Examples (Fiksel 2003)

ECONOMY	ENVIRONMENT	SOCIETY
DIRECT COSTS: Costs related to raw material, capital, operating, labour, etc.	MATERIAL CONSUMPTION: Product & packaging mass, effective product lifetime, hazardous materials used, eco-efficiency, etc.	QUALITY OF LIFE: Employee satisfaction, product or service availability, knowledge enhancement, etc.
HIDDEN COSTS: Costs related to revenue from recycling, product disposition cost, etc.	ENERGY CONSUMPTION: Life cycle energy and power use in operation	PEACE OF MIND: Community trust and perceived risk
CONTINGENCY COSTS: Costs due to employee injury, customer warranty costs	LOCAL IMPACTS: Product recyclability, run-off to surface water, etc.	ILLNESS & DISEASE REDUCTION: Illness and disease avoided & reduced mortality
INDIRECT COSTS: Customer retention costs, business interruption cost, etc.	REGIONAL IMPACTS: Smog, acid rain precursors, biodiversity reduction	SAFETY: Lost-time injuries, reportable releases, number of incidents, etc.
EXTERNALITIES COSTS: Costs owing to extreme events such as ecosystem productivity loss, costs due to resource depletion, etc.	GLOBAL IMPACTS: Global warming emissions, ozone depletion, etc.	HEALTH & WELLNESS: Nutritional value provided and subsistence cost

Table 1 lists some examples related to the conventional sustainable performance indicators (Fiksel 2003). These indicators represent the impacts of the strategy related to the life-cycle phases (as shown in figure 1) and they impact either the economy, environment or society (as classified). These indicators will help the decision makers to think through the different types of impacts that the capacity building strategies might have on the economy, environment and society during the entire life-cycle process. The final outcome of this process will lead to identification of the candidate capacity building strategies that will not only help achieve the resilience goal but also support the sustainability objectives.

FUTURE WORK

In this paper, we proposed the conceptual framework for an integrated decision support system to select the resilience enhancing capacity building strategies that will also consider the sustainability aspects. This research will be further expanded by developing a grading system for sustainability assessment to evaluate the capacity building strategies. The grading system will help to quantitatively rank the strategies based on a scale of low to high impacts on the environment, economy and society. This will also foster the prioritization and selection of strategies based on the stakeholders' objective, vision and mission. In order to quantitatively assess the impacts over the life-cycle, it is necessary to conduct the life-cycle benefit cost analysis considering all the possible effects. However, quantifying the values created due to enhanced resilience and better sustainability is extremely tedious and sometimes, it is not even possible to associate a dollar value to the benefit that is achieved during the process. In future, this research will also develop a benefit cost analysis for the strategy selection, utilising the life-cycle benefit cost analysis model developed by Hastak & Halpin (2000) that does not require monetary quantification of benefits for comparison of alternative materials.

CONCLUSION

Sustainability is an important concept that has found its application in diverse disciplines such as engineering, environmental sciences and ecology, sociology, economy, infrastructure and built environment, etc. However, using the sustainability perspective in planning for capacity building and resilience enhancement for disaster risk reduction is a novel concept. In this research, we proposed a decision support system for assessing the capacity needs to obtain a resilience goal and identify the candidate strategies and integrating it with the sustainability assessment framework. This would help to identify a subset of the candidate strategies that not only contribute to the resilience building but at the same time would offer a greener solution that will minimize the negative impact on the economy, environment, ecology and society.

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URBAN RESILIENCE THROUGH SPATIAL SYNTAX

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ABSTRACT

This paper addresses the potential for space syntax to marriage isovist patterns and social dimensions in order to interpret the resilient qualities of a city's urban form. This is to provide an alternative means to locate attributes of resilience in urban form, allowing local bodies to have the tools to perform disaster risk reduction planning so systems are as resilient as possible to the sudden hazards of a disaster. Using Wellington City as a site for testing, multiple syntax's of city are taken relevant to the projected hazards it is vulnerable to. When sections of the city are inundated, insight into how the urban form can facilitate recovery can be interpreted. Used in conjunction with resilience theory and an understanding of the site's context, this tool produces insight into current resilient attributes within a city's urban form, providing a necessary step in understanding how to manage and design for it.

Keywords: cities, disaster, resilience, syntax, urbanism

INTRODUCTION

Space syntax is a tool utilised by architects and urban planners as a means to assess configurations of urban maps and architectural plans to understand their social implications. However, these methods also have the potential measure the resilience of a city's urban form, particularly when parts of the city are inundated or require evacuation following a disturbance. When considered in conjunction with one another, a city's open space and road network are responsible for its interconnectivity. This influences the ability in which people evacuate, assemble, temporarily inhabit, and receive aid following a disturbance. Both the arrangement and construction of these open spaces and roads determine how resilient the urban form of the city is, as these are a resource that influence a community's capacity to autonomously govern their recovery. Preservation of their level of utility pre and post disturbance ensures that activities built around the use of these roads and open spaces can be preserved.

Space syntax's isovist graphs can visually locate the specific road and open spaces that have relatively greater accessibility and clearer sightlines, particularly when the areas around it become unusable. These specific roads and open spaces are prime spaces to facilitate evacuation, assembly, and/or temporary inhabitation following a disaster. This paper aims to investigate the use of space syntax in gauging the resilience of a city's urban spaces under the effects of large disturbances, whilst pinpointing specific spaces within the urban form that have a greater potential to facilitate recovery.

The paper beings by reviewing literature concerning the responsibility of open urban spaces and roads in a city's disaster recovery and the link of urban form to resilience. This is followed by an introduction to space syntax, the methodology of the paper, and subsequent syntax of Wellington City, the political capital of New Zealand. The paper then concludes with an evaluation of space syntax as a method of measuring the resilience of a city's urban form, as well as pinpointing particular urban spaces requiring greater consideration of their utility in the event of a disaster.

LITERATURE

As (Hillier & Vaughan, 2007) describe, the city is a construct of buildings and human activity, and these independencies are linked between themselves by space and interaction. The degree to which these social interactions and activities are performed are correlated with urban form. Evacuation, assembly, temporary inhabitance, and supply of healthcare and aid are part of the social activities linked with the spatial establishments of urban spaces. These are particularly practiced following the events of a disaster. However, literature linking a city's resilience to urban form, including direct guidelines on how open spaces can be arranged and designed to better aid recovery is scarce (Allan et al. 2013).

A general definition of resilience can be understood as the 'the ability of a system, entity, community or person to withstand shocks while still maintaining its essential functions' (Brand & Nicholson, 2016). From an urban context, a city's resilience is the ability for it to adapt to unforeseen disturbances, and be able to return to daily autonomy. Given the potential role of open spaces and roads to maintain social activities and provide a means of evacuation and refuge, their physicality within a city's form demonstrates that there must be a link between urban form and resilience.

This has been recognised at the governing level. The United Nations Office for Disaster Risk Reduction (UNISDR) have released a series of guidance documents named 'The Ten Essentials for Making Cities Resilient,' which were developed to escalate the implementation of the Sendai Framework for Disaster Risk Reduction (2015-2030). Of notable significance is the fourth essential of the operational framework. This directs local bodies to 'Pursue Resilient Urban Development and Design.' This based to the understanding that preemptive actions to increase the resilience capacity of roads and open space networks can safeguard extreme social and economic consequences (UNISDR, 2015).

(Brand & Nicholson, 2016) has linked resilience to urban form by comparing core characteristics of a resilient system to the performance of the Christchurch's urban spaces in the aftermath of the 2010 and 2011 earthquakes. *Spare capacity* and *safe failure*, the capacity of a system to contain redundant connections and restrict damages from flowing onto other systems, is demonstrated through Christchurch city's historic street grids, scattered reservoirs, and sufficient outdoor parks. These interventions allowed 'effective evacuation, shelter and ultimately the isolation, demolition and debris management of the CBD within a military cordon' (Brand & Nicholson, 2016).

(Allan et al. 2013) have taken a similar approach by taking a set of metaphoric attributes of resilience and comparing them with their associated definition in urban design theory. This is to understand, from a spatial point of view, how the attributed resilience metaphors (diversity, modularity, innovation, tight feedbacks etc.) as prescribed in *Resilience Thinking* by Brian Walker and David Salt (2006) can be interpreted. Based upon these interpretations, urban form and human response can be assessed. Using the case study of Concepcíon's earthquake in 2010, it was found that diverse but adaptable spaces of varying size, with clear sightlines and relative ease of access were important for quality spaces and the resulting choice of shelter sites (Allan et al. 2013). The presentation of connectivity for the practices of evacuation, assembly, and shelter within Concepcíon's urban form greatly aided the capacity of displaced communities to control their own recovery.

It is clear that there is a mutual interplay that exists between urban form and the activities of society. Linkages between resilience and urban form are apparent. Urban spaces can conservatively reflect and embody a social pattern, but too can the urban spaces generate and inform a social pattern (Hillier, 2014). Conceived by Bill Hillier (2014), space syntax is a theoretical model of human space, interested in the methods to which is it structured, operates, perceived, and integrated into society. It is a framework exercised visually, that can illustrate the intrinsic configuration behind a city's form. Space syntax provides an opportunity to assess the configuration of a city's open spaces and roads to answer questions about its social dimension. Based upon which, observations regarding the resilience of these spaces can start to be visually manifested and discussed.**SPACE SYNTAX**

The syntax process begins by activating a grid onto an imported closed map, which can range from street maps to building footprints across a city centre. The grid deconstructs spaces within the map into smaller elements and the map is computationally analysed, visually communicating the relative interconnectedness of these gridded components. Connectivity of these diagrams are derived from three abstractions of space (Potangaroa & Chan, 2010)

An isovist is the set of all gridded components, or points, visible from another point on the analysed map (Benedikt, 1979).
Axial spaces are constructed by drawing the longest single line possible from one point to another whilst avoiding collision with map boundaries (Teklenburg, Borgers, & Timmermans, 1994).
Convex spaces describe enclosed spaces where every point within the space is able to draw a line to every another point within the space whilst avoiding collision with map boundaries (Hillier & Vaughan, The city as one thing, 2007).

A common method of analysis is integration. Integration calculates the number of adjustments one would need to make in order to travel from one region to another. Areas requiring a minimal number of turns to advance to all other areas can be identified as integrated, whilst those requiring the most are separated (Potangaroa & Chan, 2010). Integrated areas are represented by the colour red, symbolising spaces with clear sight lines and accessibility. Areas deemed to be secluded are represented by the colour blue, symbolising concealed and private spaces. Based upon patterns presented by the spatial configurations imported into the framework, one can start to interpret the resiliency of a city's urban form.

METHODOLOGY

Literature has indicated the responsibility open spaces and roads have in the facilitation of recovery following a disturbance. It has also pointed towards urban resilience measures that are derived from resilience attributes and the response of communities in the event of a disaster. Particularly, the significance of connectivity in quantifying resilient public spaces and roads. If the pattern of these social configurations changes under the influence of expected disaster related risks, then there is an opportunity to observe how these social dimensions are altered in each scenario. This can start to communicate the ways in which a city will behave in multiple scenarios, pointing back towards the spatial configurations and their resilience.

To test this, a syntax of Wellington City will be analysed through isovist graphs. DepthmapX has been used for the purposes of the test. Integration will produce a graph with a spectrum of colours that will illustrate the connectivity of the open spaces and streets within the city. The imported map of Wellington will be manipulated, with sections of the city being cut off from the map. High and moderate risk liquefaction zones and tsunami evacuation zones provided by the Wellington City Council will determine the public areas of inundation and closure.

WELLINGTON

The capital city of New Zealand, Wellington, is an urban centre with extreme vulnerability to seismic activity. Major fault lines that travel through the sector are expected to heavily damage the city's infrastructure, including water, waste, drainage, and transport. Given the city's political and economic importance, the ramifications of a severe earthquake scenario will be catastrophic for the nation. Derived from the city's building footprints as of 2012, and an outline of the harbour from present aerial photography, the map as presented in Figure 1 will be the base map for the application of space syntax. The majority of the industrial and rail way sites in the northern areas of the city centre have been exempt from the syntax, due to

their limited and private accessibility.

Figure 1. Wellington City base map *Figure 2. Syntax of base map*

The isovist graph of Wellington City's base map clearly communicates the main spaces of integration, demonstrated by the warmer yellow, orange, and red tones (Figure 2). These integrated areas mostly highlight the city's main transport routes and the open spaces adjacent to them, which are the quays along the waterfront, State Highway 1 running along Arthur Street, Cambridge and Kent Terrace, and Parliament. This is largely due to the city's grid pattern, which allow parallel areas of integration straight through the city. However, in regards evacuation, Wellington may find a conflict with

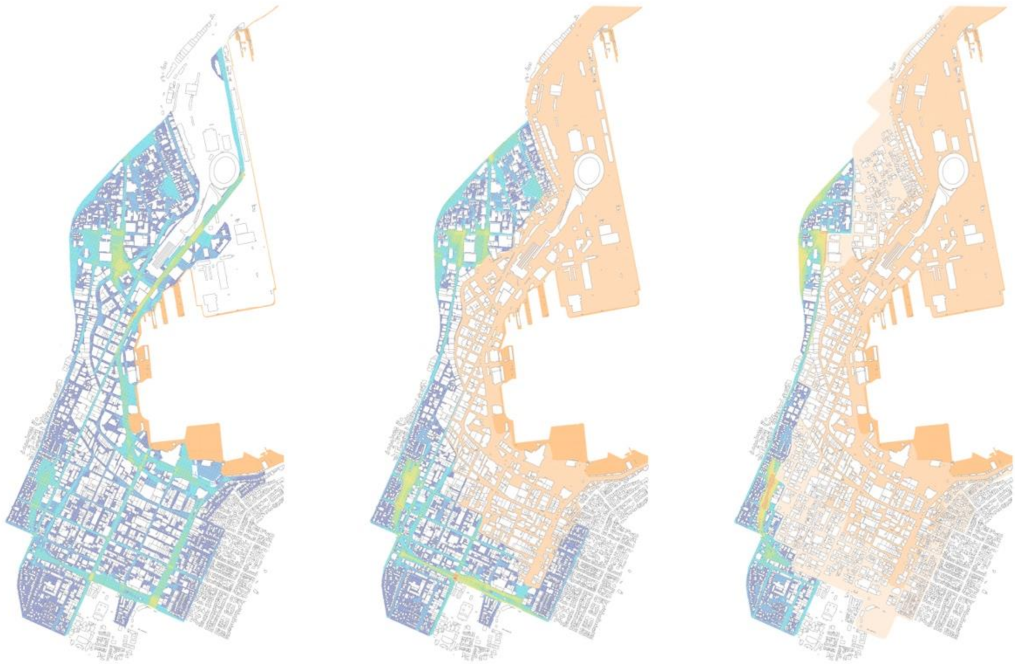
its grid pattern and contrasting integration patterns between State Highways and slower connecting roads. Although modular grids can have a high degree of permeability and have efficient interconnectivities due to their redundancy of linkages, dangerous bottlenecks can occur at junctions between two different urban typologies, in this case, city to highway (Allan et al. 2013). However, the number open spaces and amenities along the waterfront are comparatively integrated, and with the city being in close proximity to the water, evacuation would only require people to traverse a relatively short distance in the wake of a disturbance. With clear sight lines, easy accessibility for pedestrians and aid, and a variety of open and sheltered areas, there is a large quantity of functional diversity along the waterfront. This capacity to facilitate activities of recovery under disturbances undamaging to the built environment demonstrate a resilience inherent within Wellington's urban form.

Left: Syntax of Wellington City not subjected to high risk (red) of liquefaction (Figure 3), Right: Syntax of Wellington City not subjected to moderate (orange) and high risk (red) of liquefaction (Figure 4)

Wellington’s geological vulnerabilities are demonstrated by Figures 3 and 4, with significant portions of reclaimed land being highly susceptible to liquefaction in the event of seismic activity. Predictably, these high risk areas are along the city’s waterfront, where as previously observed, are well integrated and contain a lot of capacity for the city’s recovery. For the purposes of this testing, areas outlined to contain moderate and high risks to liquefaction have been assumed to be inundated. The syntax of Wellington City under these circumstances starts to expose the limitations in its urban form. With the accessibility and functional diversity of the waterfront being removed, the more secluded spaces, with limited sight lines have a greater burden of facilitating recovery. The issues surrounding the dangerous junctions and bottlenecks of pedestrian accessibility are intensified, as evacuation northbound is nullified. Here the contribution of the waterfront to the resilience of Wellington’s urban form is questioned. However, under severe circumstances where the city exhibits liquefaction in moderate and high risk areas, the open spaces surrounding parliament have improved integration and visible connectivity. Given the site’s political significance, the space’s ability to maintain function and adopt flexible occupancies during and after the effects of this particular disturbance is ideal. Another notable area within the urban form is Wellington’s war memorial on Arthur Street, which shares the same site as the northbound State Highway 1. It is a site that encourages pedestrian access and is designed to facilitate thousands in public gatherings. Refuge, assembly, and shelter are activities that will be inherent to this space if Wellington is subjected to drastic circumstances. This park sits on the edge of the city and closer to residential dwellings, providing the opportunity for withdrawal for those requiring privacy. A choice for privacy is a luxury, particularly in times where the the provision of space is scarcely limited (Allan et al. 2013). This space, as suggested by syntax integration and resilience theory can act as a resource increase the capacity Wellington's autonomy during displacement.

Left: Wellington City's 1 in 100-year tsunami evacuation zone (deep orange) (Figure 5), Middle: Wellington City's 1 in 500-year tsunami evacuation zone (pale orange) (Figure 6), Right: Wellington City's 1 in 2500-year tsunami evacuation zone (fair orange) (Figure 7)

Wellington's coastal vulnerabilities are illustrated in Figures 5, 6, and 7 with the entire city centre likely to require evacuation in an event of a 1 in 2500-year tsunami. In such an event, it would not be recommended for displaced inhabitants to find refuge within the open spaces of the urban form, but rather to evacuate from the city entirely, that is, if transporting infrastructure allows. These scenarios present an interesting spectra of spatial patterns for recovery to emerge, though anything more drastic than



a 1 in 500-year tsunami is likely to abolish most of Wellington's open space capacity to facilitate recovery. The isovist graph presented in the Figure 5 is largely unchanged to that of the base map in Figure 1. Although evacuation from the waterfront would be recommended, there are a number of other integrated open spaces scattered in the city that would support various means of refuge. Given the integrated and high accessibility of the waterfront, pedestrian movement away from the waterfront would not be of concern.

The isovist graph subjected to a 1 in 500 tsunami present a rather bleak scenario for the urban form to be of resourcefulness. Wellington's War Memorial on Arthur Street maintains high integration and accessibility, but at this point, there is a lack of diversity in the choices of open spaces for refuge. The expected torrent of water that will cover large portions of the city grid can will limit interconnectivity and the capacity of accessibility.

Wellington's susceptibility to drastic seismic impairment is a danger the city will one day face. Space syntax has provided an opportunity to gain insight into how suggested areas unaffected by calculated damages will respond. However, a line of enquiry that this method does not interrogate is how the urban spaces that are predicted to be inundated facilitate recovery. How can these particular sites be occupied and utilised in a way that allows adaptation and flexibility? In scenarios where Wellington City is forced to evacuate in a 1 and 2500-year tsunami, people will be forced to remain in the city, and it is this scenario where urban form must respond in a way other than being overrun. Well integrated sites such as Kent and Cambridge Terrace are important lifelines and are in an opportune location to aid residents in Mount Victoria and Oriental Bay. These spaces would be greatly resourceful for the resilience of Wellington's urban form, if it could be strengthened in a manner than could maintain its capacity to facilitate recovery. Although this requires the hazards of liquefaction and tsunami waves to be overcome.

CONCLUSION

This paper has addressed space syntax's ability to marriage isovist patterns and social dimensions in order to interpret the resilient qualities of a city's urban form. This is to provide an alternative means to locate attributes of resilience in urban form, allowing cities and local bodies to have the tools to perform disaster risk reduction planning so systems are as resilient as appropriately possible to the sudden hazards of a disaster. Wellington city responded seemingly well to the syntax method outlined. Through an integration analysis of the Wellington City's urban form, its redundant street connections, functional diversity, and easy accessibility of open spaces are features of the urban form demonstrating qualities of resilience. However, these are conclusions derived from Wellington's urban form without physical; alteration by disaster.

Under multiple scenarios that simulate sections of the city being closed or inundated by seismic hazards, Wellington's unaffected urban form is largely limited in its ability to facilitate recovery. Evacuation is compromised and the selection of functionally diverse open spaces is limited. Unaffected spaces like Parliament and the War Memorial demonstrate a capacity to adapt to new social programmes relating to recovery. But, they raise suspicions as to whether the quantity of such spaces are realistically capable of accommodating the enormous diversity of functions and the magnitude of displaced people required. Further research into how sites can be resistant to such effects need to be initiated. Specifically for Wellington, how highly accessible sights with clear sight lines at risk of liquefaction and tsunami inundation can be resistant to such hazards. By doing so, more of the urban form can be utilised and more resources are available for urban communities to maintain social functionality in the aftermath of a disaster.

The methodology outlined in this paper is applicable to any city, and is able to analyse a multitude of scenarios concerning the deactivating impacts of a disaster. This invariably, makes the tool very practical.

A limitation to the method is the focus on connectivity as a basis for defining the social capacities of a city. However, given the importance of accessible, flexible, and functional diversity in the spatial structure of cities and resilient systems, as well as the influence they have on facilitating recovery, linking syntax patterns to connectivity is theoretically grounded. Used in conjunction with resilience theory and an understanding of the site's context, this tool produces insight into current resilient attributes within a city's urban form, providing a necessary step in understanding how to manage and design for it.

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DISASTER IMPACTS ON THE BUILT ENVIRONMENT: A SYSTEMS PERSPECTIVE

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ABSTRACT

The effects of disasters on the built environment go beyond physical destruction of buildings and infrastructure. This research considers the built environment from a systems perspective at the city scale to enable an examination of disaster impacts including not only damage to physical assets but also the disruption of flows and the spatial redistribution of populations. It is intended to contribute to the development of a systems view of the built environment so as to better understand its resilience. Such a holistic perspective is important from both an educational and a policy point of view as it can complement or even challenge a tendency to focus on isolated elements by drawing attention to the interrelatedness of component subsystems and their interdependencies.

An initial systems model of the built environment inspired by the literature is proposed. Preliminary data gathered from a qualitative content analysis of media reports from two cities affected by conflict (Maiduguri in Nigeria and Donetsk in Ukraine) are used to assess the ways in which conflict has impacted the built environment of these cities. Whereas the data collected serves to confirm some aspects of the rudimentary systems model proposed, the research also reveals the need for further development of the model and the data collection methodology to enable a detailed consideration of underlying processes, self-organizational attributes and system boundaries for specific recommendations in terms of resilience to be made.

Key words: built environment, conflict, disaster impacts, resilience, systems perspective

INTRODUCTION

A systems perspective offers the possibility to develop a more holistic understanding of the built environment and how resilience can be incorporated into it. This is important from an educational and a policy point of view as it can complement or even counter-balance the focus on isolated elements and incremental interventions which can arise from a reductionist consideration. This research proposes a rudimentary systems model of the built environment to explore the range of impacts that disasters have on the built environment system. It is intended as an initial study into the explanatory power of systems thinking for building resilience and it contributes to the content of a disaster resilience-focused Professional Doctorate programme for built environment professionals currently being developed under the Collaborative Action towards Disaster Resilience Education (CADRE) project.

'Systems thinking' provides a framework for identifying interrelationships rather than objects, and patterns rather than snapshots in time (Senge, 1990). In the systems viewpoint, emphasis is placed on the relationship between the system under consideration (the built environment in our case) and its external environment. System inputs are drawn from the external environment, are processed, and the resulting outputs are sent back to the environment. In exploring this relationship, the main inputs, processes, outputs, and feedbacks are contemplated (Kefalas, 2011).

Both the concepts of 'built environment' and 'resilience' have developed in connection with systems thinking. Hassler and Kohler (2014) opine that developments in system ecology and environmental economics have led to definitions of the built environment as a complex, dynamic, self-producing system formulated in relation to the ecosphere. Folke (2006) notes that the resilience concept emerged from ecology in relation to ecological stability theory as the capacity for a system to persist in the face of change. Amos Rapoport noted that any consideration of a built environment must not only take into account the physical 'hardware' but also the people, their activities, wants, needs, values, life-styles and other aspects of culture. His conceptualization of the built environment involves the organization of four elements - space, time, meaning and communication – with the complex system of interactions among these comprising a complete ecological system (Rapoport, 1994). Moffatt and Kohler (2008) argue that consideration of the built environment as a socio-ecological system can enable a better understanding of impacts on it.

Folke (2006) offers a systems interpretation of the concept of resilience in terms of: the amount of disturbance a system can absorb, the degree to which the system is capable of self-organization, and the degree to which the system can build capacity for learning and adaptation. Hassler and Kohler (2014) suggest that resilience implies foresight and can be used as a central timing and memory concept. As a way of thinking, resilience can thus offer a useful context for the analysis of systems (Folke, 2006). Similarly to the concept of 'sustainability', resilience relates to system change and continuity over time (Hassler and Kohler, 2014).

This study explores the notion of the built environment as a system and the impacts that disasters have on its functioning. In this paper, a rudimentary systems model of the built environment at the city scale is outlined, the research methodology to capture some initial data regarding the impacts of disaster on two case study cities is presented and the findings are reported and discussed. Conclusions are then drawn in terms of the utility of the approach together with its limitations and recommendations for further research.

A SYSTEMS MODEL OF THE BUILT ENVIRONMENT AT CITY SCALE

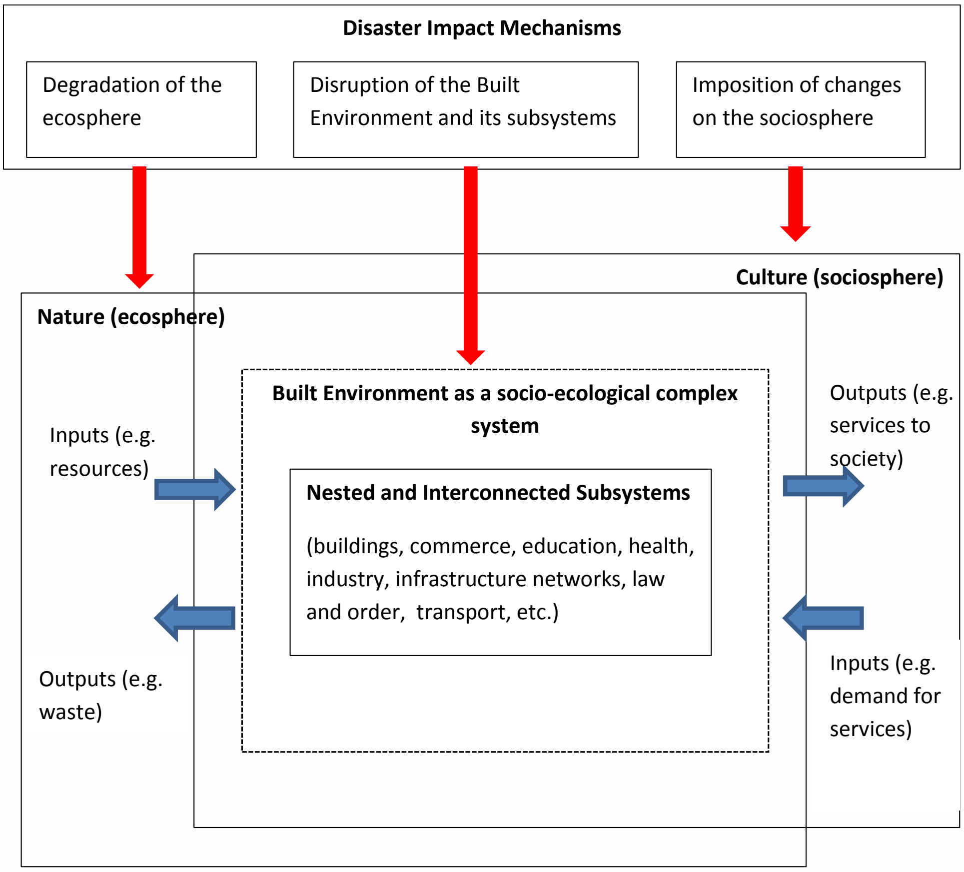

Figure 1: Systems Model of the Built Environment

The systems model in Figure 1 is proposed as a representation of the built environment at the city scale. The proposed model is developed from the depiction by Moffatt and Kohler (2008) of the built environment as a socio-ecological system in the zone where nature and culture overlap. As is typical of systems, this city scale system is comprised of numerous nested subsystems (Kefalas, 2011). For the city, these include its component infrastructure networks, buildings, commerce, education, health, industry, and transport systems, etc. all of which are interrelated and interconnected. In applying this model to our problem of disaster resilience in the built environment, we are firstly concerned with understanding how the city system interacts with the ecosphere (nature) and the sociosphere (culture). The systems perspective requires the extension of the spatial and temporal limits beyond the city itself to capture the entirety of flows (e.g. the resource flows from their origins in the ecosphere to their final return to nature). The concept of sustainability relates to the flows between nature, culture and the built environment being balanced over the long term (Moffatt and Kohler, 2008). The concept of resilience relates to their robustness in the face of disturbance (Folke, 2006).

We are thus concerned not only with the functioning of the built environment system (and its component subsystems) but also with the inputs to the built environment from nature (for example, in terms of raw materials, clean air, etc.), outputs back to nature (e.g. degraded energy, waste, etc.), its inputs from the sociosphere (e.g. human organisation) and outputs to it (e.g. transport services). So that, in considering disaster impacts, we need to record / measure: the degradation of the ecosphere; the disruption of the built environment system and its subsystems; and, the imposition of changes on the sociosphere.

RESEARCH METHODOLOGY

In broad terms, a comparative case study approach was adopted with respect to two cities (Maiduguri in Nigeria and Donetsk in Ukraine) affected by conflict in order to validate the model in Figure 1. A qualitative content analysis of media reports covering a one-year period (2015) was undertaken to assess the ways in which conflict has impacted the built environment of these two cities.

While many authors support the inclusion of conflict within the disaster definition - for example, Green and McGinnis (2002) consider 'conflict based disasters' as one of three basic disaster categories - others don't. McFarlane and Norris (2006, p. 4) define disaster as *''a potentially traumatic event that is collectively experienced, has an acute onset, and is time-delimited''* and Norris et al. (2008) point out that this definition excludes chronic environmental hazards, ongoing community and political violence, war, and epidemics, because the dynamics of these are different in respect of how they unfold over time. It is precisely this relatively slow unfolding over time that enables us to assess and record the impacts of conflict on the built environment in some isolation and that makes conflict a particularly useful form of disaster in relation to this study in terms of understanding the built environment system.

Media content analysis is a well-established research methodology which has been in use since the 1920s (Macnamara, 2005). Relatively recent developments (the Internet, powerful search engines, content analysis software, etc.) have made it a particularly convenient methodology with which to assess conflict impacts at a safe distance as there is extensive coverage of events especially by local, online newspapers. However, this approach also has pitfalls and limitations – for example, biases and selective reporting as a consequence of the tendency by reporters to rely on traditional, usually official sources. This may lead to the reporting of a "reality" as seen by only one set of actors in the situation and these are mostly emergency-oriented governmental officials (Quarantelli, 1996).

The approach adopted was to identify a suitable online news source which reported regularly from the two conflict areas. A single source for each city case was chosen in order to avoid duplications of impact reports. These were the online newspapers Vecherka Donetsk (http://vecherka.donetsk.ua/) for Donetsk, Ukraine and the Daily Trust (http://www.dailytrust.com.ng/) for Maiduguri, Nigeria. It was anticipated that the reporting may not be entirely objective but it was considered that biases would be more likely to relate to the explanations for events rather than the actual reporting of the impacts of the conflicts that occurred. In addition, only the types of impacts were being collected, not their details in terms of numbers and severity so that the sensitivity of this research to the accuracy of the reporting in those terms was also limited (provided that impacts were reported at all). In this sense the data collection for this study would be unaffected by most normal forms of reporting bias.

Having identified the data sources, a refined internet search was carried out (using the Advanced Search functions of the Google search engine) to find all the relevant articles published within these sources in the time frame imposed (from 1st January 2015 to 31st December 2015). The choice of time frame was somewhat arbitrary but it was necessary to limit the number of reports that needed to be analyzed to a manageable quantity and was convenient in that both conflicts were active during the whole of 2015.

Having identified all relevant reports within the chosen time frame, the contents were analyzed using NVivo software. The approach taken for this was to identify impacts on the built environment from the reports and code them according to their type. An initial classification based on the model in Figure 1 was generated by brainstorming and is shown in Table 1. This classification was further developed as necessary as the need for new classifications of impacts arose during the analysis of reports.

Table 1 - Initial classification of nodes for coding data

Themes (higher level nodes)	**Nodes**
Displacement of population	out of city; into city; within city
Damage to buildings	commercial buildings; institutional buildings; residential buildings
Damage to infrastructure	transport; energy; water; telecommunications
Damage to the environment	air; water; land
Disruption of services and flows	health; education; security and the rule of law; commerce; transport; manufacturing; agriculture including fisheries; mining

DISCUSSION OF FINDINGS

It is appropriate to preface this section on findings with a brief introduction of the two case study cities of Maiduguri in Nigeria and Donetsk in Ukraine.

According to Amnesty International, the situation in north-east Nigeria has constituted a non-international armed conflict since at least May 2013 (Amnesty International, 2015). The centre of the Boko Haram insurgency has been Borno State, Nigeria and Maiduguri is the state capital. Since 2009, Boko Haram has killed and abducted thousands of people and forced more than a million to flee their homes. This conflict has crippled normal life in Borno State - schools, places of worship and other public buildings have been destroyed and it has disrupted the provision of health, education and other public services (Amnesty International, 2015). According to one Nigerian newspaper, Maiduguri's population which was estimated in the 2006 national population census to be 1.2 million people, has both witnessed a dramatic exodus of residents due to the conflict, and also a huge influx of internally displaced people so that its current population is about three million people (Leadership, 11 January 2015).

According to Bachmann and Gunneriusson (2015), the nature of the conflict in eastern Ukraine remains undefined as to whether it constitutes war or civil unrest, interstate aggression or intrastate conflict. Donetsk city is the principal city of the Donetsk region (oblast) in eastern Ukraine with a population of about 950,000. By late 2014, the UNDP reported that residential housing, social infrastructure facilities (schools, preschool educational institutions, public utilities, administrative buildings), bridges, roads, forests, gas pipelines and other networks had been damaged in the conflict (UNDP, 2014). As of October 2015, the number of fatalities (for the entire conflict area, not just Donetsk) had amounted to more than 8000, with nearly 18,000 wounded, around 1.4 million internally displaced people and an estimated 900,000 people having fled to neighbouring countries (EC, 2015).

The Advanced Google Searches of the archived contents of the selected sources resulted in a total of 83 articles reporting conflict impacts on the city of Donetsk and 62 articles reporting impacts on the city of Maiduguri (within the 2015 time frame in both cases). The six charts in Figure 2 present the content analysis of these 145 reports. The first five charts show the types of disaster impacts (nodes) on the built environment system (city) together with the number of sources (articles) referring to each of them. The number of sources referencing each node rather than the total number of references to each node is reported as this is the more conservative number. The sixth chart provides a summary of the reported impacts for the two cities. Impacts across all of the impact classification categories (nodes) initially identified were referenced in at least one of the newspaper articles. It was found necessary to add only one additional category, fatalities, and this was considered in the sense of a change to the sociosphere alongside population displacements.

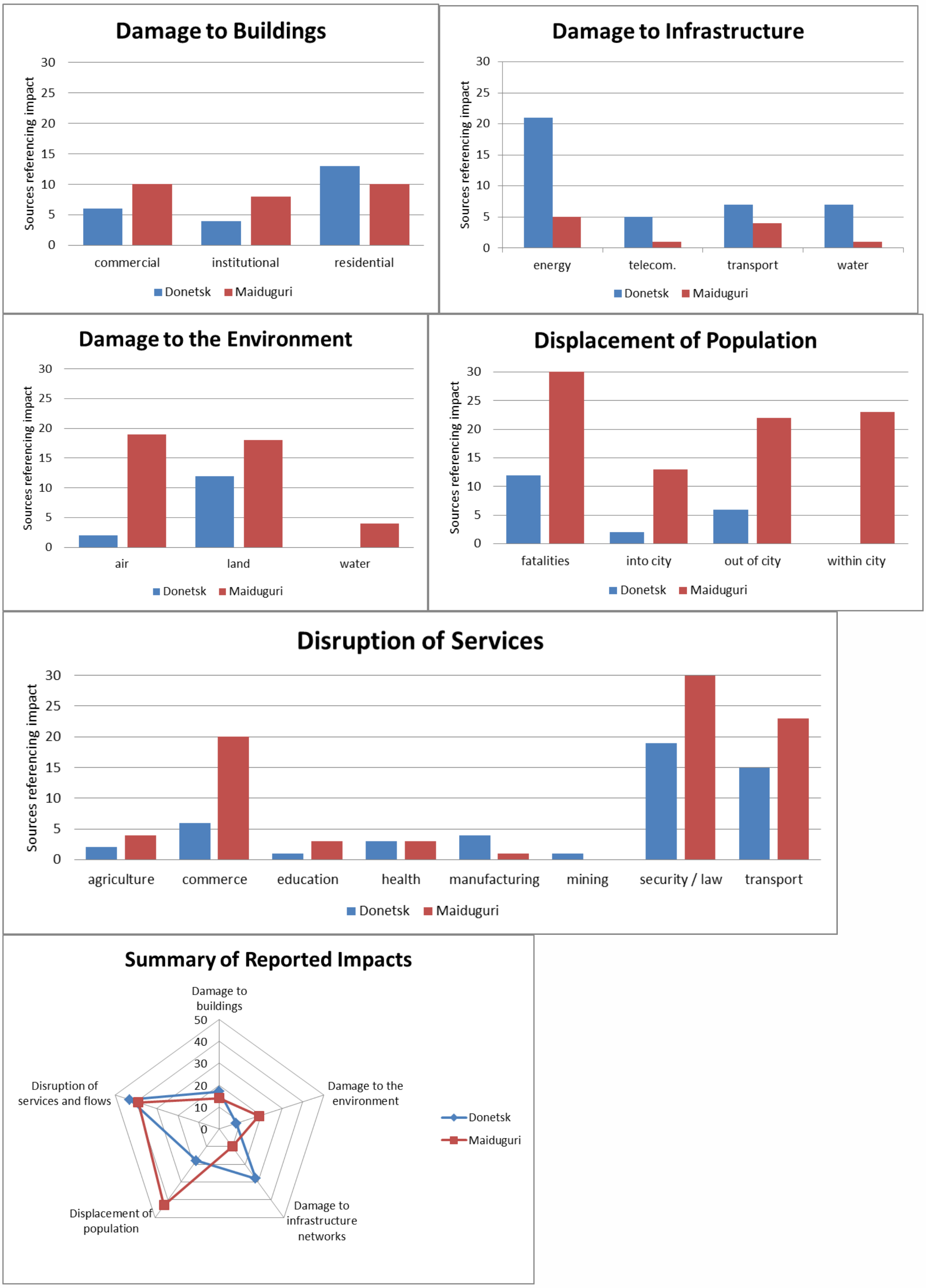

Figure 2: Charts summarizing the reported disaster impacts

It is important to note that there is no suggestion of equivalence, severity or magnitude in any of the results above. We cannot compare the nodes (e.g. damage to institutional buildings compared to fatalities) nor do we suggest that there is any equivalence between separate reports coded to the same nodes (reported damage to a residential building in Maiduguri to a similar report in Donetsk or a different case of damage to a residential building in Maiduguri). The only claim that can be made is that each reference coded to a node provides evidence that the node represents one form of impact that the disasters are imposing upon the built environment system. These impacts are significant in at least the sense that they are deemed to be 'news-worthy', i.e. of some importance or interest to readers. In aggregate, this provides us with a sense of the overall scope of disaster impacts on the built environment system. We cannot draw comparisons between the cases on the basis of this initial data.

In addition, certain specific issues with the research methodology adopted were observed. Only those impacts explicitly stated in the media reports could be captured and coded to a node so that any further impacts (implied or logically following from the stated impact) would not be coded. This potentially influenced the numbers of references recorded. A similar problem was observed with some of the node descriptions, particularly those relating to disruptions of services, e.g. "disruption of security and rule of law" and "disruption of commerce" where many statements in the media reports could be interpreted to constitute evidence of these nodes. This implies that the node descriptions in some cases could be improved by greater precision but, since our theoretical basis accepts that these service-providing subsystems are interconnected, we would anticipate considerable overlap and interrelationships between them.

As noted earlier in this paper, Moffatt and Kohler (2008) pointed out the importance of extending the spatial and temporal limits of the system model beyond the city itself to capture the entirety of flows. In our case, the imposition of the artificial time limitation (considering reports only from 2015) had the effect of excluding reports which may have referred to impacts which would have been felt in 2015 but which were no longer 'news-worthy', for example, where schools or other public institutions may have been closed prior to the study period. Similarly, both Maiduguri and Donetsk city limits acted as a filter to collecting reports but both cities undoubtedly were impacted by events in their respective hinterlands.

CONCLUSIONS

The proposed built environment system model was supported by the media report evidence in terms of its scope and component elements but the system boundaries (in time and space) imposed by the research methodology were found to be insufficiently extended. In addition, the analysis of this initial data has been limited at this stage of the research to identifying evidence of the different types of impact of conflict on the built environment. The relative frequency and severity impacts were beyond the scope of this preliminary study so that detailed comparisons of the two cases cannot be drawn beyond, for example, the observation that references to the displacement of people were reported more often with respect to Maiduguri than Donetsk while more instances of damage to infrastructure networks were captured for Donetsk than for Maiduguri. Whether these observations relate to substantive differences would require further, more quantitative, investigation.

It is recommended to further develop the systems model and the research methodology to overcome the problems of time and space boundaries and also to address the issues of equivalence, severity and magnitude so that the relative importance of disaster impacts and their interrelationships can be better understood in order to determine how the built environment system can be made more resilient.

ACKNOWLEDGEMENT

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COUNTERMEASURES TO IMPROVE HOSPITAL BUSINESS CONTINUITY IN A DISASTER

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ABSTRACT

Background and aim of this study: Recently, an organization in Japan should take countermeasures to reduce the damage of natural disasters such as earthquake. Especially, a hospital who provides necessary healthcare services to earthquake victims should ensure their business continuity when a disaster occurs. Our previous study already proposed the gap model of medical needs and service capability that showed the types of countermeasures that should be employed in hospitals to improve business continuity in a disaster and to clarify the five countermeasure types. The aim of this study is to list more detailed countermeasures focused on "type 3: Reducing to decline the service capability" and "type 4: Improvement of service capability when a disaster occurs."

Approach: At first, the management resources to provide healthcare services are extracted. Then, the more detailed countermeasure are examined per the countermeasure type 3 and 4 per the above extracted management resource. Finally, both of results are shaped into a list.

Results and findings: The vertical axis of the proposed list identifies the management resources required to provide necessary healthcare services to a patient, such as hospital staff, devices, materials, and information systems. The horizontal axis identifies the more detailed countermeasure types. For example, countermeasure type 3 is divided into "type 3-1: Strengthening to tolerance," "type 3-2: Prevention of damage spread," and "type 3-3: Ensuring redundancy." In other words, the proposed list is a matrix of management resources and more detailed countermeasure types.

As a result, 253 more detailed countermeasures for our proposed list are obtained. As the list clarifies the countermeasures that should be used for each different type of management resource in a hospital, hospital staff can easily understand the actions they must perform to improve their hospital

business continuity. Finally, the effectiveness of the proposed list in disaster base hospital A, Kawaguchi City is confirmed.

KEY WORDS:

Business continuity management system, Business continuity plan, Disaster medicine, Medical resources, Resilience

INTRODUCTION

Organizations in Japan must establish and employ countermeasures for disaster prevention and mitigation as soon as possible, because Japan has higher natural disaster risk than other countries. Many hospital that provides necessary healthcare services to the people who are injured during a disaster have to continue their services in spite of the damages they may experience. The international organization for standardization (ISO) for business continuity management system (BCMS; Ichiro N et al., 2013) is proposed; it requires an organization to perform risk analysis (RA) and business impact analysis (BIA), and then make its business continuity plan (BCP) based on the result of both analyses.

Existing research provides BCP guidelines for hospitals (Bureau of Social Welfare and Public Health, 2012; The Cabinet Office of Japan, 2005; Hidekazu T, 2012), but it only advises on certain formats and examples; the general BCP guidelines only focus on damage restoration. Countermeasures carried out before a disaster are rarely described in these guidelines. Moreover, most disaster prevention plans of local governments only describe a few countermeasures, such as the evacuation of local residents.

In general BCP studies (Hitoshi K, 2013; Masaaki T et al., 2013; Michiyo S et al., 2009), the focus is on shortening the recovery time, which is the time necessary to recover to the ordinary state after a disaster; however, this is not suitable for medical services, because they characteristically transform into disaster medical systems when a disaster occurs and delivery of services continues in extraordinary ways. Nonetheless, existing research (Kyoichi I et al., 1998) on disaster medical systems estimates the number of people who are not able to receive medical service based on the number injured by the disaster and the amount of available resources in a hospital. However, this study does not propose countermeasures for increasing the number of people who are able to receive medical services.

Although there is a research on countermeasures for emergency situations (Mitsuru Y, 2012), this study focuses on methods to treat specific patients after disasters. There are studies on hospitals' resilience evaluation (Cimellaro GP et al., 2009; Junko I, 2008; Zhong S et al., 2014), which establish viewpoints and methods for such evaluations. However, they do not propose ways to improve resilience of hospitals or regions after the evaluation.

Consequently, there is no study on ways to maintain and improve hospitals' healthcare continuity. On the other hand, Kento O et al. (2016) has proposed the gap model of medical needs and service capability that showed the types of countermeasures that should be employed in a hospital to maintain and improve the business continuity during a disaster, and to clarify the five countermeasure types. The purpose of this study is to list the more detailed countermeasures focused on "type 3: Reducing to decline the service capability" and "type 4: Improvement of service capability when a disaster occurs." This builds on the previous study, providing more information for hospital staff who need to take action for hospital business continuity.

GAP MODEL AND COUNTERMEASURE TYPE

Figure 1 shows the gap model, which consists of the following three elements. The first element is the "amount of need for medical services." This indicates a scale of medical needs after a disaster has occurred, which is composed of the number of patients, degree of injury, and so on. Medical needs after a disaster has occurred are the sum of the medical needs newly generated by the disaster as well as ordinary medical needs.

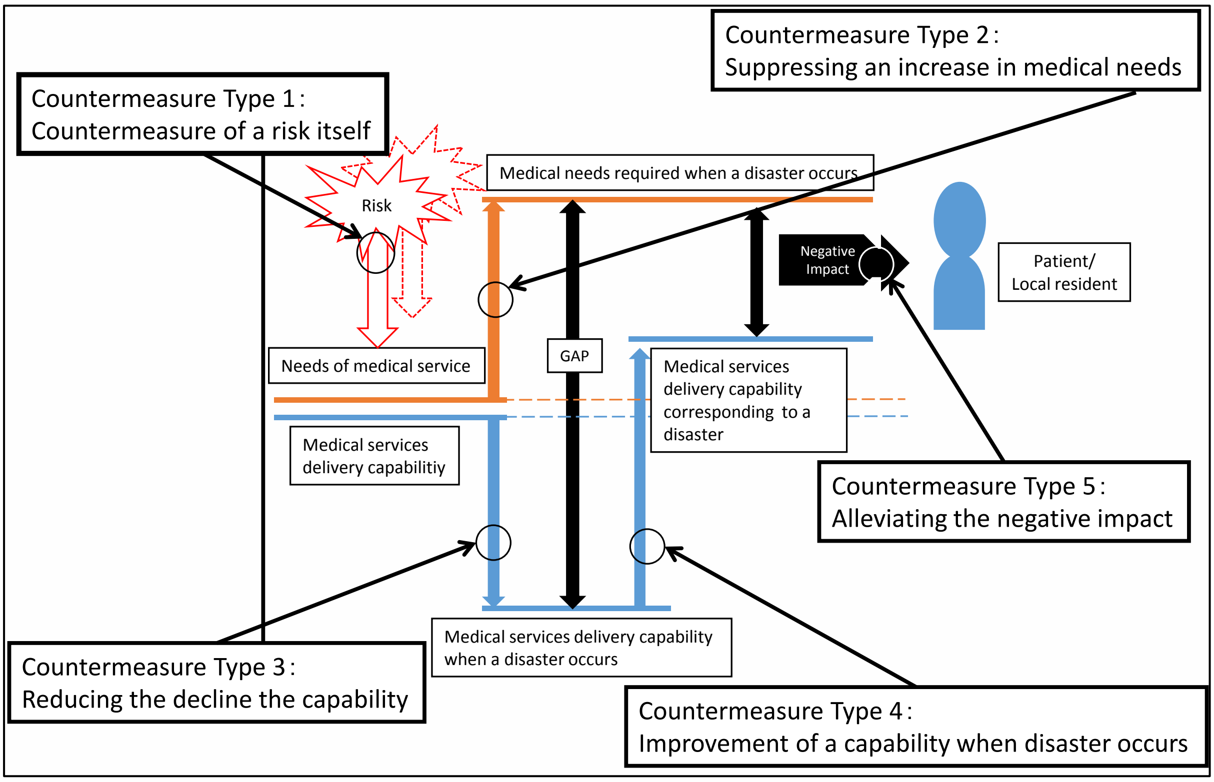

Figure 1. Gap model and countermeasure types

The second element is the "medical service delivery capabilities." This can be estimated from the amount of available resources in a hospital. For example, if electricity is disrupted and machines stop working, the hospitals' capabilities of delivering medical services declines. The capability depends on the amount of available management resources. The third element is the “gap between medical needs and the capability of medical services.” The gap indicates that organizations are unable to provide enough medical services to the people injured in a disaster. If enough medical services are not provided, negative results occur, and patients are at risk. It means that the necessary action to fill the gap is a countermeasure. This study adopt the definition of “countermeasure.”

In Figure 1, the five countermeasure types corresponding to the arrows of the gap model are specified. Furthermore, more concrete countermeasure types are deployed as shown in Table 1. Countermeasure type 1 is a measure against risk itself; it involves avoiding apparent risks, not incurring damage, and assigning responsibility for the damage caused by a disaster. Countermeasure type 2 intends to suppress the increase in medical needs associated with a disaster. Its purpose is to strengthen the local residents’ resistance and have the residents respond well to the disaster. These countermeasures involve the necessity of ensuring fewer injuries in order to suppress increasing medical needs. Countermeasure type 2 also includes the responses of each organization in that region and the precautionary countermeasures for additional medical needs, such as protection against infectious disease. Countermeasure type 3 intends to reduce the decline in capability. The capability to provide medical services is equal to the level of available resources; therefore, countermeasure type 3 contains measures to protect resources before a disaster, ensure the redundancy of those resources, initiate responses contingent on the resources available, and so on.

Table 1. Detailed countermeasure types

Countermeasure type	More detailed countermeasure type	Occasion
1 Countermeasure of a risk itself	1-1)Avoiding appearance of risks	Before a disaster occurs
	1-2)Imputation of risks	Before a disaster occurs
2 Suppressing to increase medical needs	2-1)Improvement of liviing environment safety	Before a disaster occurs
	2-2)Self-difense by residence	After a disaster occurs
	2-3)First-aid by residence	After a disaster occurs
	2-4)Ensuring human safety by each organization	After a disaster occurs
	2-5)Prevention of infectious disease and its increase	After a disaster occurs
3 Reducing the decline the capability	3-1)Strengthening tolerance	Before a disaster occurs
	3-2)Prevention of damage spreading	Before and after a disaster occurs
	3-3)Ensuring redundancy	Before and after a disaster occurs
4 Improvement a capability when a disaster occurs	4-1)Outsourcing to outsiders	Before and after a disaster occurs
	4-2)Obtaining resources from outside	After a disaster occurs
	4-3)Recovering resources	After a disaster occurs
	4-4)Redistribution of internal resources	After a disaster occurs
5 Alleviating the negative influence	5-1)Rapid apologies and public relations	After a disaster occurs

Countermeasure type 4 intends to respond to the regional medical needs after a disaster has occurred. Countermeasures of this type are separated from others to ensure effective use and to obtain external resources/recovery from their own resources. Countermeasure type 5 alleviates the negative influence of the gap between medical needs and capability, by providing explanations to local residents and patients regarding services. Actions that plan, prepare, check, and improve these countermeasures are not contained in these countermeasure types.

LIST OF MORE DETAILED COUNTERMEASURES

Scope and outline of the proposed countermeasure list

First, this study focuses on "type 3: Reducing to decline the service capability" and "type 4: Improvement of service capability when a disaster occurs," as mentioned before. Because countermeasure type 1 is not easy to implement in operational hospitals, implementation of type 2 requires cooperation among local governments, hospitals, and residents, and type 5 should be discussed after types 3 and 4. The proposed countermeasures are listed as a matrix table. The vertical axis of the list indicates the management resources required to provide necessary healthcare services to a patient, such as hospital staff, devices, materials and information systems. The horizontal axis indicates more detailed six countermeasure types. For example, the countermeasure type 3 is divided into "type 3-1: Strengthening to tolerance," "type 3-2: Prevention of damage spread," and "type 3-3: Ensuring redundancy." In other words, the proposed list is a matrix of management resources and more detailed countermeasure types.

Specification of management resources to be protected from a disaster

Generally, the necessary management resources for business management can be categorized as "human resource," "material," "device," "work environment," and "utility." This study investigates the management resources of hospital A, which is a municipal and polyclinic hospital, taking on a role of a core disaster medical hospital, and named them as management resources in a hospital as shown in Table 2.

For example, generally, human resource includes medical staff such as doctors, nurses, and so on. In material category, a hospital has medicines, medical gas, medical materials such as gauze, blood for transfusion, clothes, food and drinking water. As the financial resource can be used to obtain and modify other management resources, the required amount of financial resource can be estimated based on the effectiveness of the countermeasures that are taken for other management resources.

Table 2. Management resources in a hospital

General category	Management resources in a hospital	
Human resource	Medical staff	
Material	Medicine/ Medical gas/Medical material	
	Blood for transfusion	
	Clothes/Food	
	Drinking water	
Device	Medical device	General medical device
		Controlled medical device
		Specially controlled medical device
	Information device	Electronic medical record system
		Terminal unit/Date server
		Communication network
Work environment	Workspace	
	Possible work condition	Workbench
		Working light
		Air conditioning
Utility	Electronics	
	Machine water	
	Gas/Fuel	

Extraction of more detailed countermeasures

Based on Table 1, countermeasure type 3 is divided into the following three items: “type 3-1: Strengthening to tolerance,” “type 3-2: Prevention of damage spread,” and “type 3-3: Ensuring redundancy.” type 4 is divided into the following four items: “type 4-1: Outsourcing to outsiders,” ”type 4-2: Obtaining resources from outside,” “type 4-3: Recovering resources,” and “type 4-4: Redistribution internal resources.” The more detailed countermeasures are examined per the above countermeasure type per management resource. For example, medical staff is an important management resource to improve hospital continuity. Corresponding to “type 3-1: Strengthening to tolerance,” the measure “To wear disaster prevention helmet” is extracted. It is also necessary “To take an initial action to ensure safety of medical staff,” and “To conduct first aid for medical staff,” corresponding to “type 3-2: Prevention of damage spread.” Corresponding to “type 3-3: Ensuring redundancy,” the countermeasure “To ensure the medical staff master necessary multi-tasking skills” is useful before a disaster occurs.

Furthermore, “To list patients who can be discharged from the hospital” and “To transport patients to other hospitals in other regions” are countermeasures for “type 4-1: Outsourcing to outsiders.” Corresponding to “type 4-2: Obtaining resources from outside,” it is necessary for a hospital to request the dispatch of additional medical staff, the disaster medical assistance team (DMAT), and private volunteers. There is no countermeasure corresponding to “type 4-3: Recovering resources” in the medical staff area.

Finally, as “type 4-4: Redistribution internal resources” intends to relocate all medical staff based on the priority of necessary medical services when a disaster occurs, it can be regarded as a countermeasures for “Type 3-3: Ensuring redundancy.” Therefore, necessary countermeasures for type 4-4 are integrated into type 3-3.

As well, more detailed countermeasures for each management resource, except medical staff, corresponding to each countermeasure type are clarified. As a result, we found 253 more detailed countermeasures for our proposed list as shown in Table 3. As the list clarifies the countermeasures that should be used for each different type of management resource in a hospital, hospital staff can easily understand the actions they must perform to improve their hospital business continuity.

EVALUATION OF THE PROPOSED COUNTERMEASURE LIST

It is important for a hospital staff to examine the necessary countermeasures more comprehensively and concretely by utilizing the proposed list than before. As this study could not take such a prospective approach, the verification in this study focused on whether a hospital staff can understand the contents of the list, and the list can cover all the countermeasures that had been already taken in a disaster base hospital.

Therefore, we have verified the proposed list by answering the following three questions: Q1: Can medical staff understand the meaning of the content of the proposed list? Q2: Can the proposed list cover the countermeasures that a hospital has already taken or prepared? and Q3: Can medical staff find necessary additional countermeasures to improve their hospital business continuity by utilizing the proposed list?

To answer these three questions, the proposed list is evaluated by a doctor and a chief of the administration section, who are two of the core members to establish BCMS and improve business continuity in hospital A. Hospital A is expected to play a central role as a core disaster medical hospital in Kawaguchi City, Saitama Prefecture, Japan.

Table 3. List of obtained countermeasures (partial)

		Type 3: Reducing the decline of the capability			Type 4: Improvement of a capability when a disaster happens		
		Type 3-1: Strengthening to tolerance	Type 3-2: Prevention of damage spread	Type 3-3: Ensuring redundancy	Type 4-1: Outsourcing to outsiders	Type 4-2: Obtaining resources from outside	Type 4-3: Recovering resources
Human resource	Medical staff	To wear disaster prevention helmet	To confirm the safety of medical staff	To ensure the medical staff master necessary multi-tasking skills	To list patients who can be discharged from the hospital	To request dispatch of additional medical staff against the government, other hospitals near the region	
		To prepare protective clothing and mask	To take an initial action to ensure safety of medical staff	To increase the number of permanent staff in a hospital	To transport patients to other hospitals in the region	To request dispatch of disaster medical assistance team (DMAT)	
			To conduct first aid for medical staff	To gather the medical staff who do not work in a hospital when a disaster occurs	To transport patients to other hospitals in other regions	To request dispatch of nursing students against nursing schools near the region	
				To relocate all the medical staff based on the priority of necessary medical services		To request dispatch of private volunteers who lives in other regions	
Material	Medicine / Medical gas/Medical material	To fix racks on the wall	To bring materials to the safety zone	To build a stockpile of necessary materials		To obtain necessary materials from suppliers	
		To prevent storage containers from falling to the ground	To confirm the damage situation of the materials	To provide temporary medical gas cylinders		To obtain necessary materials from other hospitals and drug stores near the hospital	
...	...	...	...	...	...	...	...
Utility	Gas/Fuel	To reinforce utility equipment against earthquakes	To confirm the damage situation of utility equipment	To build a stockpile of necessary amount of gas and fuel		To obtain temporary gas cylinders from suppliers	To translocate temporary gas cylinders
		To change to more tough gas cylinders	To move the utility equipment to safety zone in advance	To prepare the temporary gas cylinders		To obtain necessary gas and fuel from other hospitals	

The evaluation sheet is shown in Table 4. First, both evaluators understood all the content of the proposed list. Then, they judged whether they have already applied the countermeasures shown in the list one by one; if they had already applied it, they checked the applicable box of labeled "complied with," otherwise they checked the "not complied with" box. In addition, if they found that a particular countermeasure was necessary for them, they checked the “should be added” box. The evaluation results are shown in Table 5. The numbers are the sum of all the checked countermeasures.

Table 4. Evaluation sheet

		Type 3: Reducing the decline of the capability				
		Type 3-1: Strengthening to tolerance	Complied with	Not complied with	Should be added	Cannot be judged
Human resource	Medical staff	To wear disaster prevention helmet				
		To prepare protective clothing and mask				

Table 5. Evaluation result

	Complied with	Not complied with	Should be added	Cannot be judged
A doctor	100	129	19	24
A chief of the administration section	107	132	19	14

Table 5 indicates that almost all the countermeasures in Table 3 were understood by both a doctor and a chief of the administration sector in hospital A, because they could judge whether they have already employed them. In addition, there are 19 countermeasures that should be added. This means that it is useful for medical staff to examine necessary concrete countermeasures to improve their hospital continuity. Furthermore, the list covers all countermeasures in hospital A.

DISCUSSION

Importance of this study

An appropriate disaster response is essential for the safety of community residents. Especially, necessary countermeasures should be taken as soon as possible in Japan, because Japan faces a higher risk of occurrence of natural disasters such as earthquakes, than other countries. Improvement of hospital business continuity means increasing hospitals’ capability to save the life of the injured during a disaster. Therefore, this study proposed a detailed countermeasures’ list to improve hospital continuity; this is a useful approach for an appropriate disaster response.

As mentioned in section 1, no previous study that presents comprehensively the actions required after or before a disaster occurs. The proposed list is created based on the gap model, which indicates ways to fill the gap between medical needs and the capability of medical services. Countermeasures in the list are categorized according to each management resource in a hospital. In addition, the effectiveness is confirmed in hospital A, which is a core disaster medical hospital. This means that the proposed list can clarify not only comprehensive, but also concrete and useful, countermeasures for disaster response.

Future deployment

This study focused on countermeasures "type 3: Reducing to decline the service capability" and "type 4: Improvement of service capability when a disaster occurs," as shown in Figure 1. However, detailed countermeasures for other types are also necessary for disaster prevention and mitigation. Moreover, recently, not only organizations but also area disaster response system need strong collaboration among related organizations, such as residents, hospitals, medical associations, fire and police departments, and the local governments. Therefore, necessary countermeasures as an area disaster response system and type of collaboration system they can be implemented effectively should be clarified in the near future.

CONCLUSION

This study proposed a list of comprehensive and concrete countermeasures to maintain and improve hospital business continuity in a disaster. This proposed list was developed based on the gap model. Furthermore, even if a countermeasure type is the same, different countermeasures are necessary to reduce the disaster's damage.

Therefore, this study created a list in which the vertical axis identifies the management resource required to provide necessary healthcare services to a patient, and a horizontal axis identifies the countermeasure type. The created list shows 253 more concrete countermeasures toward management resources to provide the necessary healthcare services in a disaster. In other words, this study can provide useful information for a hospital staff to take necessary actions to ensure their hospital business continuity. As future issues, the effectiveness of the proposed list should be verified based on proactive approach.

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MEASURING ORGANISATIONAL RESILIENCE: EBB AND FLOW OF ONSHORE GAS INVESTMENTS

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ABSTRACT

The literature on organisational resilience explains how firms recover from catastrophic events by focusing on adaptation principles and short-term survival. In this paper we introduce a broader conceptualisation of organisational resilience that enables the study of its relationship with firm performance across more subtle events like economic fluctuations. We the operationalise this in an organisational resilience measure that includes both strategic factors associated with forward planning and operationally oriented responses focused on immediate adaptation and problem-solving. We use a four-step process to develop, present and test the resulting seven-factor measurement scale of organisational resilience that includes the following sub-scales: Readiness, Slack, Problem-solving, Malleability, Connectedness, Adaptiveness, and Pro-activeness. We use confirmatory factor analysis to provide evidence of the reliability and validity of our scale in our sample of 400 firms. Structural equations modelling of the organisational resilience sub-scales and performance in the post-boom era and similar expectations of performance in the future illustrate predictive validity.

KEYWORDS:

Organisational resilience, Small and Medium Enterprises (SMEs), Innovation, Investment cycles

INTRODUCTION

Organisations face an increasing variety of threats to normal business activities, including adverse weather related to climate change (Linnenluecke, Griffiths, & Winn, 2012), economic crises (Amann & Jaussaud, 2012; Muurlink, Wilkinson, Peetz, & Townsend, 2012), earthquakes (Johnston, Becker, & Paton, 2012), and supply chain disruptions (Sheffi & Rice, 2005).

The literature on organisational resilience derives mostly from a focus on disaster management and reactions to severe ‘unicorn’ catastrophic events (Johnston et al., 2012; Weick, 1993). This near-term recovery perspective has overlooked the more strategic implications of resilience that pertain to the long-run survival of firms, including market positioning, competition, and/or product/service offerings which may serve as competition differentiators (Pettit, Fiksel, & Croxton, 2010)

Thus we pose the research question: What is organisational resilience, what are its theoretical dimensions, and how can these dimensions be operationalised? We undertook a structured four step process to develop a measurement scale of organisational resilience: (1) conduct a systematic literature review to develop reflective measures (2) engaged with experts to refine these measures (3) test them in a sample of Australian firms, and (4) undertake rigorous empirical analysis. This results in seven factor, 38 item, scale of organisational resilience.

Defining Organisational Resilience

Based on our analysis of the literature, we define organisational resilience as: the set of structures, processes and action repertoires that an organisation uses to maintain operations in the face of adverse events, and thrive in the post-disruption environment, both of which may contribute to the firms' ability to achieve long-term viability.

General dimensions of organisational resilience

The organisational resilience literature identifies several sub-components that help firms prepare for exogenous shocks. The ability to anticipate impending disruptions would provide the opportunity to enact a pre-prepared response. We call this readiness and consider it to be an anticipatory capability embodied in activities like questioning assumptions about a firm's environment (Lee, Vargo, & Seville, 2013), continuous monitoring the environment (Vogus & Sutcliffe, 2007), paying attention to small performance anomalies (Weick & Sutcliffe, 2006) and challenging the status quo (Rudolph & Repenning, 2002).

Another clear dimension of the organisational resilience capability is slack. Slack itself is multi-faceted and may consist of financial, capability and resource dimensions. Financial forms of slack, including savings and liquidity (Pettit et al., 2010; Smallbone, Deakins, Battisti, & Kitching, 2012; Vogus & Sutcliffe, 2007) help to ensure that costly unexpected events do not jeopardise an organization's very existence. Redundant production facilities and work locations (Coutu, 2002) ensure that firms have the reserve capacity sustain production outputs (Pettit et al., 2010). Excess inventory, safety stock levels production oriented firms may also be important (Sheffi & Rice, 2005).

Change-oriented responses

There are several factors that appear to be important in responding to an event that includes more significant changes to the organisation. One factor is adaptiveness, which enables firms to accommodate disruptions and find solutions to problems which may require more changes to maintain operational status (Sheffi & Rice, 2005).

Another important operationally-oriented action that underpins resilience is problem-solving. Problem-solving allows firms facing unique circumstances to use knowledge in novel ways and think 'outside the box' in order to find a solution. (Brockner & James, 2008; Lengnick-Hall, Beck, & Lengnick-hall, 2011)

Networks and collaborations are important for forecasting demand (Pettit et al., 2010), spreading risks providing advice (Sutcliffe & Vogus, 2003), diversifying supply sources (Sheffi & Rice, 2005) and buyers (Pettit et al., 2010).

Strategic perspective

There is a large gap in the resilience literature surrounding longer-term strategy. This is a problem because the very idea of resilience supposes longevity. For instance, Vogus and Sutcliff (2007) define resilience as 'maintenance of positive adjustment under challenging conditions such that the organisation emerges from those conditions strengthened and more resourceful' (p. 3418). Therefore, we argue a missing facet of organisational resilience is pro-activeness and argue that it concerns forward-looking investments that seek to gain competitive dominance.

RESILIENCE SCALE DEVELOPMENT PROCESS

The approach we followed aligns with DeVellis (2012) in four steps. First, we conducted a systematic literature to identify resilience constructs, existing scales and theoretically valid items resulting in a pool of 113 items. Second, we asked experts to review our scales in an attempt to refine the scale, reducing the number of indicators to 10 and the questions to 55. Third, we tested this scale in a survey of 400 Australian firms. Fourth, we analysed the data to refine and present the final organisational resilience scale.

Literature review and initial item pool

To analyse the literature on organisational resilience, we first conducted a formal literature review, following the protocol for a systematic literature review (Bakker, 2010). From 1,992 initial papers we retained 108.

Expert opinion

The initial item pool was subjected to review by experts next. A list of 113 questions was rated following Zaichkowsky (1985). This approach left with 55 items to include in the survey.

Final measure used in survey

The resulting resilience scale was a multi-factor scale with 10 reflective dimensions consisting of 55 questions. These dimensions were: Anticipation/monitoring, contingency planning, slack, networks and collaborative density, flexible roles, adaptive capacity, unconventional problem solving, resourcefulness/improvisation, strategic opportunity recognition, renewal, and pro-activeness.

Survey

To test the scale we adapted a small business performance survey instrument developed by the Centre for Business Research (CBR) at Cambridge University (UK) (Cosh, Hughes, Bullock, & Milner, 2009; Cosh & Hughes, 2000). We added a section containing 55 resilience questions.

We developed a list 2,388 potential small businesses in regional Queensland we phone surveyed executive managers and business owners, ending effort after 400 positive responses and achieving a 43.9 per cent response rate based on 400 responses and 512 direct refusals.

RESULTS

We conducted data analysis in four parts. First, we subjected the 55 items to exploratory factor analysis. Second, we fit one-factor models for each of resulting factors. Third, we specified and tested a multi-factor model to test the convergent and divergent validity of the subscales and to prove validity and reliability. Fourth, we estimate several structural models to establish the predictive validity of the new scale in terms of firm-level performance. These steps are described next.

Exploratory Factor analysis

We used the responses to the organisational resilience questions to conduct exploratory factor analysis (EFA principle component extraction and direct Oblimin rotation) in SPSS v.22. This approach statistically groups the questions we asked into larger constructs or factors, each reflecting different aspects of resilience. The Kaiser-Meyer-Olkin measure of sampling adequacy was .950 and the Bartlett's Test of sphericity was significant ($p < .001$), indicating that the sample would yield a stable factor solution. The solution yielded 10 factors with eigenvalues above 1. The first factor accounted for approximately 31 per cent of the variance, and all ten factors together accounted for 55 per cent. Two factors had only two items each. One item did not load strongly on any single factor. We therefore removed five items and arrived at an seven-factor, 50 question solution that includes the following sub-scales: readiness (9 items, α=.856), slack (5 items, α=.731), problem-solving (6 items, α=.750), malleability (7 items, α=.701), connectedness (8 items, α=.791), adaptiveness (5 items, α=.760) and pro-activeness (10 items, α=.877) (detail available from authors). The item means of these 7 factors ranged from 3.4 to 4.0 on a five-point Likert scale. Standard deviations ranged from .62 to .82 – below the range of one scale point. The absolute values of skewness and kurtosis statistics were below one, indicating a normal distribution for the factors.

Confirmatory Factor Analysis (CFA)

On the basis of the EFA we carried forward 50 items across seven subscales, which were assessed separately as seven subscales to test for unidimensionality, item validity and reliability. First, we tested the readiness construct, but this 9-item subscale lacked unidimensionality. By investigation of the factor loadings and modification indices we were able to reduce the subscale to 5-items with model fit statistics in the acceptable range (CMIN/DF=.480, p=.750, GFI=.998, RMSEA=.000). Readiness includes the items: "We maintain and encourage training that goes beyond what the job requires"; "When we face new challenges we put together workable solutions from our existing resources"; "Staff are rewarded for "thinking outside of the box""; "Our organisation quickly restores business performance after a disruption"; and "Our organisation adjusts and communicates its priorities as our circumstances change". Second, we tested slack and eliminated one factor leaving the four items, three of which were from Daneels's (2001) scale (CMIN/DF=.078, p=.78, GFI=1.0, RMSEA=.000). The slack subscale contains the items: "We maintain spare equipment, facilities or production capacity that we can use in times of need"; "Our business has a reasonable amount of resources in reserve"; "Not all of available resources are locked up in current business activities"; and "We have ample discretionary financial resources".

Third, we tested problem-solving. We retained all six items (CMIN/DF=1.14, p=.334, GFI=.992, RMSEA=.019), namely: "The job requires staff to deal with ambiguous assignments, for which no previously established procedures exist"; "Staff are encouraged to take risks when trying new ideas"; "The job requires staff to come up with new ways of doing things"; "We accomplish new challenges with resources that were not originally intended to be used this way"; "There is freedom to experiment with new ways of doing things in our organisation"; and "By combining our existing resources, we take on a variety of new challenges". Fourth, we tested malleability as a seven-factor scale, but needed to reduce it to five items to achieve unidimensionality (CMIN/DF = .038, P=.963; GFI=1.00, RMSEA=.000). It contains: "Our employees can switch to new jobs with similar responsibilities to their current jobs within a short time"; "Our partnership arrangements allow us easily adjust our product and/or service offerings"; "People in our firm are cross-disciplinary"; "Our organisation is able to easily quickly address new vulnerabilities when they are recognised"; and "We deal with new challenges by applying a combination of our existing resources and other resources inexpensively available to us.

Fifth, was connectedness which we reduced from eight to five items (CMIN/DF=.496, p=.739, GFI=.998, RMSEA=.000). It contains: "We work closely with our collaborators or network partners to spread our risks"; "We conduct scenario planning exercises to test our assumptions about our current plans"; "We understand how we are connected to other organisations and actively manage those links" "; "We actively plan with our customers how to manage disruptions"; "We actively plan with our suppliers how to manage disruptions'. Sixth, was adaptiveness, a five-item scale which we reduced to four (CMIN/DF=.315, p=.575, GFI=1.000, RMSE=.000). It contains: "We are confident of our ability to find workable solutions to new challenges by using our existing resources"; "We are able to accommodate disruptions while maintaining our current role in the industry"; "We are able to shift things around in the face of adversity and still deliver value to our customers"; and "We can always find the 'manpower' to work on special projects. Seventh was pro-activeness, originally a 10-item scale we eliminated one item to achieve fit (CMIN/DF=.751, p=.813, GFI=.989, RMSEA=.000). This factor includes: "In dealing with competitors, our business is very often the first one to introduce new products/services, administrative techniques, operating technologies, etc"; "In dealing with competitors, my firm typically initiates actions, which competitors then respond to"; "Our organisation has a history of turning threats into new opportunities"; "We take on a broader range of challenges than our competitors that have similar resources"; "We invest in building new capabilities when we face unique business challenges"; "Aspects of our business are reorganised to capture new opportunities that arise"; "We develop responses to specific threats we face as an organisation"; "We adapt quickly to accommodate changes in our environment or market"; and "Our business regularly recognises new business opportunities resulting from changes in the market place (correlational table available from authors).

Convergent, divergent and predictive validity

Next we constructed a classic multi-factor model in Amos (Version 22) to test for convergent and divergent validity of the subscales. A second order reflective model of resilience that includes all seven of the constructs was found to be a good fit (P=.000, CMIN/DF=1.442, GFI=.888 RMSEA=.033), with slack the least likely of all factors to reflect the construct well.

We then tested the predictive validity of our organisational resilience scale by creating a model that predicts performance for different years. Specifically we tested the relationship between the seven subscales and firm level performance satisfaction in 2008, 2013, and performance expectations in 2017. These dependent variables are the sum of 5-point

Likert-scale scores of perceived performance satisfaction across four dimensions: sales, sales growth, and profitability and market share. 2008 represents a baseline performance, while 2013 represents the significant uptick in business for firms related to coal seam gas investments which meant a windfall in new business in many rural areas, based in the influx of external labour to support the projects during the construction phase. 2017 represents how firms anticipate they will perform in the context of the end of the completion coal seam gas infrastructure, now that the projects have moved to the operational phase and many workers have gone back to their home towns.

We find evidence for predictive validity. The model has good fit, P=.000, CMIN/DF=3.517, RMSEA=.079. Specifically the model shows differences between the variance in the impact of individual resilience sub-factors across different years 2008, 2013, 2017. We show that performance in 2008 is predicted by connectedness and adaptiveness. This means that small rural firms that performed well were able to adapt to any change in the environment and maintained good contacts with network partners. In addition to these, performance in 2013 is predicted by slack which becomes the largest effect. This means that firms that simply have the capacity to services additional patrons, while still being adaptive and connected, were able to increase their performance satisfaction. Looking into the future, it seems that problem-solving and pro-activeness become important for firms expecting high performance in 2017. This reflects a post-construction environment where the gas industry has gone into an operational phase. Firms that anticipate doing well, appear to know they will have to be on the lookout for new business opportunities and that they will rely on creative problem-solving approaches when they are found. Interestingly, adaptiveness remains relevant across all time frames, but it is at its strongest in the 2017 timeframe. Finding workable solutions, and shifting things around to do this, appears to be a fundamental component of organisational resilience. These relationships therefore make theoretical sense, and as such we took them as evidence of the theoretical soundness of our model, supporting predictive validity.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This paper makes three main contributions to the literature on organisational resilience. First, it develops a scale for organisational resilience, consisting of seven subscales, which can be used to study organizations facing adaptation to environmental conditions beyond catastrophic events. It shows that these subscales are unidimensional, and can be used to measure the presence of resilience in organisations. Importantly, it conceptualises organisational resilience to also include strategic factors, which are beyond the short term response to an external shock. With clear evidence of its validity and reliability, it provides researchers with the ability to compare resilience across different settings to accumulate evidence of what forms of resilience matter more under different circumstances. Second, it shows how these subscales relate to performance at different stages of economic fluctuations, brought on by events such as large business investments in the surrounding region or a boom and bust cycle due to a dramatic fluctuation in demand for a particular product or commodity. In our context the sample was subjected to a multi-billion dollar capital investment cycle with the arrival of a new industry but we can envisage the scale being used in other situations such as large scale land developments like the creation of new cities in China or the rush to open new iron ore mines in Brazil between 2006 and 2012 and the subsequent closure of many of these operations in 2015-2016.

The results of our analyses provide opportunities for a number of different research directions. First, the scale allows us to explore the relationships between the sub-constructs in our scale and various measures of performance. In the future we plan to use other sources of financial data in addition to self-reported measures of performance. While the correlation of self-reported performance with financial data reported for taxation purposes is high (McCarthy, Oliver and Verreynne, 2015), we believe that a more accurate performance variable can be achieved by combining these measures.

We note limitations of our research, such as the cross-sectional nature of our data, even though we ask questions about different time periods. Longitudinal data may help to clarify some of the questions raised above regarding the emergence or decline in resilience and different factors may precede or lag other. To conclude, we suggest that practitioners can use this tool to contribute to a broadening of the literature on resilience beyond survival after disasters to the adaptation to longer-term changes in the surrounding business environment. This has application to a far greater population of firms in a wider variety of circumstances than the dominant disaster recovery focus of the current literature.

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EDUCATION TO ENSURE CONTINUOUS HEALTHCARE SERVICES DURING A DISASTER

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ABSTRACT

Japan is one of the most natural disaster-prone countries in the world. During a natural disaster or mass casualty incident, hospitals will likely receive a large number of injured persons. Some hospitals establish Business Continuity Management System (BCMS) to increase healthcare resilience. However, operating BCMS effectively in hospitals requires education and training to ensure continuous healthcare services during a disaster, though there is a lack of established content for such training. Thus, the staff may lack a good education. This paper clarified and classified course contents in a hierarchy consisting of 17 items in the first tier, 66 in the second tier, and 281 in the third tier. We arranged these results in an easy-to-read table. Then, we provided education for disaster medical care in hospital A using the contents. The course contents table enables hospitals to implement systematic education and training for disaster medical care.

Keywords: Healthcare Resilience, Disaster Medical Care, Course contents, BCMS

INTRODUCTION

Japan is one among the countries in the world that are most prone to natural disasters. It is especially vulnerable to earthquakes of large magnitudes. It is vital that under such circumstances when disaster strikes, continuation and restoration of normal life and business should be quick and effective. Disaster-prone areas, in particular, are severely impacted when there is inadequate healthcare provision to cope with disasters. Business Continuity Planning (BCP) aims to ensure business continuity in the face of disaster risk (ISO, 2012; Japan Institute for Promotion of Digital Economy and Community, 2013; Japanese Standards Association, 2013). Business continuity management systems (BCMS) are increasingly being implemented to maintain, perform, and improve BCP (ISO, 2012; Japan Institute for Promotion of Digital Economy and Community, 2013; Japanese Standards Association, 2013). ISO22301, which is an international standard for

BCMS, was published in June 2012 (ISO, 2012). The National Fire Protection Association (NFPA) had published a 2010 edition of NFPA1600: Standard on Disaster/Emergency Management and Business Continuity of Operations Programs in the United States (NFPA, 2010), and the British Standards Institution (BSI) had published BS25999 (BSI, 2007). Both NFPA1600 and BS25999 are standards for BCP and BCMS. Thus, every country attaches a great deal of importance to business continuity management.

One of the important activities to establish BCMS is to implement education and training. There is a pressing need for imparting education and training about the fundamental concepts of disaster medical care, the knowledge and skills required to cope with the disaster, and one's expected role during the disaster. Although there are several hospitals in Japan that implement training or drills for disaster medical care, such as triage, and headquarters for disaster control, there is a significant lack in the lectures organized to impart knowledge of disaster medical care.

This paper aims to develop the course contents of both the establishment of BCMS in hospitals and the implementation of disaster medical care. The results have been presented in an easy-to-read table. Furthermore, we plan to offer lectures and training using the table that we prepared in the hospital, henceforth referred to as Hospital A (539 beds, acute care hospitals). The course contents table enables hospitals to implement systematic education and training for disaster medical care.

PREVIOUS STUDIES AND THE APPROACH ADOPTED IN THIS STUDY

Previous studies on education and training for disaster medical care

Education and training for disaster medicine are implemented not merely in Japanese hospitals but in hospitals across the world as well. For example, major incident medical management and support (MIMMS) courses teach a systematic and practical approach to field medical management in disaster situations, such as how to coordinate among related organizations (Simon Carley et al., 2009). MIMMS courses are held in the United Kingdom, Australia, New Zealand, the Netherlands, Japan, and so on.

Lancer A. Scott et al. developed a novel 3-h educational demonstration project and evaluated its effectiveness in teaching medical students a few key concepts of disaster medicine, including aspects of incident command, self-preservation, and medical response (Lancer A. Scott et al., 2010).

Lauren Walsh et al. proposed 11 core competencies and 36 subcompetencies for Disaster Medicine and Public Health, including knowledge of one's expected role(s) in organizational and community response plans, effective communication with others, knowledge of personal safety measures that need to be implemented in a disaster or a public health emergency (Lauren Walsh et al., 2012).

Karen Duong et al. examined South Australian emergency nurses' knowledge and understanding of disaster response in the healthcare sector (Karen Duong et al., 2009). The findings revealed that although 95% of the nurses participating in the study agreed that disaster education for emergency nurses is important, 39% of the participants never had disaster training, while 63% of the participants had never been involved in a disaster-response situation in their professional life.

Previous studies focusing on education and training aimed at disaster medical response, such as triage, treatment, transportation, and so on. In our review of the literature, we found there were no papers focusing on education for BCMS in hospitals.

Previous study that developed course contents

Kajihara et al. proposed a method to develop course contents aimed at introducing and promoting healthcare safety management systems (HSMS) (Kajihara et al., 2012). First, they identified HSMS and healthcare safety activities that hospitals should implement. Next, they proposed course contents required to implement healthcare safety management. The proposed method of developing HSMS course contents includes the following: Step 1: Identify HSMS. Step 2: Examine the required ability to implement healthcare safety management. Step 3: Frame an outline of course contents to be developed. Step 4: Develop concrete course contents Step 5: Create a table of the course contents prepared thus.

Approach adopted in this study

This paper focused on education and training for introducing and promoting BCMS in hospitals to implement disaster medical care. Although there are several studies on disaster reduction and disaster medicine, there are very few that examine an approach to apply the management system. Management systems are effective methods for continuous improvement.

Since both HSMS and BCMS are management systems, this paper attempts to develop course contents using the method proposed by Kajihara et al. First, we identify the BCMS model that hospitals should establish. Next, we identify the ability to promote BCMS. Finally, we develop the course contents based on the BCMS model and the ability to promote BCMS.

COURSE CONTENTS FOR DISASTER MEDICAL CARE

BCMS model for healthcare

We considered a BCMS model for healthcare to develop the course contents for disaster medical care. Ogawa et al. proposed the BCMS model for healthcare (BCMS-H model) that hospitals should establish (Ogawa et al., 2015). Figure 1 shows the BCMS-H model.

In this study, the ability to promote the BCMS-H model and the course contents were developed based on Figure 1 to implement education and training in ensuring continuous healthcare services during a disaster. The study defined education and training to promote the BCMS-H model of Figure 1 as education for disaster medical care.

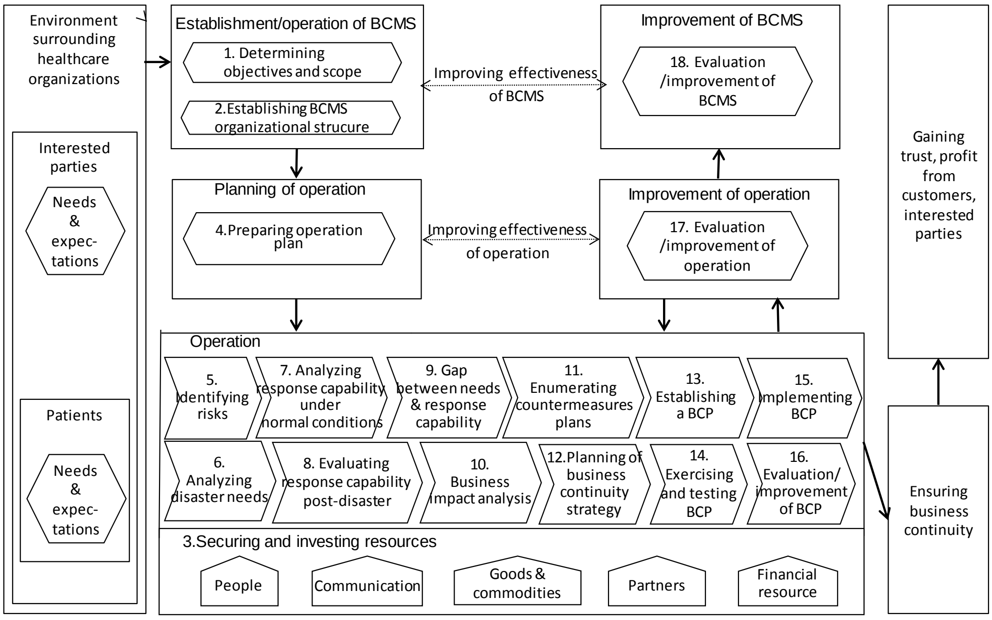

Figure 1 BCMS-H model

Ability to promote the BCMS-H

Kajihara et al. developed the required ability that hospital staff should acquire to promote HSMS. They considered this from four viewpoints: “Philosophy,” “Management System,” “Tools and Technique,” and “Technical Operation.” We looked at the required ability to promote BCMS-H from the same viewpoints because both HSMS and BCMS-H are management systems. Table 1 shows the results of the required ability to promote BCMS-H.

Table 1 The required ability to promote BCMS-H

Viewpoints	Required ability
Philosophy	(a) To understand the basic concept of business continuity management and act accordingly
Management System	(b) To implement the activities to promote BCMS-H
	(c) To manage the activities to promote BCMS-H
Tools and Technique	(d) To take advantage of the technique to be used in the operation of BCMS-H
Technical Operation	(e) To understand the organization structure to promote BCMS-H and act accordingly

Table 1 enables us to consider course contents for the course on disaster medical care without omission.

Outline of course contents

We designed an outline of the course contents to acquire the abilities mentioned from (a) to (e) in Table 1. We defined the course contents that were proposed in this session as the course contents in the first tier. The results of (a) and (b) is shown as an example.

Course contents to acquire the ability mentioned in (a)

To teach the significance and fundamental concepts of both BCMS-H and disaster medical care, trainees need to acquire a knowledge of disasters that occurred in the past, disaster preparedness, and concepts of BCMS-H and disaster medicine. We identified the contents as "Fundamental concept of disaster and disaster preparedness," "Fundamental concept of disaster medicine," and "Significance of BCMS-H" in the first tier to acquire the ability mentioned in (a).

Course Contents to acquire the ability mentioned in (b)

There is a wide range of activities to promote BCMS-H. Therefore, we identified high-priority activities to implement education and training and defined the scope of course contents for this.

Education and training for staff not only in hospital emergency departments but also in all departments because hospitals face manpower shortage during disasters.

Although activities to promote BCMS-H include devising preliminary measures to minimize the damage by disasters, priority is given for actions to be taken by the staff to cope with the disaster. Therefore, this paper focuses on the latter activities.

Based on our investigations, we listed out the activities that staff should perform during a disaster from the three viewpoints of "Organization," "Medical treatment," and "Support system" to clarify the scope of the course contents to be developed for doing this. Table 2 shows the result of the activities that need to be undertaken by the staff.

Course contents needed for the staff to acquire the ability mentioned in (b) are clarified based on the activities listed in Table 2.

We considered the contents in the first tier to understand the course contents needed to acquire the abilities mentioned in (c), (d), and (e) in a similar manner.

Table 2 The activities that staff should perform during a disaster

Function	Activities
System	Change of structure
Medical care	Medical care for the disaster victims
	Medical care for hospitalized patients
	Medical care for outpatients
	Common medical care
	Corpse management
Support	Staff management
	Cooperation and information management
	Organizational knowledge management
	Infrastructure management
	Environment management
	Financial management
	Support system management

Listing the course contents

First, we developed concrete course contents, henceforth referred to as contents in the second and third tier, using the literature survey to plan and implement education and training in hospitals. An example of how course contents was developed to acquire the ability mentioned in (b) is as follows.

For example, treating injured or sick persons during a disaster requires prioritizing the treatment according to the condition of the patients.

Table 3 A table of course contents for disaster medical care

Required ability	Business during disaster	Large contents	Mid-sized contents	Small contents
(a)		(a) [1] fundamental concept of disaster and disaster preparedness	Basics of the disaster	Definition of disaster
				Kind of disaster
				...
			...	...
		...	...	...
(b)	System	(b) [1] change of structure	Establishment and operation of disaster countermeasure	The role of disaster countermeasure headquarters
				...
			...	...
	Medical care	(b) [2] medical care for disaster victims	Triage	The purpose of triage
				...
		...	...	...
	Support	(b) [7] staff	Placement and collection of personnel	Method of gathering personnel
				...
		...	...	...
(e)		(e) [1] committee	The hospital's committee system	The role of the committee
				...
			...	...

Moreover, patients are treated not only at hospitals but also at aid stations and shelters. Therefore, we clarified “triage,” “provide treatment at aid stations,” and so on as course contents to implement “Medical care for the disaster victims” as per Table 2. We clarified and classified the course contents in a hierarchy with 17 items in the first tier, 66 in the second tier, and 281 in the third tier. We arranged these results in the easy-to-read Table 3.

VERIFICATION

We confirmed the effectiveness of the proposed contents by providing education and training in Hospital A. Hospital A is one among the core hospitals that are equipped to deal with disasters. Although Hospital A implements some training such as triage every year, lectures that provided knowledge and information about this kind of training were lacking. In 2015, Hospital A was determined to implement training for establishing the headquarters for disaster control. Therefore, Hospital A also decided to organize a lecture before the training. We selected some content, such as "How should treatment be carried out during a disaster?" and "A cardinal principle of disaster response," from Table 3 for this lecture. We also created educational material such as a text and tests to enhance their learning. The lecture was then presented via e-learning systems.

Next, training began for establishing the headquarters for disaster control. Participants of this training were required to have discussions about disaster response based on cards that showed the extent of the damage. Cards were given out to participants in a time-series order. Participants were divided into three groups of six members each, henceforth referred to as Group A, Group B, and Group C, to confirm the effectiveness of the lecture. Group A members, were recipients of the complete lecture we selected from the course contents table. Group B had members received only a part of the lecture we selected. Group C members did not receive any lecture before the training. We evaluated the result of the training to confirm the effectiveness of the lecture.

We considered both, the expected disaster responses and the timing for each response, henceforth referred to as the model answer.

We compared the results of each group with the model answer.

Table 4 shows the result of the aforementioned evaluation. "○" of Table 4 signifies that both disaster response and the timing of each group corresponded with the model answer. "△" signifies that either the disaster response or the timing corresponded with the model answer. "×" signifies that neither corresponded with the model answer.

Table 4 The result of the evaluation

No.	Expected disaster response	Group		
		A	B	C
1	Determine whether the headquarters for disaster control is established or not	○	○	○
2	Be issued a business continuity plan	○	△	×
3	Determine whether the headquarters for disaster medical summary is established or not	○	○	×
4	Establish the medical system based on the victim's number	○	○	×
5	Determine the dissolution of the headquarters for disaster medical summary	△	△	△
6	Determine the dissolution of the headquarters for disaster control	×	×	×

Table 4 shows that the number of "○"s of Group A is larger than that of the other two groups. Therefore, we concluded that a lecture based on any of the course contents from the table before a training session was effective.

DISCUSSION

Significance of this study

The course contents needed to promote BCMS-H in each hospital was delineated in this study (based on Figure 1). Current education and training for disaster medical care focuses only on disaster medical response, such as triage, transportation to another hospital, and so on. The course contents derived from this study includes not only disaster medical response but also the fundamental concept of business continuity and management systems. Learning from the course contents of the table set forth by this study enables establishing a system to have seamless and uninterrupted healthcare services during a disaster. Moreover, it becomes easy to plan effective training by comparing the course contents of the proposed table and the current education and training adopted by each hospital.

In addition, we implemented education and training by using the course contents table in Hospital A and verified the effectiveness of this study. This paper therefore proposed a concrete course plan to implement education and training. The results of this study can enable other hospitals to carry out an effective training program to ensure continuous healthcare services during a disaster.

Furthermore, this study succeeded in clarifying the course contents needed to promote BCMS-H according to Kajihara’s method. The results proved that the Kajihara’s method can be applied to course contents in promoting other management systems as well.

Necessity to combine education and training in collaboration with healthcare-related organizations in the area

It is necessary to conduct both normal medical care and disaster medical care continuously during a disaster. Moreover, since medical care needs change by the hour during a disaster, functions that guarantee ongoing healthcare also change. To continue to provide healthcare services during a disaster, it is not enough for a hospital to merely establish BCMS. There is a pressing need to collaborate among various healthcare-related organizations, such as hospitals, municipalities, medical associations, pharmaceutical associations, and trade associations. It is important to establish BCMS in collaboration with healthcare-related organizations in the area.

This paper focused on education and training needed to establish and promote BCMS-H in a certain hospital. To establish the aforementioned BCMS in the area, it is necessary to clarify the course contents to collaborate among healthcare-related organizations, to understand the role of each organization, and so on. In addition to the proposed educational content, based on this research, a future study can bring forth the course contents needed to establish BCMS in the area. Disaster Management Plans (DMPs) are prepared by municipalities to summarize action plans that help in maintaining a standard of living for the citizens. It is also necessary to investigate DMPs in several municipalities and consider the role of each organization and its course contents. Therefore, education and training together with healthcare-related organizations in the area enable communication among related organizations and improve cooperation between hospitals and clinics.

CONCLUSION AND FUTURE ISSUES

This paper clarified the course contents for disaster medical care and listed these results as shown in Table 3. First, BCMS-H model to be established in a hospital was identified. Next, the required ability to promote BCMS-H was established. Then, the course contents were clarified based on the BCMS-H model and the required ability derived. The BCMS-H model enables us systematically clarify the course contents. Finally, a part of the education and training for disaster medical care was implemented to confirm the effectiveness of the course contents table.

A future research will develop the course contents needed to establish BCMS in the area based on the results of this research. Moreover, the educational assessment methods of this training are not established. These are future issues that need to be looked into.

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CONSEQUENCES OF INVOLUNTARY RELOCATIONS THAT AFFECT THE PROCESS OF RECOVERY: A LITERATURE REVIEW

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ABSTRACT

Lately, the growing number of refugees has captured the world's attention enormously. However, the even greater number of Internally displaced persons (IDPs), who have been forced to flee their homes but, remain within the boundaries of their own country, did not attract much attention of the world. The results of internal displacement not only affect the IDPs themselves. It also has an impact on the government, local authorities, and the host community in whose neighbourhood the displaced people are relocated.

Most of the times, the government or relevant local authorities relocate IDPs in a different location to safeguard them against the negative effects of disruptive events. Generally, involuntary relocations aim at improving the lives of IDPs. However, it often acts only as a temporary relief and fails to ensure their long-term modes of livelihood. Accordingly, this paper aims to analyse different dimensions of factors that slow the process of recovery.

This study was conducted through a comprehensive literature review to investigate the research question: 'What are the challenges and obstacles faced by the communities during involuntary relocations?' Number of studies provide evidences to the effect that the incompatible integration of communities that have been built upon different economic status, social settings and physical aspects could act as stressors in the recovery process. For example, social disintegration and severe impoverishment are some of the immediate consequences of involuntary displacements, which affect the economy of the region. Therefore, the importance of collaboration between the host and displaced communities needs to be drawn upon in addressing the economic, social, cultural and physical consequences of involuntary relocation projects.

Key words: Host community, Integration, Internally displaced persons, Involuntary relocation, Recovery

INTRODUCTION

Occasionally, disasters alter lands unsuitable for human habitation. Consequently, the communities who have been living in those lands need to be relocated in favour of or against their will by the government or relevant authorities in order to safeguard them against future disruptive events. Involuntary relocations, despite the triggers, do have negative impacts on the people even though their physical assets have been completely recompensed (Cernea, 1995; Maldonado, 2012). The results of internal displacement not only affect the people who are displaced. It also has an impact on the government, local authorities, and the host community, in whose neighbourhood the displaced people are relocated (Badri, Asgary, Eftekhari, & Levy, 2006; Barenstein, 2015). Studies (Aldunce, Beilin, Handmer, & Howden, 2014; Manyena, O'Brien, O'Keefe, & Rose, 2011) prove that, restoring the same state of a community at which it has already been before the disaster is almost impossible. Because, disasters alter some of the characteristics which determine the construction of a community. This raises the interest in how people would adjust to an entirely new environment and what are the obstacles and challenges faced by the host and displaced communities during and after involuntary relocation.

RESEARCH METHOD

This paper aims at exploring the challenges and obstacles faced by the communities during and after involuntary relocations. Accordingly, this paper has been written based on a literature review, from the data gathered across different sources such as; peer reviewed journals, conference proceedings, books, official reports and official websites. Among these 26 articles are selected to identify the obstacles and challenges faced by the communities. Table 1 shows the journal types from which the articles are selected. Collected information were organised and synthesised to draw conclusions.

Table 1: Journals publishing selected articles

Journals	No
Journal of Refugee Studies	2
International Journal of Disaster Resilience in the Built Environment	2
Sri Lanka Journal of Social Sciences	1
International Journal of Project Management	1
Disasters	2
Journal of Development Studies	1
International Journal of Water Resources Development	1
Social science & medicine	1

Society and Natural Resources	1
Social Psychiatry	1

CHALLENGES AND OBSTACLES FACED BY THE COMMUNITIES

Contemporary literatures related to displacements are different from the traditional theories. Traditional migration theories largely discuss the economic, geographic, and demographic issues of migrants. Migration theory of Lee (1966) is one of the traditional theories that describes four factors that affect the process of displacement, despite the distance and nature of act (voluntary/involuntary). They are; attracting and repelling factors associated with the place of origin, attracting and repelling factors associated with the place of destination, intervening obstacles, and personal factors. However, emergency displacements are more complex than the voluntary displacements. Therefore, it requires multi-disciplinary approach to address the issues associated with them (Beggan, 2011). Scholars approached this issues from different angles, including economic, social, physical, cultural, psychological, natural, and political aspects. However, they are all intertwined and act as a barrier for the recovery of the community.

Among different types of relocations, some involves two communities. They are; displaced community, and host community, in whose neighbourhood the displaced community has been relocated. These two communities and their functionality cannot be always homogenous (Lakshman & Amirthalingam, 2009). This is even critical in multicultural and multilingual countries. As an effect, soon after the relocation, the level of functionality of communities drops from the point it was used to be. Ideally, it is expected to restore following an exponential recovery curve (Refer Figure 1), as the communities get assistance from government and other humanitarian organisations at the beginning of the relocation.

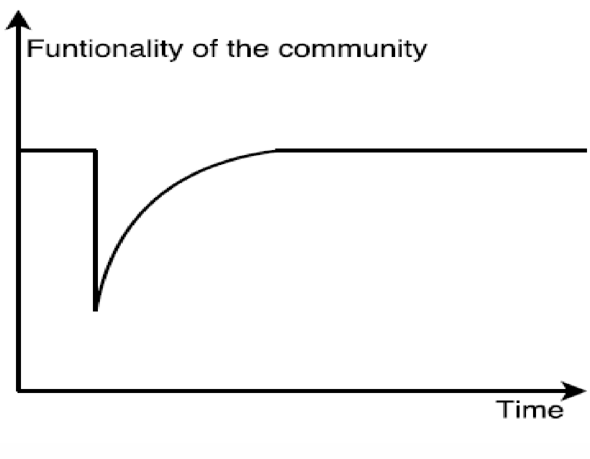

Figure 1: Exponential recovery curve

However, it is not always true as it is influenced by intervening obstacles. Figure 2 illustrates the network of intervening obstacles.

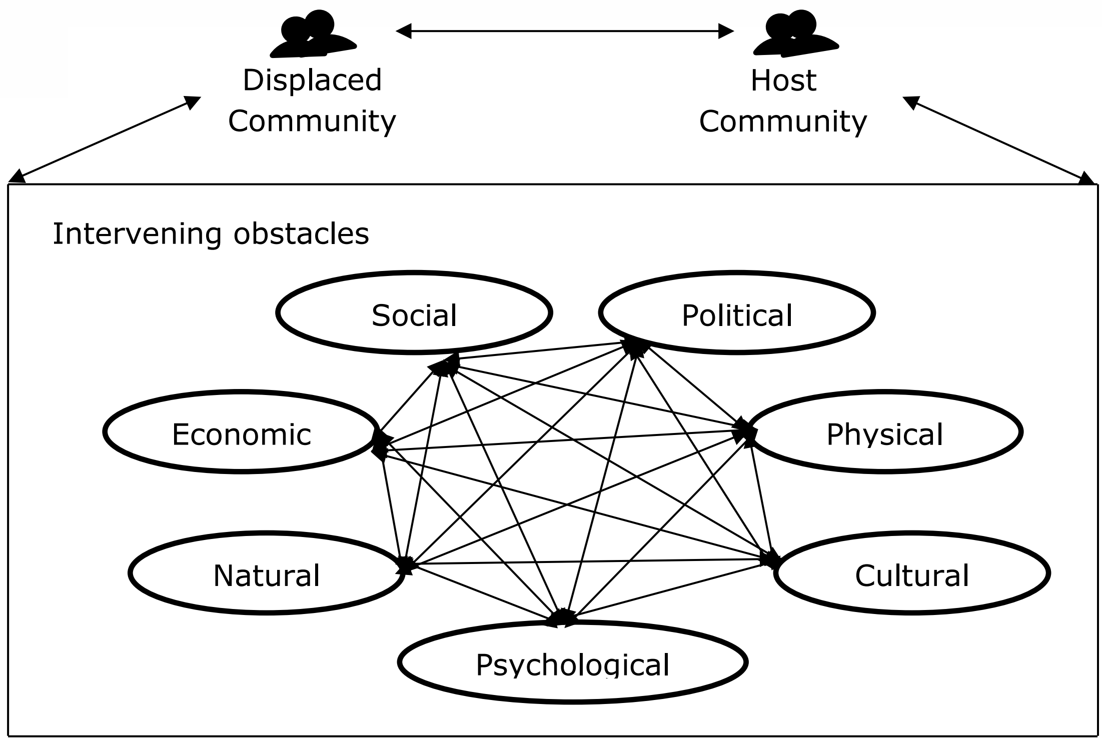

Figure 2: Network of intervening obstacles

According to Lee's (1966) traditional migration theory, every place has its own characters that act to hold and repel people. For example, good weather holds people and bad weather repels them. A successful migration needs a push from the place of origin and a pull from the destination, which motivate the people to migrate despite of all the obstacles. The problem with the involuntary relocations is, even though the place of origin pushes the people to move, the place of destination does not often pull them. Finally, the community ends up in a clump of obstacles because of the push from both the sides.

Table 2 shows the list of intervening obstacles that have been identified under each of the main category based on different studies. However, the likely occurrence of these problems is subjective to specific cases.

Table 2: Intervening obstacles that affects the recovery

Main factors	No	Sub factors	Authors
Economic	1	Landlessness	(Cernea, 1995; Kumarasiri, 2009; Lakshman & Amirthalingam, 2009; Robinson, 2003)
	2	Land right/ ownership issues	(Barenstein, 2015; Godamunne, 2012; Gunawardena & Wickramasinghe, 2009; Koria, 2009)

Main factors	No	Sub factors	Authors
	3	Decline in the employment opportunity	(Badri et al., 2006; Cernea, 1995; Robinson, 2003)
	4	Debt-bondage	(Robinson, 2003)
	5	Decline in the income	(Kumarasiri, 2009; Lakshman & Amirthalingam, 2009; Maldonado, 2012; Robinson, 2003; Ruiz & Vargas-Silva, 2013)
	6	Leads to price increases	(Ruiz & Vargas-Silva, 2013)
Social	7	Loss of social rights/ social protection	(Foresight, 2011; Manatunge, Herath, Takesada, & Miyata, 2009; Robinson, 2003)
	8	Decline in social status/ Drop in living standard	(Brun, 2009; Cao, Hwang, & Xi, 2012; Lakshman & Amirthalingam, 2009)
	9	Decline in the quality of education	(Badri et al., 2006)
	10	Disruption in social support networks	(Badri et al., 2006)
	11	Loss of networks	(Cao et al., 2012; Lakshman & Amirthalingam, 2009)
	12	Issues in local community relationships	(Gunawardena & Wickramasinghe, 2009; Thalayasingam, 2009)
	13	Marginalisation/ weakening of social integration	(Cao et al., 2012; Cernea, 1995; Manatunge et al., 2009; Thalayasingam, 2009)
	14	Food insecurity/ poor nourishment	(Cao et al., 2012; Cernea, 1995; Godamunne, 2012)
Physical	15	Resettlement in unfamiliar and inhospitable locations	(Robinson, 2003)
	16	Inadequate sanitation	(Badri et al., 2006)
	17	Local climate adoptable houses	(Barenstein, 2015)
	18	Incompatible house design	(Barenstein, 2015; Gunawardena & Wickramasinghe, 2009)

Main factors	No	Sub factors	Authors
	19	Access to physical infrastructure (Drinking water, electricity, roads, common buildings, schools, etc.)	(Gunawardena & Wickramasinghe, 2009; Laugé, Hernantes, & Sarriegi, 2015; Thalayasingam, 2009)
	20	Reduction of community resources (Medical, educational, etc.)	(Cao et al., 2012; Cernea, 1995; Foresight, 2011; Magis, 2010; Manatunge et al., 2009; Muggah, 2000)
	21	Distance from the previous location	(Gunawardena & Wickramasinghe, 2009; Lakshman & Amirthalingam, 2009; Manatunge et al., 2009)
Cultural	22	Cultural disintegration	(Robinson, 2003)
	23	Mismatch of culture	(Gunawardena & Wickramasinghe, 2009)
	24	Communication difficulties due to regional differences in dialect and culture	(Cao et al., 2012)
Psychological	25	Separation from family members	(Nicassio & Pate, 1984)
	26	Painful memories of war and departure	(Nicassio & Pate, 1984)
	27	Abuse of human rights	(Robinson, 2003)
	28	Distress	(Cao et al., 2012)
Natural	29	Vulnerability to environmental changes	(Foresight, 2011)
	30	Changes in land use patterns	(Ruiz & Vargas-Silva, 2013)
Political	31	Decline in political representation	(Muggah, 2000; Thalayasingam, 2009)
	32	Increased risk of political and criminal violence	(Muggah, 2000)
	33	Legal status	(Foresight, 2011)

DISCUSSION

Economic obstacles are one of the key issues that affect the process of recovery. Financial recovery pattern of the displaced community would be varied depends on the livelihood of the displaced community and that of the host community. Lakshman and Amirthalingam (2009) found that, if the labours have demand in the host community for the works in which they are skilled at, financially they recover quickly. Whereas, farmers and fishermen take a long time to recover as their livelihoods are attached with their habitual residence. Further, household enterprises also take a considerable amount of time to regain new clients. This proves that, owing to the struggle in finding the income source, displaced people face a decline in income at the beginning of the displacement (Godamunne, 2012). Cernea (1995) states that, this decline leads to sever impoverishments and extends beyond the immediately affected population, if the displacement is inadequately handled. Consequently, it consumes a long time for the community to recover.

Further, physical relocation planning often does not include plans for new job creations (Cernea, 1995). Employment opportunity also depends on the type of livelihood that the displaced community was engaged in before disaster. Displaced community has some difficulties in continuing capital and entrepreneurship oriented livelihoods such as farming, fishing, livestock, and commercial enterprises, in the new environment as they already lost their assets completely or partially during the disaster (Lakshman & Amirthalingam, 2009). This makes the families to seek different employment opportunities among the host environment. The situation is similar for the skilled labours if there is no demand in the host community for the works that they are skilled at. Based on different case studies, it has been proved that, the displaced population cannot find opportunities for certain jobs in the host community, if they have neither the skill nor the qualification for those jobs (Cao et al., 2012). Decline in the employment opportunities is not only a problem of displaced community, but also it affects the host community. Because, displaced people become competitors for the available job opportunities in the host environment (Badri et al., 2006).

Relocation from one location to another changes the lifestyle of a community. Cao et al. (2012) state that, the lifestyle changes add new expenses to the budgets of households. Also, it alters the traditional economic system, replacing it with a new system based on the differences in the workforce. Consequently, it leads to price increases in the economy. As a result, studies show that, the number of working members in a family has risen not only among displaced community but also among host community in post disaster resettlements (Badri et al., 2006).

Economy of a community is interrelated with its social status. Social status of a community will be degraded, if the power of economy of a community declined. Soon after the relocation, displaced community loss its social organisation structures, informal and formal networks, associations, and local societies (Cernea, 1995). This leads to social marginalisation, if the displaced community could not establish a healthy relationship with the host community (Cao et al., 2012). However, the free houses and other assistance given to a selected community, ignoring others would create a social imbalance among the community and prevent healthy relationship among communities (Belgian Red Cross, 2009). Consequently, issues similar to loss of social life, decline in living standard, weakening of social integration, and disruptions in social support networks can be experienced by both displaced and host communities (Brun, 2009; Foresight, 2011; Manatunge et al., 2009).

Further, studies show that the resettled communities often found the new houses unsuitable, as it is built culturally and socially inappropriate and different from what they have used to be (Badri et al., 2006). As a consequence, Barakat, (2003); Oliver-Smith, (1991); and Jha et al., (2010) supported the outcome that, the people refuse to live in new settlements and return to their previous places (as cited in Barenstein, 2015). Moreover, the available infrastructure and common resources will become overwhelmed unless it is adequately planned to serve an additional community (Cao et al., 2012). This is again interrelated with socioeconomic trust among communities. A study conducted by Brun (2009) gives example for the consequence that, the displaced and host communities develop some clashes among themselves and displaced community could be marginalised by the host community out of fear of losing resources, government job allocation, and education quota.

Cultural values of a community including indigenous practices, rituals, shifting cultivation, crafts, construction, and identity is another factor that acts as a barrier for the process of recovery (Singer, Hoang, & Ochiai, 2015). Displacement from the habitual residence often become a trigger for the 'longing for belonging' state of the re-settlers as they cannot practice all of those cultural values in the new environment. Cultural, regional, and ethnic differences between host and displaced communities can act as triggers for discrimination and racism (International Committee of the Red Cross, 2011). Furthermore, social settings and psychological aspects could also lead to slow recovery of the community.

Additionally, natural, psychological, and political barriers (Refer Table 1) also strengthen the dominoes effect and slow the process of recovery. Therefore, these factors should be considered during the planning phase of resettlements, if not, alternatively, government or relevant authorities need to intervene by taking necessary actions to reduce this effect.

CONCLUSION

Involuntary relocations are rather common after a disaster if the land become unsuitable for inhabitancy. Mostly, it often acts only as a temporary relief and fails to ensure the community's long-term modes of livelihood. Following the relocation, displaced and host communities face many problems related to economic, social, and cultural incompatibilities. Because, initial relocation plans often consider the host community and the community compatibility. Therefore, integrating mechanisms to improve collaboration between host and displaced communities, including communities' concerns and requirements is necessary to reduce relocation failures and to enhance quick recovery.

This is a part of a PhD project and further field studies will be conducted in order to identify the needs and expectations of the communities, and the barriers to fulfil them to establish a durable solution.

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CULTURE AND RESILIENCE: LESSONS FROM NEW ORLEANS AND JAPAN

Lisa J. Richardson, PhD and Denese O. Shervington, MD, MPH

ABSTRACT

On August 29, 2005 Hurricane Katrina struck New Orleans and the Gulf Coast of the United States. The impact of failed levees, poor evacuation planning, and slow governmental rescue and response efforts differently impacted individuals and groups according to their age, gender, race/ethnicity, language access, education, employment status and income. Inequities such as lower socio-economic status, substandard housing, and social marginalization translated into heightened disadvantage and increased disaster risk for the most vulnerable citizens. Less than a decade later in 2014, New Orleans was designated as one of the Rockefeller Foundation's 100 Resilient Cities. This announcement celebrated the ability of the city to successfully rebound and thrive after disasters despite the fact that racial and ethnic minorities continue to experience disproportionate physical disaster impacts, poorer psychological outcomes, diminished standard of living and exacerbated poverty during the reconstruction and rebuilding process. Based on case studies and ethnographic field observations in New Orleans and Tohoku Japan this paper will: 1) problematize the notion of resilience in the context of increased disaster risk and vulnerability along racial/ethnic and other differences; 2) explore the ways that resilience can be defined and facilitated through access to resources that prioritize individual and collective coping in culturally meaningful ways; and 3) investigate the ways resident constructions of culture build a sense of collective power of individuals to navigate community disruption and grapple with collective trauma after a disaster.

Key words: Culture, Disaster, Race, Resilience, and Vulnerability

RESILIENCE AND ADVERSITY

Resilience can be broadly defined as the capacity of a dynamic system, individual, organization, geography, or culturally bound community, to anticipate and adapt successfully to challenges (Masten, 1990). In of light the increased global vulnerability to disaster, more governmental, philanthropic and civic attention has been focused on efforts to build community resilience. Scholars who study the distinctive cultures, geographic and social settings, and histories of adversity of indigenous peoples, argue that specific social determinants of health point to particular sources or processes of resilience. In the case of oppressed people of color and indigenous peoples around the world, some of these strategies of resilience draw from traditional knowledge, values, practices and emerging global networks of oppressed peoples pursuing common cause (Schoon, 2006).

At the individual level, a body of multidimensional research suggests that processes of successful coping are attributable to a range of biological, psychological, relational, and socio-cultural factors, particularly in circumstances where people experience high levels of exposure to environmental adversity (Ungar, 2013). This ecological conception of resilience links individual resilience to a process of complex interactions between individuals and their environments that influence development over the life course (Gotham, 2013). New research on community resilience is also making conceptual linkages between the ways concentrated geographies of social vulnerability can be mapped to guide emergency planners and policymakers leading disaster response efforts (Bergstrand, 2015). The potential devastation of disasters are compounded by the traumatic experiences of individuals and chronic adversities such as poverty, racial and ethnic oppression, gendered inequalities, and social marginalization endured by the most vulnerable populations.

This paper examines two disaster sites, Japan and New Orleans Louisiana, to problematize the notion of resilience, and what Boyden and Mann (2005) have argued is 'the central role of culture' to increase the capacity to access resources that enhance health in one's own environment. These case studies illustrate that cultural resources, including neighborhood-based social networks, place-based revitalization efforts that include ritual, music, visual arts, and investment in cultural traditions, can provide the strongest opportunities for equitable community recovery and rebuilding after disaster.

THE NEW ORLEANS DISASTER: HURRICANE KATRINA

In 2004, the Federal Emergency Management Agency (FEMA) and Louisiana's Office of Homeland Security and Emergency Preparedness, conducted a tabletop exercise that simulated a Category 3 storm hitting and flooding New Orleans. It identified a huge gap in existing disaster planning - an estimated 100,000 people would not be able to evacuate without assistance (Lavelle, 2006). The 2000 U.S. Census corroborated that finding, and showed that 27% of New Orleans households, amounting to approximately 120,000 people, were without private vehicles. In spite of this, New Orleans evacuation policies continued to rely on citizens' access to private means of transportation (Spence, 2007) though research, community wisdom, and local history showed that African Americans were less likely than Whites to have a private vehicle, an evacuation plan in place prior to hurricane (Delisi, 2006), and were less likely to have evacuated during the past storms (Elliot, 2006).

When Hurricane Katrina struck the Gulf Coast on August 29, 2005 the world witnessed an unprecedented American catastrophe. For several weeks, New Orleans, the Big Easy, the unique American city known worldwide for its music food and African-flavored culture, was submerged under several feet of water. Major floodwalls failed after two days of intense storm surges rendered the city's pumping system incapable of draining the rising water. As a result 80 percent of the urban footprint of the city flooded with water reaching up to 5 meters. The failure of the Army Corps of Engineers levee system impacted areas far beyond New Orleans, leaving catastrophic property damage in coastal communities of Mississippi and Alabama. Federal disaster areas were designated along 90,000 square miles of the Gulf Coast, and affecting more than one million people. Total damage to the region has been estimated at $151 billion, making Hurricane Katrina the most expensive disaster in United States history (National Centers for Environmental Information, 2015).

Five empirically supported intervention principles have been identified to inform efforts at the early to mid-term stages of coordinated response a natural disaster (Hoboll, 2007). These principles emphasize promoting: 1) A sense of safety; 2) a sense of calm; 3) a sense of self and community efficacy; 4) a sense of connectedness; and 5) a sense of hope. Such an approach was not adopted in response to Hurricane Katrina (See Table 1). A sense of safety and calm was overshadowed by media focus on crimes of survival and desperation. A sense of personal and collective efficacy was not cultivated given that the community was not given the needed financial and emotional resources to get back on its feet and re-establish its longstanding social networks and connectedness. Today a significant number of New Orleanians remain displaced and unable to return.

RESEARCH METHODS

The data to follow were collected from a variety of primary and secondary sources. Primary data were collected through in-depth interviews, focus groups and listening sessions in New Orleans and Japan. Focus groups were conducted with African American residents in New Orleans in 2006 (n=65). Over three months in 2009 more than 100 African American residents from a range of neighborhoods, income levels, and ages provided data through semi-structured one-on-one interviews to explore the sources of their self-identified post-disaster stress. Primary data on post-evacuation experiences was triangulated with document analysis of a Harvard study in 2006 (n= 1043) that found: 1) stressful experiences were more commonly reported by the poor, racial and ethnic minorities, and those with fewer years of formal education; and 2) that the proportion of respondents reporting worse health post-Katrina was higher among those with lower income residents. Secondary data on New Orleans were collected through content analysis of local and national news coverage immediately following Hurricane Katrina and a rapid assessment conducted by Columbia School of Public Health and the Director of the National Center for Disaster Preparedness (Abramson, 2006a). The rapid assessment surveyed 12,000 displaced residents to inform policymakers about health and social services needs of displaced people living in transitional housing. The findings highlighted persistent medical and mental health needs attributed to untreated chronic diseases, psychological and emotional traumas related to the despair of a massive dislocation, and the deprivation of the chronically poor and the newly impoverished. These themes and secondary data from local, state and national governmental reports on the response, recovery effort, and enduring impact of Hurricane Katrina shaped the data collection instruments employed in New Orleans.

Similarly, primary data on disaster in Japan was collected through in-depth interviews with 30 key stakeholders, academicians, government officials, NGO leaders and survivors. Listening circles were conducted by a New Orleans delegation with survivors of Miyakejima and Tohoku including community elders, citizen groups, and civic leaders (n = 300). Document analysis of print media, disaster preparedness community action plans, official response efforts, and recovery protocols provided secondary data. In addition to direct observations in Japan and New Orleans, Japanese leaders presented policies, procedures, and lessons learned, during in-person meetings in New Orleans, Tokyo, and Tohoku between 2008 and 2011.

Table 1.American Response to Hurricane Katrina

Elements o Successful Recovery	**Post –Katrina**	**Community Impact**
Promoting Safety	Sensationalized Violence	Increased perception of threat
Promoting Calm	Promulgation of Fear	Heightened stress response
Promoting Self and Collective Efficacy	Abandonment of the most vulnerable	Loss of control, self-regulation, competency and value
Promoting Social Connectedness	Anomie	Isolation Disintegration of community norms
Promoting Hope	Re-traumatization Heightened isolation	Despair Powerlessness Loss of 'tragic optimism

The Miyakejima Japan Disaster: Mt. Oyama Volcano

Volcanic eruptions of Mt. Oyama on the island of Miyakejima began on June 26th, 2000. Over several weeks, volcanic mud continued to flow as eruptions and large streams of smoldering rock and volcanic ash spewed from the volcano. Following a large-scale eruption on August 29, 2000, 2829 residents were ordered to evacuate on September 2, 2000. The evacuees were first taken to the National Olympic Center in Tokyo, and gradually moved to unoccupied public housing apartments owned by the Tokyo Metropolitan government. Later the Japanese government created the Support Reconstruction of the Victims' Life Law for Miyakejima refugees to prioritize reconstruction of damaged homes on the island. The infrastructure for this effort was developed in 1998 when the Tokyo Volunteer Network for Disaster Relief (VNDR) was created to spearhead a comprehensive strategy and coordinated national response through a network of nationwide organizations, businesses and individuals.

The VNDR opened the Miyakejima Disaster Tokyo Volunteer Relief Center. It had a simple motto, "Not Even One Suicide". Return to the island was considered safe in July 2004. The Volunteer Center prioritized facilitating consistent contact among the residents through four simple actions: 1) publishing an islanders' telephone directory; 2) organizing frequent meetings among the displaced people; 3) securing donations of fax machines from businesses to enable communications among community members; and, 4) creating and distributing a weekly newsletter. In 2004 approximately 75% of the residents of Miyakejima returned after four and half years, a rapid repopulation that the Mayor, Sukeyasu Hirano, attributed to the support evacuees received from the government and the cadre of Tokyo volunteers. He stated,

> Thanks to the efforts of countless volunteers from the national and Tokyo government as well as numerous citizen groups, whose activities helped maintain a sense of community and uplifted spirits, we were able to cope with the aftermath of the eruption, evacuate the island, preserve the island, support the refugees and conduct an experimental return to Miyakejima and prepare for a large return (Japan Society Annual Report, 2008).

Five years later, on August 29, 2005 the American Gulf Coast faced a natural disaster of unfathomable proportions. In the spring of 2008, a delegation of Japanese visitors, including the Mayor Hirano of Miyakejima, and Yasushi Aoyama, the former deputy governor of Tokyo and a professor at Meiji University, arrived in New Orleans as part of a learning exchange. The exchange included a visit to Japan by several New Orleans recovery groups to develop strategies and practices that build community resilience.

In Japanese culture, the needs of the group are seen as superior to the ends of the individual. Arguably in the American context, more value is placed on individualism than on the provision of resources that can be equitably provided to all members of the society based on their relative needs. These fundamental differences serve as the basis for understanding many of the differences in disaster response efforts in the United States and Japan. New Orleans' unique cultural features, often attributed to African retentions of collectivism and tight social bonds, complicate a sharp contrast between the two cultures. As one resident stated, "Without the people, there is no New Orleans culture."

This spirit resonated with the Japanese, and mirrors their ways of drawing on their culture to address the five elements of successful recovery (See Table 2).

Table 2.Japanese Response to Miyakejima

Elements o Successful Recovery	**Post-Miyakejima**	**Community Impact**
Promoting Safety	Frequent pre-disaster drills Focus on the vulnerable – elders, poor, homeless	Survivors feel protected Survivors trust each other
Promoting Calm	Infrastructure rebuilding (housing) is top priority	Survivors feel nurtured Survivors feel valued
Promoting Self and Collective Efficacy	Civil society provides assistance, 'Together we can do this'	Survivors tap into individual, collective sense of mastery
Promoting Social Connectedness	Opportunities (technological and interpersonal) for networking	Social cohesion Clear channels of communication
Promoting Hope	We are a 'culture of disasters- we always survive'	Survivors cultivate 'tragic optimism'

Vulnerability and Community Resilience

Despite the factors preventing many people from being able to evacuate New Orleans on their own, the mandatory evacuation of New Orleans called on August 28, 2005 made no provisions to evacuate homeless, low-income, or the city's elderly or infirmed residents. Traumatized Black survivors trapped in the city and awaiting rescue, were labeled as thugs and looters as they sought food and other necessities. Disaster victims attempting to walk over a bridge out of New Orleans to safety were held at gunpoint, or physically brutalized. Consequently, most of those stranded in the city were the Black poor, the elderly, children, and the sick. Public administration scholar Christine Stivers (2006) highlights several examples of grave bureaucratic failures, including the slow transportation of food and water to the Louisiana Superdome, which served as a, "shelter of last resort" to over 25,000 people (Brinkley, 2006). Many scholars, including Stivers, see racism as one of the major factors accounting for the increased risk of adversity among low-income African Americans during Hurricane Katrina, and the recovery process in its aftermath (Page, 2006, September 12).

The media shape how a disaster is framed in ways that influence survivors' and others' understanding of the event, including emergency managers and key decision-makers. Scholarly analysis of disaster metaphors and myths traced the impact of exaggerated and extreme portrayals of looting and lawlessness during Katrina to critical policy decisions. Local government, seemingly overwhelmed and under-prepared, failed to take the immediate steps necessary to avoid chaos. Delays at all levels opened the door for unnecessary suffering during the most critical response time. Three days after the levees were breached in New Orleans, the decision to re-direct police officers to attend to lawbreakers rather than to life-saving activities lessened the survival chances of stranded residents. Many policymakers argued that the military should have played the primary role in disaster response despite 50 years of sociological research showing that the emergency behavior of most disaster victims is orderly and prosocial when they do not fear for their lives (Tierney, 2006).

Though the destruction caused by Hurricane Katrina affected the entire Gulf Coast, the intensity of flooding unequally impacted New Orleans communities. Before Katrina, 37 percent of the African American population of New Orleans was living in conditions of concentrated neighborhood poverty, representing the second highest rate in the nation (Brand, 2009). African American communities were damaged more than White communities and African Americans affected by the storm have since reported higher rates of unemployment, psychological distress, and general life disruption than Whites (White, 2007).

Cross-cultural Exchanges between Japan & New Orleans

In 2008 when Professor Yashudi Aoyama and the Vice Governor and Chief of Miyakejima disaster management visited New Orleans, they expressed a desire for meaningful cross-cultural exchange saying, "The people of the two areas may speak different tongues, but both share the same determination to rise above disaster." Aoyama's delegation insisted on the importance of equitable treatment for all residents in the post-disaster recovery in areas vulnerable to disaster. He stressed,

> It is simply not enough to restore a city to its former state. Post-disaster recovery means that all residents can come back and begin living there again…when we are asked why we would fight to return to a place that people expect disaster to strike again, we believe in the right of all people to return to their home…the infrastructure may have broken, but not our hearts. That is why we go back."

In 2009, Professor Aoyama invited a group of government officials and community advocates from New Orleans to visit Japan to learn more about disaster preparedness and recovery. Disaster volunteers, survivors and scholars discussed the influences of Japanese culture that have shaped their collective responses to disaster in terms of policy, practices and community rebuilding. In that exchange they discussed the need to move beyond market-driven solutions to effectively facilitate human recovery after a disaster. They stressed that 'community resilience' would be unattainable without maintaining group cohesion and clear channels of communication at the neighborhood level. Additionally, it was suggested that New Orleans had to consciously label its culture, "as vulnerable to repeated disaster," as the Japanese had, and embrace the example of mutual dependency during acute shocks to come.

Cultural Norms and Building Resilience

On March 11, 2011 an earthquake registering 9.0 on the Richter scale struck Tohoku in the northeastern coast of Japan. Forty-five minutes later it was followed by a massive tsunami, with waves of 40 meters reaching up to six miles inland. The disaster killed over 25,000 people and caused extensive damage to the infrastructure and the Fukushima Nuclear Power plant. In spite of the high level of disaster preparedness in Japanese culture – including frequent disaster drills and mitigation strategies—the magnitude of the tsunami overwhelmed all existing rescue and recovery efforts, and challenged Japanese cultural norms about grief, sadness and loss. As one town official stated,

> No one could have imagined this. It is unspeakable.. Now, there is no past, it has all been washed away. We just have to reconstruct and rebuild. This is what the people who lost their lives would have wanted.

There is no specific word for 'grief' in the Japanese language and public displays of emotion are considered shameful. Instead the culture expects that individuals tap into their "inner fortitude to help them accept the painful givens of life."

Recognizing the powerful role of culture in disaster recovery and community resilience, Professor Aoyama invited a delegation of New Orleans leaders to Japan once more, this time, "to encourage and give hope to the local Japanese people faced with recovery" when their collective norms were overpowered by the scale of the destruction. At his request, the group did not include elected officials or disaster specialists. Instead a singer, a musician, a photographer, a community cultural leader, and a community-based psychiatrist and public health expert traveled to Tohoku. In exploring the role of culture in disaster recovery, he requested cross cultural activities from the New Orleans delegation that would: 1) Share the power of their music as a vehicle for healing; 2) Show the ways that cultural traditions (i.e. second lines, jazz funerals, and brass band street culture) direct people how to celebrate life and respect death; and 3) Reflect on 'the right of return' for people displaced by disaster. Aoyama felt the cultural activities such as these during the moment of extreme suffering could help people access what resilience researchers now describe as the social ties that are the context for robust resilience strategies (Ungar, 2011a). He also wanted, "to remind the Japanese people that recovery of people's unity and identity is important as much as, or more than, the recovery of buildings." Aoyama and his colleagues saw cultural exchange as the most promising vehicle to facilitate individual and community resilience, by providing a framework in which Japanese individuals could locate themselves in relation to others, and to a larger shared context (Ungar, 2011b). As the Japanese leaders articulated, "The enormity of the destruction, coupled with the nuclear disaster has created psychological damage, suicide and an increase in alcohol use."

Meaning systems profoundly shape the ways that people go about overcoming difficulties (Norris, 2008). Aoyama identified ways that New Orleanians are living examples of tradition and the potential for utilizing culture as a resource for community recovery and rebuilding after disaster. He noted, "It was the love of the city's culture, artistic expression and traditions that brought New Orleanians back home in spite of the difficulties."

The volunteers from across Japan operated out of the Volunteer Center for the massive cleanup effort. A top priority was salvaging photos and memorabilia, especially Buddhist plaques with the names of deceased family members. Other community centers served as temporary shelters for the elderly. The elders known as the "original grandmothers" were committed to adhering to cultural norms of emotional restraint and acceptance. They consistently said that it was easier for them to show their emotions with the New Orleans visitors because verbalizing their own pain was seen as dishonorable and a disservice to the community at large. They believed it was their cultural duty to focus instead on their younger family members who relied on them for strength.

These attitudes were scrutinized by many Japanese national leaders in response to the meltdown at the Fukushima Daiichi nuclear power plant that followed the earthquake and tsunami. According to the chairman of an independent panel who released a scathing report describing the accident as a "profoundly man-made disaster", misplaced deference and other norms of Japanese culture were at the heart of Fukushima disaster. In response Kiyoshi Kurokawa, a medical doctor and professor emeritus at Tokyo University, critiqued what he called the 'ingrained conventions of Japanese culture' that hamper individual healing in community-wide trauma,

Our reflexive obedience, our reluctance to question authority, our devotion to 'sticking with the program', our groupism, and our insularity were the cause of fatal safety missteps and lack of readiness. The report demonstrates that ignorance and arrogance unforgivable for anyone or any organization that deals with nuclear power. It found a disregard for global trends and a disregard for public safety (The Guardian, July, 2012).

CONCLUSION

Resilience, as a concept, has recently shifted from a sole focus on the individual to community and national levels, which emphasize the uniqueness of geographical context, collective experiences and local knowledge (Hultman, 2006). We posit that community resilience requires a deep understanding of the culture of a place, its strengths, its limitations and its potential as a catalyst for transformation to overcome acute shocks and chronic adversities. Several studies on disaster survivors' resilience have found that family and culture contain rich resources for disaster survivors to cope with adversity (Agani, 2010). In many ways identification and involvement with one's culture can offer avenues to help sense making and facilitate problem-solving strategies that are both meaningful and deployable.

In 2013 the Rockefeller Foundation named New Orleans one of the 100 Resilient Cities. A core concept of this initiative is that local governments be as attentive to chronic stresses as they are to acute shocks and traumatic events. According to Maxwell Young, Director of Communications and Marketing for 100 Resilient Cities, "While there is still much work to do, what New Orleans has done is miraculous. Seeing how it's come back from something that fundamentally threatened its existence is amazing." But Young also points out that cities are more often destroyed by the stresses of crime, water shortages or high unemployment rates, than they are by Category 5 hurricanes and inadequate floodwalls. Measures of the ability of a neighborhood, a cultural community, or group with a shared social status 'to bounce back' from adversity must take into account the additional burdens that chronic stressors place on marginalized peoples (Park, 2006).

As researchers, government officials and civic leaders explore approaches to building both individual and community resilience, lessons from New Orleans and Japan raise several questions – how does culture impact the ways people prepare for and respond to disaster? What are the ways to discover which cultural norms should be retained, discarded, and or refined? Examples from Japan and New Orleans point to the need for nuanced responses to such questions.

New Orleans is an important site to study the social and ecological theories on disaster recovery outcomes and repopulation. Against the backdrop of racial injustice, poverty and a legacy of place-based inequality, New Orleans is celebrated for its culture, ambient history and heritage of collective ritual across racial and ethnic lines. Though the city is recovering, many of the most damaged neighborhoods do not exemplify the 'comeback story of resilient New Orleans' (Gotham, 2013). Critiques of the uneven recovery contend that government and private organizations have taken a laissez-faire approach to recovery and left weighty rebuilding decisions to the most influential residents, businesses and organizations (Brand, 2009). Due to the lack of governmental strategy to promote social connectedness and facilitate individual and collective self-efficacy, opportunities were lost to build community resilience by utilizing the transformative power of New Orleans' culture.

More than a decade after Katrina, racial and economic inequality continues to deepen. Today the median income for White families in New Orleans is $60, 553 and the median for Black families is $25,102, or $35,451 less than Whites. At the same time, fifty percent of Black New Orleanians now live in poor households, a higher percentage than when the storm hit. In addition, there are now 3221 fewer low-income public housing apartments in the city. These data suggest that the prospect of return is rather grim for the 99,650 Black New Orleanians who have not come back. The resurrection of working class neighborhoods is paramount in order to achieve community resilience because the city's culture, particularly the music, is anchored in neighborhood traditions.

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COMPARING AND EVALUATING HONG KONG'S ADAPTATION AND RESILIENCE POLICIES

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ABSTRACT

The Paris Agreement, the Sendai Framework for Disaster Risk Reduction 2015–2030, and the Sustainable Development Goals have provided strong synergy for the formulation of the post-2015 development agenda. To tackle damages and losses brought by climate change, natural disasters and man-made shocks, the agenda demands governments at all levels to formulate and develop appropriate adaptation and resilience policies to achieve the development goals and targets in an integrative manner. Drawing from published literature, this paper aims to review and evaluate Hong Kong's existing policy instruments and practices through the lens of adaptation and resilience. To achieve that necessitates the development of an integrated framework for adaptation and resilience policy analysis. In this paper, a framework is developed based on the well-recognised NATO (Nodality, Authority, Treasure and Organisation) policy development model and practical resilience engineering approaches. Through the framework, Hong Kong's policies and practices pertinent to sustainable development, climate change, urban planning, built environment management and hazard management are analysed to investigate the paths and policy alternatives as well as the possibility for the city to achieve the post-2015 development goals and targets.

Key words: Adaptation, policy instrument, post-2015 development agenda, public policy, resilience

INTRODUCTION

The Paris Agreement which sets a target to limit the temperature increase to 1.5°C above pre-industrial levels has gained unprecedented support of 177 countries / cities since its opening for signature in April 2016. The Paris Agreement along with the Sendai Framework for Disaster Risk Reduction 2015–2030 and Sustainable Development Goals has formed the basis of the post-2015 development agenda with a desire to address the issues and impacts brought by climate change, natural disasters and man-made shocks (Roberts *et al*., 2015). The agenda demands governments at all levels to formulate and develop appropriate adaptation and resilience policies to achieve the development goals and targets in an integrative and collective manner, e.g. by enhancing the coherence of existing policies or implementing new integrated policy instruments.

Mitigating the effects of climate change, natural disasters and man-made shocks is a long-term goal and multi-disciplinary effort, which calls for pragmatic actions by central, regional and municipal governments, local communities and private enterprises (Angel *et al*., 2016). In recent years, several initiatives have been launched for cities, sub-national regions, companies, investors and civil society organisations to register actions and commitments for addressing climate change, providing visibility to the diversity of climate actions, mobilising broader engagement and accelerating ambition for resilience. Examples of these include the Non-State Actor Zone for Climate Action (NAZCA) set up by the United Nations Framework Convention on Climate Change (UNFCCC); 100 Resilient Cities by Rockefeller Foundation; Making Cities Resilient by United Nations International Strategy for Disaster Reduction (UNISDR); C40 Cities Network; ICLEI-Local Governments for Sustainability; and the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories.

Like many other high-density mega-cities, Hong Kong (HK) has begun to develop and introduce various actions to tackle the challenges arising from climate change. For instance, the city is actively promoting greenhouse gas (GHG) emission reduction policies, e.g. by changing the fuel mix of local electricity generation and reducing the energy consumption of the building and transportation sectors, etc. On the other hand, a series of infrastructure enhancement plans and programmes have been put forward to improve urban resilience instigated by climate change, flood mitigation, landslide prevention, etc. (HKENB, 2015a, 2015b).

Despite great efforts being attributed to combat climate change, mega-cities around the world are encountering challenges and obstacles in formulating and implementing adaptation and resilience policies, such as how to achieve vertical and horizontal coordination within and between government authorities, actors and departments; how to improve internal city operations and capacity; how to demonstrate benefits and gain support for climate actions; how to engage urban stakeholders; how to collaborate with the private sector; and how to get funding for climate actions (C40 Cities, 2016). From the public policy cycle perspective, high-density mega-cities need a holistic policy analytical tool to help policymakers unveil the gaps of existing practices and hence devise concerted polices for adaptation and resilience.

Drawing from available literature, this paper aims to develop an integrated policy development framework to help high-density mega-cities conduct an empirical review and evaluation of the existing policy instruments and practices through the lens of adaptation and resilience.

After an introduction to relevant research works in the subsequent section, a framework based on traditional policy development model – NATO (Nodality, Authority, Treasure and Organisation) is proposed for adaptation and resilience policy analysis. With this framework, HK's policies and practices pertinent to sustainable development, climate change, urban planning, built environment management and hazard management are reviewed and analysed. The paper is concluded by summarising the main contribution as well as the issues and implications of applying the proposed framework in order to enable high-density mega-cities to delineate the paths and policy alternatives and examine the possibilities of achieving the post-2015 development goals and targets.

RELATED WORKS

Adaptation and resilience

Adaptation and resilience concepts have garnered the attention of policymakers, government authorities, practitioners and scientists around the world in recent years with a hope to deal with the challenges and risks triggered by climate change, known threats and unpredictable adverse events, e.g. natural disasters, cyber incidents, industrial accidents, pandemics, acts of terrorism, sabotages and destructive criminal activities.

'Adaptation' refers to the adjustments in the ecological, social, technical or economic systems in response to the expected or actual adverse events, potential damages caused by adverse events, or to the opportunities associated with the changes triggered by climate change (UNFCCC, 2015; UNISDR, 2009). 'Resilience' is defined by the United Nations and the US National Research Council as the ability of a system, a community or a society being exposed to hazards to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events (NRC, 2012).

In recent years, national level or sector-specific adaptation and resilience strategies and policy frameworks have been promulgated, e.g. the United States' PPD-21 Plan, EO-13636 Order and NIPP plan (NIAC, 2014); and Australian's National Strategy for Disaster Resilience (Morley *et al*., 2015).

At the local government or city level, 67 cities amongst hundreds of cities have been selected to join the Rockefeller Foundation's 100 Resilient Cities Network (www.100resilientcities.org) in order to pilot the City Resilience Framework developed by Arup. In the US, over 40 communities have created stand-alone climate adaptation plans (Woodruff & Stults, 2016). The Resilient America Roundtable, and the Community and Regional Resilience Institute are also helping local communities to strengthen their resilience to man-made disruptions, natural disasters and extreme events through various pilot programmes and information technology systems. In Asia, the Asian Climate Change Resilience Network was launched in 2008 to help Asian cities strengthen their urban climate change resilience.

Considering a community or a city as a place with a geographical boundary that is occupied by a group of individuals and organisations and functions under a jurisdiction of a governance structure, which is usually composed of interdependent components and services or capitals (Flora *et al*., 2016), a generic, systematic and multiple-paradigms policy development framework is indispensable for a community or a city to formulate and implement consistent adaptation and resilience policies, in both the horizontal and the vertical dimensions (Dow *et al*., 2013; Erisman & Ciais, 2015).

United Nations post-2015 development agenda

2015 has become a milestone for sustainable development as three high-profile international policy processes have been agreed and subsequently been converge into a single agenda — which is referred to as the 'post-2015 development agenda' — through the United Nations. The post-2015 development agenda should help address the impacts, disasters, risks and challenges brought by climate change. The agenda consists of three processes, namely the (i) Sustainable Development Goals (SDGs) adopted in September 2015 (UNGA, 2015a); (ii) Sendai Framework for Disaster Risk Reduction 2015-2030 adopted in March 2015 (UNGA, 2015b); and (iii) UNFCCC Paris Agreement established at the 21st Conference of the Parties (COP21) in Paris in December 2015 (UNFCCC, 2015). The agenda synergises the three processes and provides a collective policy framework for our society to tackle and adapt to the challenges and risks in post-2015 sustainable development (Roberts *et al*., 2015).

The SDGs containing 17 goals and 169 targets provide useful guideline for international sustainable development, such as the monitoring strategies as well as the well-balanced and integrated manners to achieving sustainable development in environmental, social and economic dimensions. Many targets in the SDGs are relevant to climate change. Besides, close to 30 targets (e.g. SDG 9, SDG 11b and SDG 13) are directly or indirectly related to disaster risks reduction, climate resilience, and resilience of a community (UNGA, 2015a).

The Sendai Framework comprises 7 global targets, 4 action priorities and a set of guidelines for the globe to reduce disaster exposure and vulnerability and enhance resilience over the next 15 years. The framework aims to mitigate the risks and losses resulting from both natural and anthropogenic adverse events. In order to prevent any interconnected risks and disasters as well as to handle the associated uncertainties, the Sendai Framework suggests members developing and adopting multi-hazard approaches, integrated measures, inclusive risk-informed decision making processes, all stakeholders engagement partnership models, and open mechanisms for information and science-based knowledge exchanging through the applications of emerging information technology like social media, mobile technology and big data (UNGA, 2015b).

The UNFCCC Paris Agreement seeks to strengthen the global response to combat climate change through a system of nationally determined country-level emission reduction targets, known as the Intended Nationally Determined Contributions, through deep reductions in global GHG emissions. The agreement aims to establish links between the mitigation, adaptation and loss and damage; to build resilience capability; to increase the ability to adapt to the adverse impacts of climate change; and to foster low carbon societies and economies (UNFCCC, 2015).

The three processes under the United Nations post-2015 agenda provide great synergies for sustainable development. Of which, one crucial step of implementing the processes is to enhance and orchestrate relevant policy interventions and instruments at various levels of governments.

Public policy cycle and NATO framework

Public policy can be defined as "*a course of action or inaction chosen by public authorities to address a given problem or interrelated set of problems*", which is composed of entwined elements: problems, goals, means and instruments, and actors and agents (Leslie, 2014). Policy-making is usually viewed as an instrumental problem-solving process or cycle which consists of five key stages: agenda-setting, policy formulation, decision-making, policy implementation and policy evaluation. Policy means or instruments mainly refer to the technical mechanisms used by governments to attain policy goals through intervening the behaviour of individuals, groups and other governments in all stages of the policy cycle (Michael, 2011).

A government can leverage a variety of resources or tools across all stages of the policy cycle to formulate, execute and evaluate policy instrument options for accomplishing policy goals. NATO is a generic framework that can be used to categorise these government resources (Hood & Margetts, 2007).

'Nodality' implies that the government is at the centre of information, social and political networks. When striving to achieve the policy targets, the government would take proactive actions, e.g. by educating citizens to change their behaviour. *'Authority'* means that governments can use the legitimate or official power to permit, prohibit, or command action of target populations. *'Treasure'* points to the fact that governments can employ monetary resources and financial incentives, e.g. funds and taxation, to maintain public goods and services, to induce targets to adopt policy-preferred behaviour, or to impose costs on targets for making changes. *'Organisation'* gives the government physical ability to act directly to achieve the policy objectives (e.g. mobilising workers or harnessing government procurement capacity).

Based on the ways in which government would use the NATO resources, i.e. either as detectors to collect information or as effectors to make impacts on the world outside, policy instruments can be grouped into different categories. Besides, instruments appraisal criteria including automaticity, visibility, intrusiveness, cost and precision of targeting should also need to be referred to analyse or calibrate different policy mixes for selecting the most appropriate instruments suitable for specific governance modes, policy contexts and contingent government resources (Michael, 2011).

AN INTEGRATED FRAMEWORK FOR ADAPTATION AND RESILIENCE POLICY CYCLE

Although the post-2015 development agenda has specified the policy goals and targets for adaptation and resilience at the international level, cities or governments would still be required to formulate their local policy instruments to fulfil the agenda requirements based on the unique characteristics of the city or the community capitals. However, they are facing great challenges in employing basic government tools for designing and implementing adaptation and resilience policies (Henstra, 2015; Vogel & Henstra, 2015); they lack comprehensive resilience knowledge, technical capacity, policy process and reference cases, not to mention about aligning with their pledges on adaptation and resilience.

Among various of approaches to the study of public policy, NATO provides a simple and elegant way to understand public policy-making. By treating government as a 'black box' and focusing on how it interacts with society, the approach could simplify and break down complex policy concepts into distinct elements, and therefore may aid the comparison of policy-making across sectors, across locations, across governance and over time, or assist the process of policy evaluation (Margetts & Hood, 2016). In the the context of resilience management and engineering, the Resilience Analysis Grid approach (Hollnagel, 2015), the resilience matrix and lifecycle frameworks (Linkov, *et al*., 2013), and the Whole Community approach (Plodinec, 2015) offer some generic guidelines for making actionable policy choices across multiple disciplines. Therefore, an integrated framework (FARP) which incorporates the policy and technical elements and merits of these approaches should be able to help a city or government conducting analysis and comparison of existing policy mechanisms and design new policy instruments to enhance adaptation and resilience capacity.

Figure 1 presents the structure of the proposed FAPR framework, which consists of nine essential steps: (i) setting local post-2015 adaptation and resilience agenda; (ii) sorting out the policy instruments relevant to adaptation and resilience from existing city governance practices; (iii) classifying the selected instruments into different categories according to the NATO model; (iv) appraising or comparing the categorised instruments qualitatively; (v) evaluating current performance and capacity of a city towards adaptation and resilience; (vi) conducting holistic policy analysis using systematic models according to different policy options; (vii) making decision for the course of actions or non-actions; (viii) implementing new or updated policies; and (ix) assessing, monitoring and calibrating the policies based on the feedback received for continuous improvement. The FARP framework should help integrate various stages of policy cycle with the adaptive, iterative and cyclical processes in order to improve the adaptation and resilience of a community or city under a social-technical system regime.

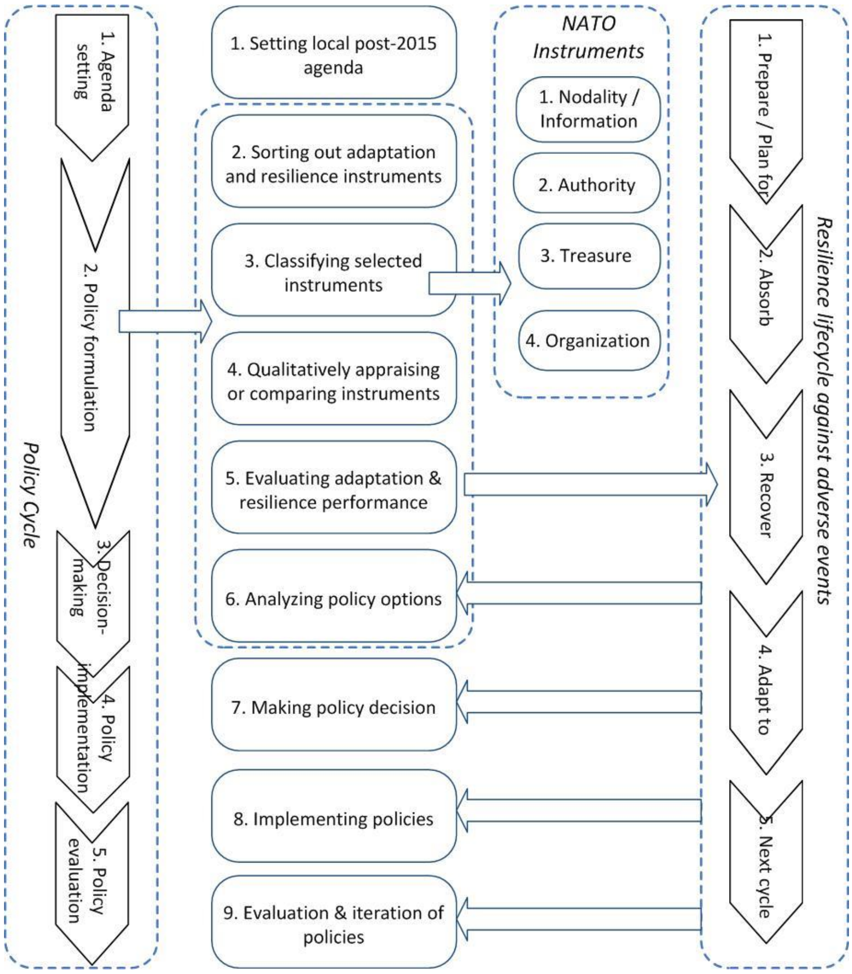

Figure 1. Schematic diagram of the FARP framework

Setting local post-2015 adaptation and resilience agenda: A global level adaptation and resilience policy agenda has been agreed and set in the United Nations post-2015 development agenda through the synergies of sustainable development, disaster risk reduction and climate change agenda. Local governments, states or cities shall refer to their nations' agenda or pledge to implement their own policies for adapting to losses and damages resulting from climate change, natural disasters and man-made threats, and preventing further impacts.

Sorting out the policy instruments relevant to adaptation and resilience from existing city governance practices: All existing policies from different government departments and agencies, or along the capital dimensions of a city (i.e. natural, cultural, human, social, political, financial and built capitals) should first be collected. These policy instruments should be filtered out through the lens of adaptation and resilience.

Classifying the selected instruments into different categories according to the NATO model: The selected instruments according to the NATO scheme and the targeting city capitals or government management sectors (e.g. water, transportation, buildings, energy, etc.) should be organised into a matrix like category map.

Appraising and comparing the categorised instruments qualitatively: Interdependency, inter-relationships and gaps of the instruments can be easily perceived and observed according to the sparseness of the established instrument map. Two or more maps can be constructed to compare the adaptation and resilience policy instruments from different cities or government departments, and this should help illustrate their commonality or otherwise the differences.

Evaluating a city's current performance and capacity towards climate adaptation and resilience: To carry out the evaluation, a city should be considered as a social-technical eco-system or a system-of-systems and its resilience should be investigated from multiple perspectives, e.g. from the perspectives of the city's abilities of monitoring, responding, anticipating and learning to tackle natural disasters and other hazards (Hollnagel, 2014). With that, a set of consistent adaptation and resilience metrics can be devised to enable stakeholders to monitor and track the progress of adaptation and resilience although the measurement can be very challenging which not only requires a set of agreed indicators, but also necessitates reliable data and algorithms (NRC, 2012). Attentions should be paid to the interdependency amongst different community capitals, and uncertainties and the cascading effects of various adverse events.

Conducting holistic policy analysis using systematic models based on different policy options: A number of models and approaches are available for policy analyses, and examples of these include the input–output analysis, game theory, cost–benefit analysis, econometric model, operations research, system dynamics, agent based modelling and complex network analysis. In today's pluralistic, open, globalised and networked society, all the contents, contexts and implications of these models shall be synergised to provide policymakers and stakeholders with information about how the system works currently and to explore the likely consequences when different policies are implemented under different circumstances in the future. The most recent policy-making approaches, such as the predict-and-act approach, expected outcomes approach, scenario analysis, exploratory modelling and analysis, dynamic adaptive approach and toolkit concept, and so on can be deployed to deal with uncertainties and complexities due to the combination of various policy instruments (Walker *et al*., 2013).

The step 7, 8, 9 of the FARP framework in Figure 1 are standardised components of general policy development cycle, with the details available in many policy science theories (Michael, 2011).

ANALYSING HONG KONG'S ADAPTATION AND RESILIENCE POLICIES

Methodology

The proposed FARP framework can be utilised in various ways by local governments with particular governance modes to analyse and compare their adaptation and resilience public policies. As a common research component of several recent projects awarded by the research team, the following step-wise approach has been designed by the authors to investigating Hong Kong's resilience policies: (i) comprehensive desktop study and general assessment of existing policy instruments related to adaptation and resilience; (ii) online / offline interviews and surveys with experts from government departments, industries, community managers and citizens to unveil their awareness on post-2015 agenda targets, adaptation and resilience; (iii) case studies by referring to relevant governmental departments and typical types of communities to examine the detailed components of existing polices such as the policy goals, actors, instruments, agents and community components (Pal, 2014). Frameworks and theories of policy process (e.g. multiple stream theory) could be leveraged to conduct the studies (Sabatier & Weible, 2014); (iv) focus group meeting with policy scientists, engineering experts and policymakers to solicit their suggestions on categorizing collected policy instruments and prioritizing Hong Kong's post-2015 development agenda goals. The results of above interviews and case studies will be presented to trigger comments from the participants; the participants will be requested to classify the policies with the NATO schema (Vogel & Henstra, 2015); and the interaction map between different post-2015 agenda goals will also be devised and organized on three, five or seven-point ordinal scale to support the decision-making on priorities of goals (Nilsson *et al.*, 2016); (v) workshop consisting of experts addresses, panel discussions and break-out sessions host by sector-specific experts to unify the adaptation and resilience concepts, develop consistent resilience metrics and evaluate Hong Kong's current capacity. The resilience matrix, lifecycle and whole community approaches are to be employed to orchestrate the discussions (Linkov, *et al*., 2013; Hollnagel, 2015; Plodinec, 2015); (vi) holistic policy analysis by a multi-disciplinary research team of domain experts and policy-makers, using systematic policy models and the obtained results and feedbacks from above activities and to identify gaps and derive new policy instruments; (vii) testing and verification of research results by transdisciplinary experts via rounds of interviews, forums and seminars; (viii) trial runs of new policy instruments at multiple government departments and typical types of communities; and (ix) next cycle of policy development.

Results

Currently, several research projects related to urban resilience of Hong Kong as well as its adaptation and resilience policies are being undertaken by the authors. As a first step of these projects, the authors have conducted a comprehensive desktop study about Hong Kong's adaptation and resilience policies using the proposed FARP framework and the methodology. The policies are collected from the websites of over 10 policy bureaux and departments of Hong Kong, as well as from the recently published government reports (HKENB, 2015a, 2015b; LEGCO, 2016). Through a general analysis to these policies and practices, the preliminary results are obtained and highlighted as follows:

(a) HK has recognised the importance of stepping up climate actions in a holistic manner and the need to draw up long-term climate policies as the city has set a target to reduce its carbon intensity by 50-60% by 2020 against its 2005 level. In addition, as China is one of the signatories of the Paris Agreement, HK is endeavouring to contribute to the national effort. Recently, an inter-departmental Steering Committee on Climate Change has been formulated to steer and co-ordinate the climate actions of various bureaux and departments and to formulate long-term city-level climate strategies and come up with a carbon reduction target for 2030 (LEGCO, 2016).

NATO / Capital	Nodality / Information	Authority	Treasure	Organization
Natural			Revamping fuel mix	
Cultural				
Human				
Social				
Political				Steering Committee on Climate Change
Financial			(1) Green Transport Fund; (2) Building Energy Efficiency Fund Scheme	
Built	(1) Energy Saving Plan for Hong Kong's Built Environment 2015 ~ 2025+; (2) Post-COP21 Green Building Imaging session; (3) Energy Saving for All campaign; (4) consultancy study on sea level rise; (5) Hong Kong 2030+: Towards A Planning Vision and Strategy Transcending 2030; (6) weather warning and alert system; (7) early storm surge alert systems; (8) BEAM Plus rating; (9) carbon labelling for construction products	(1) Building Energy Efficiency Ordinance; (2) Building Regulation; Energy Efficiency Ordinance	(1) Energy audits and energy saving practices for government buildings; (2) extend rail network and prioritize public transport; (3) promote energy efficient vehicles; (4) implement waste reduction, reuse and recycling plans; (5) build new waste treatment facilities to recover energy; (6) Landslip Prevention and Mitigation Programme; (7) drainage master plan and improvement works	(1) Energy audits and energy saving practices for government buildings and public estates; (2) Contingency Plan for Natural Disasters; (3) Inter-departmental Task Force on Emergency Preparedness; (4) Headquarters Emergency Coordination Centre of Home Affairs Department and District Emergency Coordination Centres

Table 1: Hong Kong's Existing Adaptation and Resilience Policy Instruments

(b) HK has taken various measures to combat climate change, i.e. mitigation, adaptation and resilience (HKENB, 2015a, 2015b). As illustrated in Table 1, existing programmes and policy instruments can be grouped into a matrix using community capitals and NATO schemes as the dimensions.

(c) Table 1 demonstrates that most of HK's adaptation and resilience practices are driven or led by government departments with focus primarily on the built capital. HK would be benefitted from more policies, particularly the ones on the adaptation and resilience capacity of other community capitals, as well as from that for the city or community as a whole.

(d) From the published reports, it is obvious that the HKSAR government has put 'mitigation' as an effort to reduce GHG emissions while 'adaptation' as an attempt to anticipate the impacts and prevent damages of climate change and 'resilience' as an initiative to cope with climate change related stresses (LEGCO, 2016). However, stakeholders in HK are yet to reach a consensus on the above-mentioned concepts, and there is still a lack of a set of consistent metrics to quantitatively evaluate, monitor, track and improve the city's performance towards adaptation and resilience.

(e) The desktop study reveals that the use of systematic models to analyse HK's existing adaptation and resilience policies is still very limited.

(f) HK's adaptation and resilience policies should not be limited to fulfilling the requirements of the Paris Agreement, but they should also be formulated and implemented to achieve the post-2015 development agenda goals and targets.

(g) The policy journey of HK to fulfil the post-2015 development agenda is still at an infancy stage. Therefore, education, engagement, collaboration and partnership amongst the community, government departments and private sectors are crucial if the city were to align its local agenda with the post-2015 agenda and implement holistic and consistent public policies to combat climate change.

CONCLUSION

High-density mega-cities like HK urgently need to develop tailored adaptation and resilience polices to tackle the damages and losses brought by climate change, natural disasters and man-made shocks as well as fulfilling the requirements set forth by the post-2015 development agenda. This paper proposes an integrated framework based on a well-recognised policy development model NATO and practical resilience engineering approaches. The framework should assist local government of high-density mega-cities to explore the gaps of existing practices and devise new policy instruments.

Using the proposed framework, the existing practices of HK to mitigate GHG emissions, the readiness to adapt to climate change, and the way to strengthen climate resilience are examined. The preliminary results show that certain efforts are needed for HK to examine the paths, policy alternatives and work plans to achieve the post-2015 agenda targets.

To make the proposed framework more practical, some research and development gaps should be filled, and these include the development of (i) a toolkit for policy analysis based on an ensemble of systematic models; (ii) a set of adaptation and resilience metrics; (iii) a data scheme for encoding information on community capitals; and (iv) an information technology system for appraisal and management of urban resilience.

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BUILDING BACK BETTER IN GAZA

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ABSTRACT

Building Back Better signifies the opportunity that post-disaster reconstruction presents to induce resilience into communities and overcome recurring vulnerabilities. The framework for BBB created by Mannakkara and Wilkinson recognizes that BBB requires disaster risk reduction, psycho-social recovery of affected communities, regeneration of local economy, and effective and efficient implementation of reconstruction and recovery processes.

Mannakkara and Wilkinson's BBB Framework was used to assess the recovery of agricultural businesses affected by the 2014 conflict in Gaza, Palestine. The military assault on Gaza caused extensive damages to the agricultural sector. A rehabilitation project conducted by the Agricultural Development Association (PARC) and Diakonie Katastrophenhilfe (DKH) to strengthen the resilience of 310 households and their agribusinesses and fisheries provided a unique opportunity to test the applicability of the BBB Framework in a conflict situation, and understand how it can apply to a specific sector such as agriculture.

Fieldwork was administered in Gaza by conducting focus groups with green house farmers, poultry farmers, livestock and dairy farmers, and fishery farmers. The data collected focused on: physical asset resilience; land-use; preparedness and risk reduction; community recovery; business recovery; and effective implementation.

The results from this study provided valuable insight into what is practical and effective in a complex environment like Gaza. Specific BBB indicators for agricultural business recovery in Gaza were developed from the findings to assist local farmers build back better, improve resilience and successfully recover their livelihoods.

Key words: *Build Back Better, Gaza, Agriculture, Post-Disaster, Reconstruction*

INTRODUCTION

Building Back Better (BBB) has become a prominent concept in both pre- and post-disaster management. BBB advocates for using post-disaster recovery as an opportunity to holistically improve a community's resilience (Clinton, 2006; Mannakkara & Wilkinson, 2014; Monday, 2002). BBB has been identified as one of four priority areas of actions in the United Nations Sendai Framework for Disaster Risk Reduction in the next 15 years (UNISDR, 2015).

Following the July 2014 military assault in Gaza, Palestine organisations involved in recovery operations made a decision to instil resilience in affected communities. The agricultural sector being a key economic driver in Gaza, the Agricultural Development Association (PARC) in partnership with the German NGO Diakonie Katastrophenhilfe (DKH) decided to adopt a BBB approach to the agriculture rehabilitation process.

This paper presents the outcomes of a project administered in Gaza to introduce BBB and strengthen the resilience of key agricultural businesses using Mannakkara and Wilkinson's modified BBB Framework. This paper introduces the framework, describes the project implemented in Gaza and presents the findings of focus groups conducted in Gaza to test the framework and develop BBB indicators for the project.

BUILDING BACK BETTER

"Building Back Better" (BBB) became popular as a catch-phrase particularly following the 2004 Indian Ocean Tsunami (Clinton, 2006). It was recognized that the time period following a disaster is an optimal time to make changes in a community. BBB is defined as a way to use the reconstruction process following a disaster to improve a community's physical, social, environmental and economic conditions to create a more resilient community in an effective and efficient way (Kennedy, Ashmore, Babister, & Kelman, 2008; Khasalamwa, 2009; Mannakkara & Wilkinson, 2014).

Mannakkara and Wilkinson (2014) conducted international case studies on BBB and developed a BBB Framework which was adapted for this project (figure 1).

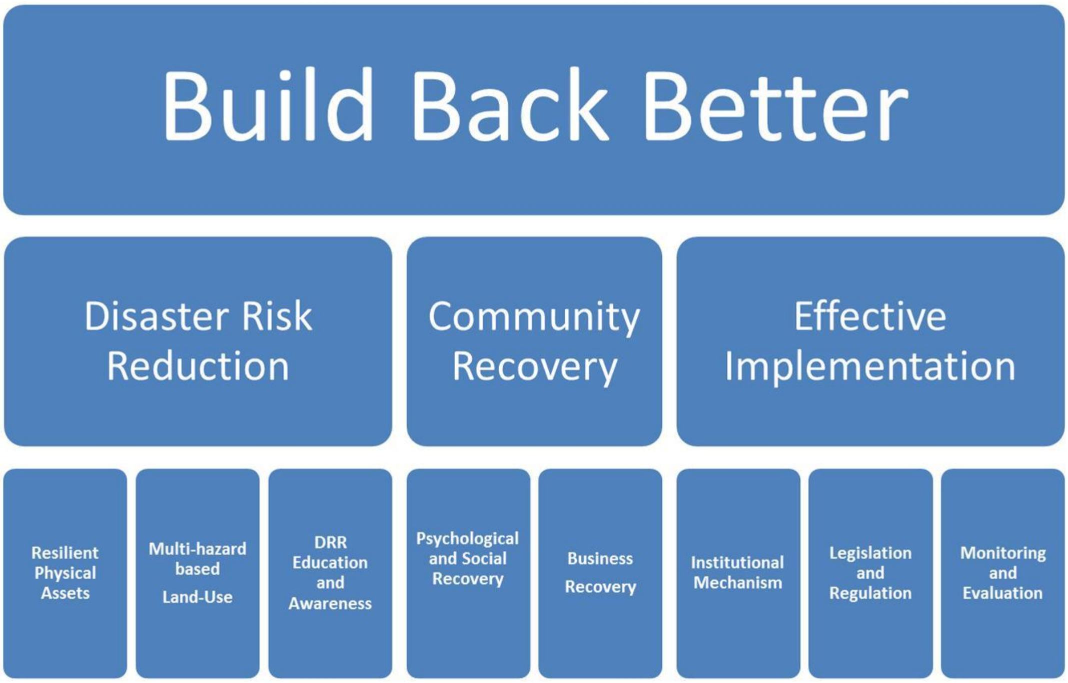

Figure 1: The Modified Build Back Better Framework (Mannakkara and Wilkinson, 2014)

The BBB Framework illustrates that building back better requires consideration for:

Disaster Risk Reduction (DRR) – Improving disaster resilience in a community by minimising/eliminating disaster risks through (1) improving the resilience of the built environment and physical assets (James Lee Witt Associates, 2005; Sandeeka Mannakkara & S. Wilkinson, 2013); (2) better land-use planning in response to risks (Batteate, 2006; Mannakkara & Wilkinson, 2012b); and (3) providing DRR education and awareness to educate communities on how to incorporate disaster capacity through early warning, disaster preparedness, evacuation and management plans.

Community Recovery – Supporting the overall recovery of the community through (1) implementing programmes for psychological and social recovery to assist the community with re-establishing their lives through advisory services, counselling and methods of empowerment (Gordon, 2009; Mannakkara & Wilkinson, 2015); and (2) regenerating and rejuvenating the community's economy by helping businesses recover, facilitating the return to traditional livelihoods, and introducing new economic opportunities (Mannakkara & Wilkinson, 2012a; McComb, Moh, & Schiller, 2011).

Effective Implementation – Enabling reconstruction and recovery to progress in an effective and efficient manner through (1) establishing an institutional mechanism that is fitting for the local community and coordinate the recovery process (Brinkerhoff, 2005; Samaratunge, Coghill, & Herath, 2012); (2) using appropriate legislation and regulation to enforce BBB-based practices and to improve efficiency by fast-tracking processes (Sandeeka Mannakkara & Suzanne Wilkinson, 2013; Rotimi, Myburgh, Wilkinson, & Zuo, 2009); and (3) putting in place monitoring and evaluation mechanisms to improve the recovery process and extract lessons for the future (Bevington et al., 2011).

INTRODUCING BUILDING BACK BETTER IN GAZA

Gaza Context

The Gaza Strip, or Gaza is a self-governing Palestinian territory. It is situated on the east coast of the Mediterranean Sea and borders Egypt and Israel. Gaza is often subject to environmental problems such as drought, desertification and water scarcity due to salination of fresh water and depletion and contamination of ground water resources. The industries in Gaza are commonly small family businesses.

Gaza was subject to ongoing military assault for seven weeks in July 2014 by land, sea and air. At least 2,145 people were killed and over 60,000 homes were damaged or destroyed (State of Palestine, 2014). The conflict created a scarcity of water, energy, food and shelter, whilst the agriculture industry in particular suffered heavily. Rapid damage and loss assessments conducted in 29 locations showed extensive damages to crop production, poultry farmers, livestock farms and fisheries amounting to nearly 23 million USD in damages and losses (PARC & DKH, 2015).

Project Information

The project "Improve food security and enhance resilience in Gaza through optimised rehabilitation of agricultural infrastructure" was implemented by PARC and DKH in 2015 with the following objectives:

Strengthen the resilience of 310 households and their businesses (100 Greenhouses, 100 Poultry farms, 60 Livestock and Dairy Farms and 50 Fisheries) against future shocks via the use of a **Building Back Better** approach in the rehabilitation process

Restore the means for minimum subsistence and improve food security for the 310 households

Rehabilitate the 310 agribusinesses and fisheries to be able to contribute to food security in the region by increasing production and supply of food products to the markets in Gaza

Introduce the **Building Back Better** approach to the agricultural sector in Gaza, with best practices shared with relevant actors and allow for possibilities of replication and improvement

The implementation of the project involved:

Conducting a Participatory Risk Assessment in Gaza by DKH (DKH & PARC, 2015)

Selection of beneficiaries by PARC

Desktop study by international BBB consultants

Field visit to conduct focus groups with selected beneficiary groups by international BBB consultants accompanied by PARC and DKH

Development of a BBB roadmap for the project including specific BBB indicators for the beneficiary groups

The Field Visit and Focus Groups
The field visit took place from Monday 28th December 2015 to Sunday 3rd January 2016 and included four 2.5 hour focus groups held with each respective beneficiary business type. The beneficiary meetings were based on having 10% of the total number of beneficiaries attending the focus groups. The central objectives and questions for the focus group discussions are shown in table 1.

Table 1: Objectives and questions for the beneficiary focus groups in Gaza (Source: Author)

Objective	**Question(s)**
Identification of the methods and technologies used for physical asset resilience	What methods, materials and techniques are you using to move on with your life and business?
Identification of land use examples and their evidence basis	How did/do you select that land you use now?
Identification of the effective education programmes and training that had been used for preparedness and risk reduction	What informal or formal training have you been given that assisted you to face risks and hazards?
Identification of community recovery within communities	How did the conflict impact on you and how did you recover?
Identification of the evidence for business recovery	How do you know that your business has recovered?
Identification of examples of effective implementation from an institutional, regulatory perspective together with monitoring and evaluation	What effective examples of implementation (at any level) are you aware of?

Findings: BBB Indicators for Gaza Agricultural Business Recovery

The findings from the desktop study, field visit and focus groups showed that the modified BBB Framework formed a good basis to assess Gaza business recovery. The results showed that the BBB indicators proposed by Mannakkara and Wilkinson for DRR, community recovery and effective implementation can be tailored to cater to the local context and nature of businesses.

Disaster Risk Reduction

Table 2 shows the DRR initiatives proposed for BBB of agricultural businesses in Gaza based on the data collected. Improving the resilience of physical assets primarily meant repairing physical damages incurred along with introducing technological improvements to the businesses. Although revising land-use based on multi-hazard assessments is a universal indicator for BBB, the beneficiaries stated that relocation was deemed an impossible and impractical option for them. The study participants however stated that minor alterations of land-use was possible such as changing the orientation of greenhouses and barns for better ventilation and adding crops to diversify the businesses. Providing DRR education and awareness was seen as most effective through involving the community in DRR activities. The community was closely involved in the participatory multi-hazard mapping exercise conducted by DKH (DKH & PARC, 2015), which was a successful example of engaging the community to utilise their knowledge, as well as raise awareness on DRR. Participatory exercises and outreach activities urge farmers and their families to think differently to protect their businesses and families.

Table 2: Disaster Risk Reduction Initiatives for Building Back Better Agricultural Businesses in Gaza (Author)

Business Type	**Improving Physical Resilience**	**Land-Use**	**DRR Education and Awareness**
Greenhouse Farmers	Repair physical damages incurred Strengthen drainage systems inside the greenhouse Use reflective sheeting over plastic Install ventilation windows Adopt insect and salt-resilient crops Use thermal disinfectants for the ground to prepare soil for next growing season Rain-water harvesting Install on-site water storage tanks	Change orientation of greenhouse	Training for new technologies, techniques and use of new equipment Facilitate knowledge-sharing in local neighbourhood and friend networks
Poultry Farmers	Repair physical damages incurred Install an efficient heating system Install effective humidity control Enable easy access to chemicals and medicine for disease prevention Access to quality food for bird stock Desalinisation of water	Change orientation of barn Plant crops in a section of land	Training for new technologies, techniques and use of new equipment Facilitate knowledge-sharing in local neighbourhood and friend networks
Livestock and Dairy Farmers	Repair physical damages incurred Provide access to secure and cost-effective barns for animals including modern technology such as steel feeders, mechanical drinking and isolation units for lambs Install better drainage and ventilation systems in barns Provide equipment and tools for safer birthing Water harvesting	Change orientation of barn Plant crops in a section of land using in-house manure	Training for new technologies, techniques and use of new equipment Facilitate knowledge-sharing in local neighbourhood and friend networks

Fishermen	Repair physical damages incurred Provide good quality spare parts for repairs Providegood quality fishing equipment including boats, nets, tools, motors etc.	N/A	Training for new technologies, techniques and use of new equipment Facilitate knowledge-sharing in local neighbourhood and friend networks

Community Recovery

The psychological and social recovery of the beneficiaries were assessed by administering the Depression Anxiety Stress Survey (DASS42) (Lovibond & Lovibond, 1996). In Gaza, PARC and DKH officers carried out the survey on 96 individual beneficiaries. The results showed that overall the depression level amongst the participants was rated mild; anxiety was rated moderate; and stress was rated normal. There were however six individuals with unusually high anxiety and one with unusually high depression. This data serves useful in determining what psychological and social interventions are required at the individual and community levels. The focus groups illustrated that the psycho-social interventions that were required and applicable in Gaza reflected international findings (table 3).

The focus groups illustrated that supporting business recovery needed to be centred on identifying businesses' recovery needs, creating immediate jobs, and supporting rapid recovery and upgrading of businesses. Modified BBB indicators tailored for business recovery are shown in table 3.

Table 3: Community Recovery Initiatives for Building Back Better Agricultural Businesses in Gaza (Author)

Business Type	**Psychological and Social Recovery**	**Business Recovery**
All	Consult and include community for DRR processes (e.g. hazard mapping, technical assessments, recovery planning etc.) Create and strengthen community/business groups and networks Keep community/businesses regularly informed of recovery plans, decisions and implementation Coordinate with partner NGOs for psychological, spiritual and/or religious support	Arrange (short-term) alternative employment options such as labour work Provide access to social support from Government Provide DRR and business recovery training Assist with the replacement of damaged physical assets Facilitate collaboration and cooperation between businesses

	Assist families to move back to their homes	Diversification of businesses

Effective Implementation

It was necessary for the farmers to understand the main actors in each business sector and their roles in the recovery process, and most importantly understand what key partnerships can assist with recovery and BBB. Therefore introducing farmers to each other to assist collaboration and cooperation, encouraging farmers to share knowledge and resources and strengthening existing community and business networks were identified as crucial BBB initiatives at the grassroots level.

Using legislation and regulation for recovery as identified by the modified BBB Framework did not come across as relevant or applicable for the beneficiaries, however it was recognized that steps should be taken at the sector level to improve recovery activities in the agricultural sector and support BBB.

Monitoring and evaluation for BBB is to be conducted by PARC and DKH by performing pre- and post-intervention surveys, undertaking regular reporting exercises to identify on-going issues and track rebuilding and recovery progress, extracting lessons learnt to modify future processes as well as design training programmes and education campaigns.

CONCLUSIONS

Building Back Better is a prominent concept in post-disaster recovery to induce resilience into communities following a disaster. Following the devastation caused in Gaza by the 2014 conflicts, there was a strong desire to introduce BBB concepts and rebuild affected agricultural businesses in a resilient manner.

Mannakkara and Wilkinson's (2014) modified BBB Framework was used in an agribusiness rehabilitation project in Gaza to evaluate the practicability of BBB. The findings showed that the framework served as a robust and useful tool to introduce and implement BBB concepts for the recovery of agricultural businesses in Gaza. BBB indicators were tailored to suit the local context and constraints and overall provide a good starting point for successful and resilient recovery.

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RESILIENT PRODUCTIVITY-PERFORMANCE CONSTRAINTS IN NEW ZEALAND ROAD MAINTENANCE AND REHABILITATION PROJECTS

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ABSTRACT

Road pavement maintenance and rehabilitation contractors (RPMRCs) face challenges inherent in performance-based rewards which seek to maximize tax dollar through whole-of-life best value in the project delivery process. To be successful, contractor's productivity and performance should remain high and resilient to internal and external constraints in the project environment. There is little research on the priority constraints to productivity and performance in the New Zealand (NZ) roading sector. This paper presents preliminary findings of a study which aimed to investigate the key productivity constraints faced by RMRCs and the associated mitigation measures. Senior managers and directors of medium- to large-sized NZ roading contracting firms were interviewed in the process of an exploratory survey. Feedabck was analysed using the multi-attribute technique.

Results revealed 70 productivity constraints faced by RPMRCs in New Zealand; In diminishing order of influence, these were aggregated into eight broad categories as follows: finance, workforce, technology/process, statutory/regulatory compliance, project characteristics, project management/project team characteristics, unforeseen circumstances, and other/ external factors.The report highlights the most influential constraints in the eight broad categories.

The findings contribute to knowledge by revealing critical factors constraining productivity performance of NZ RMRCs and the associated improvement measures. New and more enriching perspectives were provided on how contractors could leverage their limited resources to addressing the identified key constraints.

Keywords: Performance resilience, productivity, road maintenance, road rehabilitation, road pavement

INTRODUCTION

Soundly constructed, well operated and routinely maintained road network is a key facilitator of economic growth (NZTA, 2014a). This is because a well-maintained road network enhances and sustains national and regional communications in a more effective, efficient and safe manner, which in turn, helps support a thriving New Zealand.

Recent study by McPherson and Olsen (2016) suggested that the annual investment by the New Zealand Transport Agency (NZTA) in the operation and maintenance of state highway network is around $500 million, with annual rehabilitation/ upgrading costs amounting to $1.5 billion (NZTA, 2014b). Transit New Zealand (Transit NZ, 2000) reported that more than 56% of its annual budget is allocated to general maintenance, reseal and pavement rehabilitation works in order to provide an acceptable level of service to road users and to counter rapid pavement deterioration rate.

With the New Zealand road network asset currently valued at approximately $26 billion, one of the biggest concerns for decision makers in the New Zealand roading industry is on how to ensure that every dollar of investment in road infrastructure development, operation and maintenance maximizes value to the taxpayers. As a result, service providers are expected to do so much work with so little resources. Consequently, road contractors responsible for designing, constructing and maintaining the road infrastructure networks are put under enormous pressure to optimise their work in order to maximize value delivery in the process.

However, contractors who are at the forefront of road infrastructure asset development face enormous constraints that hinder their productivity and performance – and resultantly, the extent of value they can deliver. The productivity constraints have brought about major setbacks to infrastructure project delivery such as cost overruns, delays and poor quality of work (Pell et al., 2015). To help the roading contractors improve their productivity, it is therefore imperative to provide information on the constraints they face in their day-to-day project implementation role and effective ways of mitigating the constraints.

Several studies have looked at the challenges faced by contractors in the infrastructure asset delivery and maintenance. For instance, the UK's Network Rail (2014) identified issues such as capacity limitations, poor performance management and progress tracking, poor safety management, unproductive organizational culture, weather and climate as some of the constraints faced by service providers in infrastructure asset development and maintenance. Other issues included poor asset strategic planning, policies and communication, as well as supply chain limitations (Assaf and Al-Hejji, 2006). McKinsey (2013) noted that a major problem for contractors at the tendering and contract signing stage is that they take on higher risks that are disproportionate to their reward in the contract, and this often results in serious resource constraints during the implementation phase. The Controller and Auditor General's Office (2011) identified New Zealand specific challenges in public infrastructure asset development and management to include issues such as acute skill shortage, unrealistic public expectations, the fiscally constrained environment within which infrastructure asset is procured and managed, and the type of procurement and contracting strategies adopted for infrastructure development which are not necessarily the most appropriate for collaborative relationships and successful project delivery.

Though a number of studies have investigated constraints faced by roading contractors, there is a lack of prioritization of these challenges – especially in the context of the New Zealand roading sector. Are the challenges identified in overseas countries applicable in New Zealand? What specific constraints are faced by the New Zealand contractors in the road pavement maintenance and rehabilitation projects? What mitigation measures are applicable to the New Zealand roading sector? While overseas studies are robust in regards to addressing some of these questions, there is a lack of empirical study in the New Zealand context. This study will aim to contribute to bridging the existing information gap. Empirical data will comprise structured interview-based feedback provided by experienced roading contractors who were involved in road pavement design, construction, maintenance and rehabilitation projects.

RESEARCH AIM AND OBJECTIVES

The aim of the study was to investigate issues surrounding the productivity and performance of contractors handling road pavement maintenance and rehabilitation projects in New Zealand. The study also looked at practical and innovative ways of resolving the issues.

The key objectives of the study were as follows.

To identify and prioritise the factors constraining contractors' productivity and performance in the road pavement maintenance and rehabilitation (RPMR) process.

To explore measures for mitigating the identified constraints with a view to improving efficiency and productivity in the RPMR.

LITERATURE REVIEW

Productivity in context

'Productivity' is a complex concept that is interpreted in a variety of ways depending on the context and the objectives sought. From a production system perspective, Bjork (2003) defined productivity as the ability of a system to convert input resources into outputs. This efficiency perspective of productivity expresses the concept as a quantitative relationship between output and input. It does not address the effectiveness criterion, which evaluates the extent of achievement of set goals or objectives (Mbachu, 2011). Unfortunately, this efficiency perspective is widely adopted by economists. For instance, Schreyer (2001), while relaying the economists' perspective of the concept defined it as the ratio of a measure of output to a measure of resource input.

The economist's or efficiency perspective of productivity is not quite helpful to the construction industry stakeholders in terms of offering a quantitative tool for measuring and benchmarking project performance. The Statistics New Zealand (2016) corroborated the inadequacies of the efficiency-only perspective of the concept and its lack of effectiveness focus by noting that "the economist's perspective of the concept (i.e. the output to input ratio outcome) is not a measure of effectiveness because it reflects only how much extra output is produced per unit of input, not whether that input has an effective outcome. To provide a more relevant definition that is consistent with the project performance measurement and benchmarking needs of the industry, a number of authors have come up with some definitions. For instance Chan and Chan (2004) defined the concept as a measure of the extent of achievement of project goals or objectives, namely time, cost, quality and scope accomplishments.

A more holistic definition that is widely accepted – especially among construction industry stakeholders – expresses productivity in the context of performance measurement – i.e. as a measure of how well resources are leveraged to achieve set targets or desired outputs (Durdyev and Mbachu, 2011). This definition is adopted in this study as it is consistent with the research objectives.

Productivity and performance in the context of road pavement maintenance and rehabilitation – the NZTA's perspective

As the client or employer to roading contractors in New Zealand, the NZTA specified seven criteria for assessing contractors' performance of the work category they are prequalified to undertake. The seven performance criteria as set out in the Contractor Prequalification Application (NZTA, 2016) are as follows:

Quality assurance
Traffic management
Environmental management
Health and safety
Project management
Quantum or size of work
Co-operative and pro-active partnering.

Contractors are required to meet or exceed the classification level input requirements for all the above seven performance criteria as a condition to maintain the classification level for their prequalified work category. Therefore, from the perspective of the NZTA, contractor's productivity and performance is assessed based on the extent to which the contractor is able to perform in relation to the above seven criteria. As some of the criteria do not have objective measures of accomplishment and therefore require subjective assessment, it is uncertain how NZTA conducts the assessment. However, in its document that sets forth the bases for contractor payment in the Network Outcomes Contract (NZTA, 2015), it is evident that productivity and performance is largely based on accomplishment of the schedule, cost and quality targets, but with compliance of the seven criteria being constraints that must be managed to the threshold level.

Constraints in road pavement maintenance and rehabilitation projects

Identifying key constraints in improving productivity and performance in the RPMR is important so as to be able to direct available resources towards eliminating, mitigating, or transferring the risks involved (Diewert, 2001; Dunston et al., 2000). A few studies have looked at productivity constraints in road pavement maintenance and rehabilitation projects. Durdyev and Mbachu (2011) provided a holistic model of internal and external productivity constraints that is based on a global framework, 'PESTELI' (Political, Economical, Socio-Cultural, Technology, Legal/Political, and Industrial constraints). Also, internal constraints can be modeled from the scope of the '6 Ms' of the business process improvement: money/finance, management of the workforce, manpower, machinery, materials, and method process (McKinsey, 2013). Also, a study by Chan et al. (2001) listed numerous factors related to improving productivity and performance in road pavement maintenance. The authors showed that proper management of the identified potential delay factors can improve productivity rates. However, none of these studies provided a prioritized list of measures for mitigating the constraints.

Summary of review of literature and gap in knowledge

Review of literature to date has provided insights into the key concepts that underpin this research and the extent to which the research objectives have been addressed in previous studies. It was found that while several studies have been completed in the research area, few studies exist in the New Zealand context. The New Zealand roading sector is unique in many respects, such as socio-cultural dynamics, regulations, industry characteristics, and legislations. Therefore overseas findings relating to the topic may not be wholly applicable in the New Zealand context given its unique settings. In addition, the productivity constraints identified in other countries were largely unprioritised. This study will address this knowledge gap by investigating productivity constraints and improvement measures that are unique to the New Zealand roading sector. In addition, the constraints will be prioritised in order of their relative influences, so contractors can focus their limited resources on addressing those constraint factors and improvement measures having the highest impact on productivity outcomes.

RESEARCH METHOD

A two-stage descriptive survey method involving pilot and structured interviews was adopted for this phase of the study; this is consistent with the exploratory nature of the research goal (Ellis & Kumar, 2015).

Scope of data sources was limited to views expressed by senior managers and directors of contracting firms involved in road pavement design, construction, maintenance and rehabilitation in New Zealand as provided in the 30 April 2016 edition of the NZTA Register of

Prequalified Contractors (NZTA, 2016). The NZTA register provided the sampling frame for the study.

Pilot interviews

The first stage of empirical data gathering involved the use of in-depth pilot interviews conducted with experienced contractors in the roading industry. A selective and purposive sampling method (Bernard, 2011) was used to select convenience samples of senior managers and directors of contracting firms that make up the sampling frame. Participation was on the basis of willingness to grant approximately one hour for an in-depth interview. Six contractors agreed to be interviewed. These were recruited from each of the three main New Zealand cities – Auckland, Christchurch and Wellington. The aim of the interviews was to explore the key factors constraining productivity performance in road pavement maintenance and rehabilitation projects in New Zealand. Also questions were asked about the key improvement measures which the interviewees believed could enhance success in the delivery of road pavement maintenance and rehabilitation projects.

Structured interviews

An open-ended questionnaire was developed using the constructs identified at the pilot interviews. Before being used for the structured interviews, the questionnaire was pre-tested for clarity and relevance. Subsequently, invitations were extended to 60 convenience samples of senior managers and directors of contracting firms in the sampling frame who were based in Auckland, Wellington and Christchurch; the invitees did not participate in the pilot interviews and the questionnaire pre-tests. The intention was to recruit about 60 contractors who could grant quality time for the structured interview, comprising 20 from each of the three cities. The open-ended sections of the structured questionnaire served to elicit from the interviewees further constructs that were not included in the list identified during the pilot interviews.

Data analysis

The multi-attribute analytic technique was used to analyse the quantitative data obtained from the structured interviews. The use of this technique was deemed appropriate because the aim was to prioritise the relative levels of influence or effectiveness of the individual items in subsets based on the mean ratings assigned by the raters (Chang and Ive (2002). The analysis involved computing the mean rating (MR), as the average of raters' collective ratings of a variable in a subset based on the 5-point rating scale used. MR was computed as the sum of the product of each rating point (P) assigned to the i^{th} item in the subset, and the corresponding proportion of raters assigning the rating point to the item (i.e. $R_{\%}$). Mbachu (2011) provided a modified form of Chang and Ive (2002) expression for computing the mean rating as shown in Equation 1.

$$MR_i = \sum_{i=1}^{5} (P_i \times R_i\%) \quad (1)$$

Where: MR_i = mean rating point computed for the ith item in the subset; P_i = Rating point *i* ($1 \leq i \leq 5$ – for 5-point Likert scale); $R_i\%$ = Percentage response to rating point, *i*, out of the total number of respondents in the survey.

RESULTS AND DISCUSSIONS

Survey Responses

Out of 60 prospective interviewees invited to participate in the structured interviews, only 41 agreed. 39 out of the 41 provided usable responses. Two responses were discarded for being grossly incomplete. These were from two of the five interviewees who chose to complete the online version of the questionnaire rather than participating in the face-to-face or phone interviews. The survey responses confirmed that the constructs generated at the pilot interviews were robust and provided a comprehensive list of the productivity constraint factors and their mitigation measures. The few additional factors supplied in the open-ended sections of the completed questionnaire were largely re-wordings of the constructs in the list provided for rating.

Demographic Profiles

NZTA's prequalification categories of the interviewees' firms

Analysis of the demographic profiles of the interview participants showed that out of the NZTA's four prequalification categories for contractors, majority (i.e. 50%) worked for contracting firms in the road surfacing work category. Others worked for contracting firms in the categories of general road construction (40%) and bridge construction (10%). None of the participants worked for contracting firms in the routine and minor works category. The findings at this stage of the research were therefore largely influenced by the opinions of senior managers and directors of contracting firms that specialized in road surfacing jobs. The greater proportion of interviewees in this category was a positive outcome, given their direct relevance to the focus of the research.

Findings in Relation to the First Research Objective

The first objective of this study was to identify and prioritise the factors that could constrain contractors' productivity performance in the road pavement maintenance and rehabilitation (RPMR) process. Results in relation to this first objective are discussed as follows.

Broad- and sub-categories of factors constraining contractors' productivity performance

Findings from the first phase pilot interviews revealed 70 constraint factors which were aggregated into eight themes: finance, workforce, technology/ process, statutory/regulatory compliance, project characteristics, project management/project team characteristics, unforeseen circumstances, and other/ external factors. The broad categories and the sub-constraint factors are summarised in Table 1. The table also provides the sub-constraints under each broad category; these are listed in diminishing order of influence.

Table 18: Broad- and sub-categories of factors constraining contractors' productivity performance in road pavement maintenance and rehabilitation projects in New Zealand

Broad constraint category	Sub-constraints
Project Finance Issues	Inaccurate estimate Lack of collaboration between consultant & contractor Inadequate supply or high cost of needed resources: money, men, materials, & machinery Construction-phase defective or non-compliant work Under-valued work Late payments Dispute and litigation costs Lenders' high interest charges Financial capacity for the scale and complexity of work involved
Workforce	Lack of good leadership/management capability Low level of motivation/commitment Low level of skill and experience of the workforce Poor monitoring or appraisal of performance Overly long working hours with insufficient rest periods, especially during night work Inadequate empowerment (training and resourcing) Poor resource levelling Lack of experience of current job and operational conditions Workforce health issues Workforce absenteeism
Technology/ Process	Resistance to accept new technologies in road maintenance projects (include new methods & materials) Ineffective approach to road maintenance Lack of adequate training on new process and technologies Inadequate road failure detection system Inadequate IT infrastructure and application in road maintenance industry Suitability or adequacy of the plant & equipment employed Insufficient monitoring process for road failure detection
Project characteristics	Site location and environmental constraints (e.g. traffic volume, climate, subsoil, and topography) Planning & logistic issues impacting on continuous work flow (e.g. non-closure period) Un-conducive time frames within which most road works must be carried out Public notification issues (e.g. community and environmentalists' resistance to infrastructure development plans) Type of procurement adopted

	Project complexity: scale, design Relation between rehabilitation scale and plant utilisation Nature and significance of road in the road hierarchy
Project management/ Project team characteristics	Frequency of design changes/change orders/late changes Lack of sufficient planning from the outset Lack of effective communication/ clarifications of expectations among key stakeholders Relationship management/degree of harmony, trust, and cooperation between contractor, consultant, and council Lack of organisational learning: Learning from previous projects Client's overt influence on the project process Lack of proper and regular coordination, supervision, performance monitoring, and control Experience and competencies of the project team Lack of project organisational culture that supports high productivity and performance Poor project management and risk management process Poor collaboration and supply chain management, especially as it relates to "just-in-time" supply principles Supplier related issues (delays, inferior goods)
Statutory/ Regulatory compliance	Health & Safety in Employment Act Resource Management Act Local Authority Bylaws ISO 9001-Quality ISO 14001-Environmental standards Construction Contracts Act Employment Relationship Act Consumer Guarantees Act Fair trading Act
Unforeseen circumstances	Inclement weather Unforeseeable ground conditions forcing design revisions On-site accidents Natural disasters/Acts of God
Other/ external factors	Market conditions and level of competition in the industry for jobs Inflation/ fluctuations in material prices Energy crises/ rising costs Frequent changes in government policies/ legislation impacting on construction Interest rate/ cost of capital Fluctuations in exchange rate Post-construction defective or non-compliant work User/Client value perceptions Durability of completed work within the defects liability period or warranty/ guarantee Post completion deterioration rate relating to rough use In-use conditions being at variance with prior production assumption

Discussions

The following subsections present discussions on the findings in relation to the eight broad categories of constraints highlighted in Table 1.

Project finance related constraints
Table 1 shows that out of the nine subconstraint factors identified under the project finance broad category, the most influential constraint to roading contractors' productivity and performance is the problem of inaccurate estimates. This finding is consistent with Peshkin et al.

(2007) conclusion that contractors themselves cause their problems by not accurately estimating the full costs of work prior to coming up with a tender figure. Perhaps, this problem is prevalent because of the competitive tendering process that is often based on lowest conforming tender which is mostly used for public sector contracts (Lee et al., 2002).

Workforce related constraints

Ten subconstraints were analysed under the workforce broad category. The most influential is the contractor's lack of good leadership/management capability. Müller and Turner (2010) argued that poor project management capability has huge impact on project outcomes due largely to poor coordination of the various stakeholders' inputs in the project delivery process.

Technology/process related constraints

Under this broad category, resistance to accept new technologies in road maintenance projects featured as the most influential out of the eight constraints in the group. This result is in agreement with Peshkin et al. (2007) conclusion that resistance to technology-driven change is usually due to the time and resources involved in training staff on the use of new technologies or simply because contractors are not convinced that the benefits are worth the investment. This is largely on account of a short-term view of the benefits of technology.

Project characteristics related constraints

Table 1 showed that the broad category of project characteristics comprised eight constraints. The most influential in the group relates to site location and associated environmental constraints such as traffic congestion, climate, subsoil, and topography. These findings are consistent with Lee et al. (2002) statement that location-based construction logistics issues such as road restrictions and traffic volume can significantly influence productivity and performance in road maintenance projects. In addition, Phillips and Kazmierowski (2010) found that subsoil condition could have a high level of impact on productivity rate in road projects.

Project management/ project team characteristics

Out of the 12 constraints identified under the broad category of project management/project team characteristics, issues relating to frequency of design changes or late change orders exert the highest influence. This finding agrees with the conclusions of Alinaitwe et al. (2007) that late change orders – especially at critical stages of the project implementation – could slow down progress; and if the Principal to the contract refuses to accept the changes as true variation under the contract conditions, the contractor bears the full risks, which could constrain the cash flow and completion time.

Statutory/ regulatory compliance
Nine factors were analysed under the broad category of statutory compliance. Issues related to compliance with the Health and Safety in Employment Act (now called Health and Safety At Work Act 2015) featured as the most influential out of the nine subconstraints. This should be expected because of the huge penalties associated with violation under the new Act. For instance, Work Safe New Zealand (WorkSafe NZ, 2016) advised that Category 1 offence under the new Act attracts the highest penalty for a company (up to $3 million), for an officer ($600,00 or five year years in jail or both) and for an ordinary worker ($300,000 or five year years in jail or both).

Unforeseen circumstances
Only four constraints were identified under this broad category. Inclement weather was rated as the highest influential factor among the four constraints. The New Zealand Standard 3910 includes inclement weather as part of conditions for variation entitlements only if a reasonable contractor is not able to foresee the weather pattern during the weather-constrained period of work; however the variation entitlements are not an option under lump sum fixed price contracts with no allowance for contract adjustment.

Other external factors
Eleven factors were identified under this group, with the highest influencing factor being issues relating to market conditions and level of competition in the industry. This finding should be expected given that the New Zealand construction industry in general is prone to boom-bust cycle which has been identified as one of the greatest problems hindering productivity and growth of the industry (Academy of Constructing Excellence New Zealand, CAENZ, 2015). The issues stemmed from cash flow problems associated with under-pricing during periods of stiff competition or resource problems associated with taking on too many jobs beyond company's resource capacity during the boom phase.

Relative levels of impact of the broad categories of constraint factors on contractors' productivity and performance
Table 2 presents the result of multi-attribute analysis of the participants' ratings on the relative levels of impact of the broad categories of constraint factors on RPMR contractors' productivity and performance. The table shows that out of the eight broad constraint factors, only the workforce constraint category was rated as being 'High' with a mean rating of 3.45. In diminishing order of impact, the following six constraint categories were rated as being 'Moderate': Project management/project team characteristics, project characteristics,

project finance, technology/process, unforeseen events, and statutory compliance.

In many respect, this result is not consistent with related findings in previous studies. For instance, Lee et al. (2002) and Peshkin et al. (2007) concluded that cash flow or project finance – being the lifeblood of the business – has the potential to exert the most profound influence on productivity and performance of contractors handling public and private sector projects. Also statutory/ regulatory compliance issues should have received very high rating given the increasingly over-regulated environment within which contractors operate in New Zealand, especially in relation to the new Health and Safety At Work Act 2015.

Perhaps, the perception that workforce related issues encapsulate all other issues could contribute to this result. For instance, statutory penalties occur when workers fail to do what they are supposed to do in terms of adhering to the specified compliance standards for the work. Cash flow or financial issues arise when workers fail to be prudent in their work processes or involve in excessive wastage, shoddy work or idleness.

Table 19: Relative levels of impact of the broad categories of constraint factors on contractors' productivity and performance

Broad categories of constraint factors	Ratings on relative levels of impact					Mean rating (Eq.5)	Level of Impact	Responses
	Very Low	Low	Moderate	High	Very High			
1. Workforce	2.6% (1)	10.5% (4)	36.8% (14)	39.5% (15)	10.5% (4)	3.45	High	38
2. Project management/ project team characteristics	0.0% (0)	10.8% (4)	54.1% (20)	27.0% (10)	8.1% (3)	3.32	Moderate	37
3. Project characteristics	0.0% (0)	15.8% (6)	44.7% (17)	36.8% (14)	2.6% (1)	3.26	Moderate	38
4. Project finance	7.9% (3)	26.3% (10)	34.2% (13)	23.7% (9)	7.9% (3)	2.97	Moderate	38
5. Technology/process	2.6% (1)	26.3% (10)	47.4% (18)	21.1% (8)	2.6% (1)	2.95	Moderate	38
6. Unforeseen events	2.7% (1)	40.5% (15)	32.4% (12)	16.2% (6)	8.1% (3)	2.86	Moderate	37
7. Statutory compliance	15.8% (6)	21.1% (8)	31.6% (12)	28.9% (11)	2.6% (1)	2.82	Moderate	38
8. Other external forces	24.3% (9)	35.1% (13)	27.0% (10)	8.1% (3)	5.4% (2)	2.35	Low	37

Findings Related to the Second Objective

Table 3 presents findings in relation to mitigation measures for addressing the identified constraints faced by RPMR contractors.

Table 20: Measures for improving productivity in the road maintenance and rehabilitation projects

	Constraint mitigating/ productivity Improvement measures	Response	Mean rating	Remarks
1	*Planning*: Proper planning should be done upfront to establish the benchmarks for downstream performance reviews and progress update; also provide plans for other challenges such as risks for statutory compliance (health and safety, environmental impact, traffic management, etc)	40	4.78	Very high
2	*Funding/ resourcing*: Provide adequate funding and cash flow to ensure good progress and quality of work; ensure adequate level of resources to suit work demands and optimise efficiency and utilisation (i.e. not too much or too little plant and people resource)	39	3.98	High
3	*Scheduling*: Proper scheduling of operations to smoothen peaks and troughs in resource demand in line with resource ceilings/ capacity. Schedule work to minimise impact of weather; e.g. weather affected works should not be planned in winter	38	3.88	High
4	*Communication*: Ensure effective communication network to permit adequate information flow for clarity and prompt decision-making and to minimise duplication of efforts due to communication gap to the 'frontline' people.	38	3.73	High
5	*Worker empowerment through engagement*: Involve all those that will implement the project in the planning and decision-making process so everyone knows the goals and expectations and can take ownership and commit to overall outcome achievement, as well get updated on changes.	38	3.68	High
6	*Teamwork/ collaboration through coordination*: Use good coordination skills to foster collaboration among key stakeholders - client, contractor, consultants, suppliers, etc - to work collaboratively and ensure maximum value delivery from design through production and construction to operation and maintenance.	40	3.63	High
7	*Procurement and contract strategies*: Clients should rethink preference for lowest price conforming tenders and traditional system approaches to more collaborative procurement and contract strategies that focus on life cycle value and win-win outcomes for all stakeholders.	37	3.59	High
8	*Skilled workforce*: Ensuring only qualified and experienced workers are employed to mitigate poor quality of workmanship and accidents on sites	38	3.55	High
9	*Staff training*: Provide adequate training programme to update and broaden staff skills on current best practices and trends, e.g. new occupational health and safety requirements on site. Up-skill the people making the decisions – i.e. engineers, clients and contractors.	39	3.52	High
10	*Early contractor involvement*: Encourage early contractor involvement in the design and planning and planning phase to ensure buildability and more innovation that can reduce costly and time-consuming variation and rework associated with design solutions not aligning with practical site	36	3.49	High

	conditions.			
11	*Supervision*: Proper supervision of the workforce to minimise idle time, poor productivity and work progress	38	3.46	High
12	*Project review and experiential learning*: Revisiting completed projects and learning from mistakes or better ways of achieving things outside the square -	36	3.44	High
13	*Innovation and win-win outcomes*: Minimise red-tape and bureaucracy in decision-making processes; encourage innovation and share equally any associated rewards for cost and time savings among contributors.	36	3.42	High
14	*Staff motivation*: Provide adequate incentives to motivate staff for peak performance	38	3.40	Mod
15	*Information technology (IT)*: Integration of IT in the work processes to improve efficiencies, productivity and performance, using minimal resource inputs.	37	3.38	Mod
16	*Technical and management competencies of decision-makers:* Improve technical/practical knowledge and management capability of road authority engineers & consultants to align their decisions to practical realities and in line with contractors' innovative processes for optimum productivity and outcomes.	39	3.37	Mod
17	*Outcome- rather than process-focused*: Focus on outcomes rather than process to avoid the current practice of missing the goal and 'covering of tracks just in case things might go wrong'	38	3.35	Mod
18	*More competitive market structure*: Resolve oligopoly to improve efficiencies through fostering competition and innovation. Encourage smaller work packages to enable small to medium competitors to compete for jobs rather than having gigantic projects that only the few big companies have capacity to compete for, which excludes the majority of the SMEs.	37	3.34	Mod
19	*Minimising over-regulation*: Minimise regulatory and statutory controls that inhibit innovation and creativity towards efficiencies and productivity. The regulators should be in partnership with the service providers, get on-board and work as teams, guiding each other along the way rather than waiting for mistakes and passing on blames.	35	3.33	Mod

Table 3 shows that none of the 19 mitigation measures identified during the pilot interviews was perceived as being ineffective for mitigating productivity constraints in the road pavement maintenance and rehabilitation projects. However, only one mitigation measure – i.e. proper upfront planning – was perceived as having ‘Very High’ level of effectiveness. This result is consistent with Alinaitwe et al. (2007) conclusions that proper planning which is based on accurate project data at the onset could prevent problems encountered at critical stages of the project implementation. This is because plans developed upfront provide the benchmarks for downstream performance measurement. It is surprising, though, to note that planning is superior to adequate funding and cash flow as productivity constraint measure. This contrasts with the findings of other authors such as Mbachu (2011) to the end that, as the lifeblood of the project execution process, cash flow is the key driver of success or failure in project delivery. Perhaps the study participants rated planning as the most effective mitigation measure on the understanding that proper planning should address all other issues including cash flow and resourcing.

Broad categories of the constraint mitigation measures
As an outcome of thematic analysis, the 19 sets of constraint mitigation measures presented in Table 3 were clustered under five broad categories. Figure 1 highlights the broad categories as technology/ process, human resources management, leadership/ project management, contract and financial management and external measures. Leadership/ project management should be the most effective mitigation measures since this cluster comprises the most effective mitigation measures presented in Table 3. This is consistent with KPMG's (2013) advice that the role of project leadership is to formulate a robust project delivery strategy; this typically drives every other aspect of the project including quality of design, cost construction and project completion date.

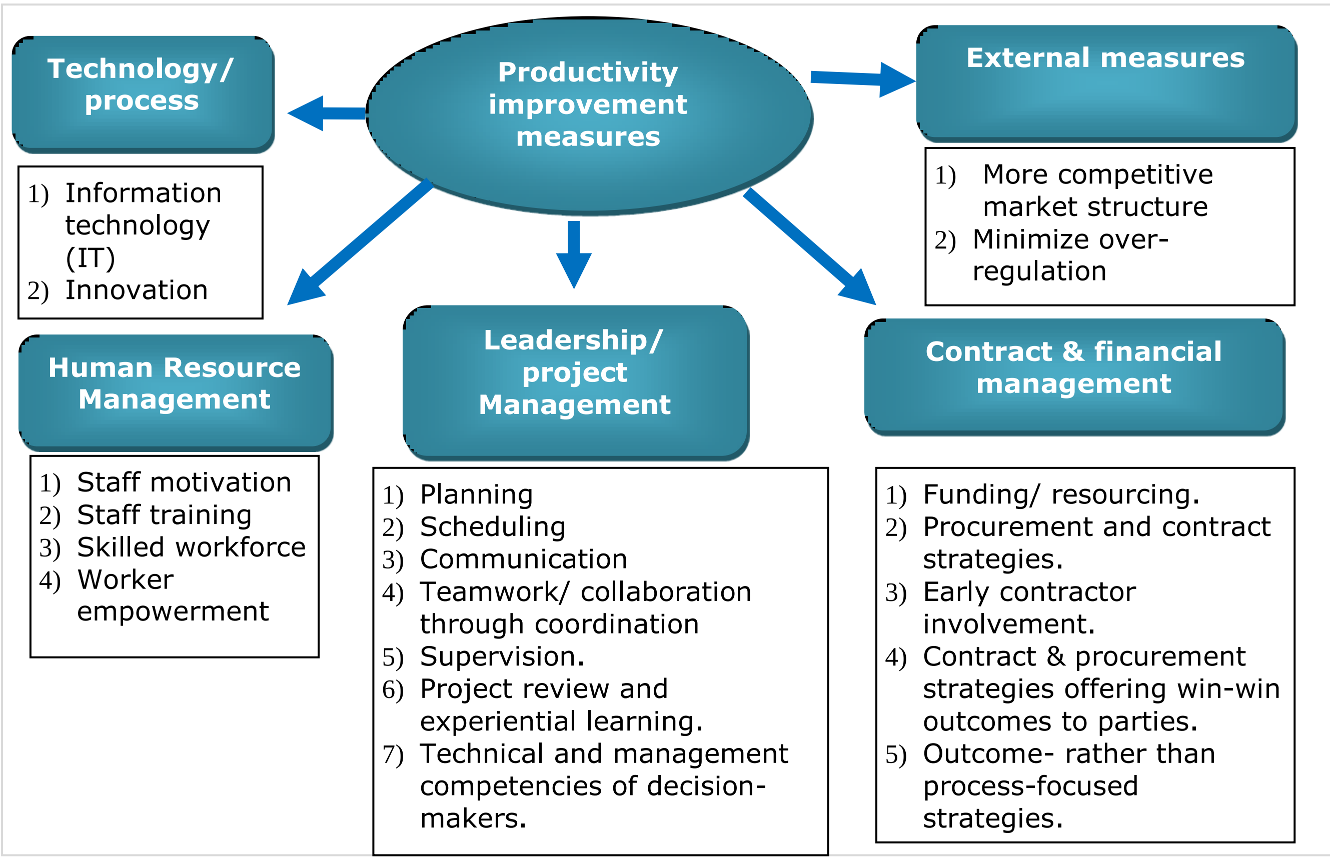

Figure 15: Measures for mitigating constraints and improving productivity and performance in the road pavement maintenance and rehabilitation projects

Extra suggestions

In the open-ended sections of the questionnaire, the interviewees provided extra suggestions for mitigating constraints and improving productivity and performance of the contractors in the road pavement maintenance and rehabilitation projects. The unedited suggestions are as follows.

"Currently jobs have to be milled, filled, and finished in one day. This means for every site you need a traffic management team, milling, and paving crew. If you could have independent milling and paving crews, you could double the output. Each crew could mill or pave for 8-10 hours per shift, instead of 4-6 hours each. The number of crews could be reduced and cost per ton laid would be significantly reduced".

"Allow for greater disturbance to public in order to have projects completed more efficiently and cheaper. Timing and availability of road closures is important - if we had full closures we could complete a whole lot more work".

"Across the board realisation that financial difficulties on smaller to medium contractors (i.e. not the big four main contractors in NZ) are reducing actual competition in the industry (which helps the big four). Genuine competition needs to occur and packages that suit contractors other than the big four need to be considered. Large companies are underbidding maintenance contracts to remove local competition".

"Use of more effective and efficient materials: e.g. use more SBS modified binders in place of current materials; and emulsion based products in place of current products".

"Use of partnering in the project procurement to achieve win-win outcomes for all".

CONCLUSIONS

This study aimed to investigate the priority constraints road pavement maintenance and rehabilitation (RPMR) contractors face in New Zealand (NZ) as well as strategies for improvement. Preliminary findings of interview-based qualitative survey of medium- to large-sized roading contractors in NZ revealed 70 productivity constraints which were aggregated into eight broad categories as follows: finance, workforce, technology/process, statutory/regulatory compliance, project characteristics, project management/project team characteristics, unforeseen circumstances, and other/ external factors.

Result of multi-attribute analysis of the relative levels of influence of the broad constraint categories on RPMR contractors' productivity and performance shows that only the workforce related constraint category was rated as being 'High' on a 5-point influence rating scale. In diminishing order of influence, the following six constraint categories were rated as being 'Moderate': Project management/ project team characteristics, project characteristics, project finance, technology/process, unforeseen events, and statutory compliance. Other external factors were perceived as being of low influence, indicating that the bulk of the constraints faced by the contractors stemmed from sources internal to the project environment.

Nineteen sets of measures were identified for mitigating the productivity constraints with a view to improving the contractors' productivity and performance. The most effective measure related to proper planning at the outset. The 19 sets of constraint mitigation measures were clustered under five broad categories, comprising technology/ process, human resources management, leadership/ project management, contract and financial management and external measures. Leadership/ project management was found as the most effective set of mitigation measures since this cluster comprises the majority of mitigation measures that received 'High' to 'Very high' ratings.
The findings have advanced existing knowledge by revealing critical factors constraining productivity performance of RPMR contractors in New Zealand, as well as effective measures for improvement. The key limitation of the findings at this stage of the research is that it is based on feedback from a limited number of participants which were not representative of the potential participants in the sampling frame for the study. As a result, the findings cannot be reliably generalised beyond the scope of the data used. Further research on the subject is recommended to ensure that representation of the views of the individuals and companies that comprised the sampling frame is achieved. The current findings will provide the starting point for the future research.

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ANALYSING DROUGHT RESILIENCE THROUGH THE COMMUNITY CAPITALS FRAMEWORK: CASE STUDY; EASTERN CAPE, SOUTH AFRICA.

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ABSTRACT

Drought remains one of the disasters impacted most people in the world. The current drought experienced in southern Africa, Ethiopia, Kenya and Australia again illustrates the importance of drought risk reduction through the development of drought resilience strategies. The United Nations Secretary General recently proposed an A2R climate resilience strategy during the most recent COP 21 in Paris, France. The A2R strategy highlights the importance of (i) Anticipate, (ii) Absorb, and (iii) Reshape. The shift in focus from climate change to climate resilience emphasise the acknowledgement that we as humans might not be able to stop climate change and that we should focus on the resilience of society and systems to climate shocks. Droughts are expected to occur more regularly and might be more severe than previously and the need to adapt and to build resilience is now greater than ever. Africa is especially vulnerable to dry periods and food insecurity is currently a reality in many parts of Africa.

This research provides a drought risk assessment framework with the hazard (metereological impact) and eight community capitals as basis of assessment. The framework was developed and applied in the Easten Cape province in South Africa as part of a larger drought risk assessment research project funded by the Water Research Commission (WRC) and the National Department of Agricultute Forestry and Fisheries (DAFF).

Meteorological data for 80 years was used to calculate the Standard Precipitation Index (SPI) and drought severity for 220 quaternary catchments. These values were used in the risk assessment equation that also considers eight community capitals for each catchment, namely (i) human, (ii) cultural, (iii) social, (iv) economic, (v) natural, (vi) infrastructure, (vii) institutional, and (viii) political.

Research methods such as Rapid Rural Appraisal, group discussions and expert inputs contributed to the indexing of all indicators on a likert scale of 1 -5 and the weighting of the different indicators as well

as the eight capitals. These values were then combined with the hazard index, which then provide us with a drought risk index for all 220 catchments.

INTRODUCTION

Droughts have a devastating effect on livelihoods, agricultural systems, and economies. Drought is the disaster in Africa affecting more people than all other natural disasters combined. The 2015 drought in southern Africa was partly the result of the lowest average annual rainfall for the region. However, the 2015 drought was exacerbated by poor governance prior and during the drought. Critical water infrastructure was not maintained. Development planning did not consider the rapid population growth and population movement and the country now also face food insecurity for the first time during the past 80 years. The agricultural sector specifically incurs millions of dollars in losses every year. For example, the direct mean annual loss (MAL) to the extensive livestock sector in the Northern Cape alone is in the excess of 40 million dollars (Jordaan, 2011).

Most people in agriculture acknowledges climatic extremes and the fact that future dry periods is a given. It is just a matter of when and how severe. The challenge though, is to prevent dry periods from developing into disaster droughts (Ribot, 1996; Wilhite, 2000; Dercon & Porter, 2007; IPCC, 2007, Jordaan, 2011; Jordaan, 2014). Important is the vulnerability and the resilience of the agricultural sector as key factors in drought prevention and mitigation. Jordaan (2011) highlighted the critical role of vulnerability and resilience in drought risk management. One cannot assess drought risk by looking at precipitation, evaporation and transpiration alone (Wilhelmi, 2002; Wisner *at al*., 2004; Gbetibouo & Ringler, 2009, Jordaan, 2012; Jordaan, 2014; WRC, 2015). These are variables used for the hazard assessment and not total drought risk. Hazard assessment is only one part of the risk assessment equation (Wisner et al., 2004; Jordaan, 2011; Jordaan, 2014; WRC 2015).

Vulnerability and resilience are key to any disaster risk assessment and should always be assessed in relation to a specific hazard (drought in this case) (Ribot, 1996; Wisner *et al.,* 2004; Dwyer *et al.*, 2004; National Drought Mitigation Centre, 2010; Jordaan, 2014). Already during the 1980s, Easter, Hufschmidt & McCauly (1985) proposed the integration of socio, environmental and economic factors in watershed management. Currently, much research focus on climate change and future climate scenarios, yet very little work is done on the vulnerability of the agricultural sector and communities and more specifically in the extensive livestock sector toward climate change (Jordaan, 2011). Gbetibouo & Ringler (2009) reported on the vulnerability of the South African farming sector to climate change and they mention the lack of vulnerability assessments at regional level as one of the major gaps in climate risk assessment. Any drought strategy should consider the vulnerability and resilience to droughts amongst all role players in agriculture (Wisner, Blaikie & Cannon, 2004; Van Zyl, 2006, Jordaan, 2011).

Jordaan (2011) highlighted the difference between commercial farmers and communal farmers in terms of drought impact. South Africa consists of two agricultural systems; a technologically advanced commercial sector and a largely subsistence, poor, communal and small-scale farming sector. The commercial farming sector is primarily responsible for surplus food production with the communal sector mainly providing livelihoods for more than 1,29 million families in South Africa. Communal subsistence farmers for example experience normal dry periods as droughts simply because of (i) the lack of adaptive and coping capacity, (ii) imperfect markets and additionally the result of ill-defined property right systems, which lead to (iv) increased land degradation and (v) over-grazing. The climate affecting them is the same as for the rest of commercial farmers yet the vulnerabilities and coping capacity differ dramatically (Jordaan, 2011).

In order to fully understand the complexity of drought risk, one need to understand all the factors contributing to drought. Drought risk is not only the result of below average rainfall or climate change. This is exposed in a Water Research Commission (WRC) funded research project currently underway in the Eastern Cape province in SA (WRC, 2015).

RESEARCH OBJECTIVE

The results discussed in this paper is part of a larger Water Research Commission (WRC) funded project to conduct a drought risk assessment for rainfed agriculture in three district municipalities in the Eastern Cape province in South Africa. This paper only deals with the risk assessment methodology

STUDY AREA

The Eastern Cape is one of the regions most suitable to compare drought vulnerability, adaptation, coping and resilience of commercial and communal subsistence farmers because of the historical demarcation of the former homelands, Transkei and Ciskei. Large areas in the Eastern Cape are still managed by Chiefs with mainly communal property right systems. These areas are entwined with well-planned commercial farms with well-defined property right systems. The Eastern Cape also covers different rainfall zones with Aliwal North at the north-west and Queenstown/East London/Port Elizabeth at the east.

The Eastern Cape (EC) is one of the nine Provinces in South Africa (SA) and borders Kwa Zulu Natal (KZN), Free State (FS) and Lesotho to the north, Northern Cape (NC) and Western Cape (WC) to the west. The Indian Ocean covers the southern and eastern border of the province (See Figure 1).

FIGURE 1: PROVINCIAL BORDERS IN SOUTH AFRICA.

The province boasts with natural beauty that includes temperate forests, rolling landscapes of hinterland, semi-desert areas of the Karoo to the west and beautiful and unspoiled coastlines to the east. The north-east of the province touches the southern tips of the Drakensberg mountain series while mountains and foothills are common in the southern parts of the province. The coastal region in the east is temperate with high rainfall areas to the northern coastal region (Province of the Eastern Cape, 2010).

The total area of the EC is 17,1 million ha of which 86,8% or 14,8 million consist of farm land. Six comma nine percent or 1,2 million ha is arable with 13,6 million ha available for grazing. Three comma seven percent or 623 400 ha is conservation areas with 140 000 ha under forestry and 1,49 million ha or 8,7% of the land in the province is used for other purposes.

Agriculture in the EC is classified as commercial and developing or subsistence and small-scale. The number of commercial farmers declined by nearly 10% between 2002 and 2007 from 4 376 to 4 006. The EC have the second largest number of subsistence and communal farmers after Kwa Zulu Natal with 310 400 farmers; that is 24% of the 1,29 million subsistence farmers in SA. Two thirds of the population in the EC lives in rural areas and agriculture is an important factor in the development of people's livelihoods in the EC. Six hundred and forty three thousand households or 37,3% of total households in the EC are involved in agricultural activities. Of these 48,5% are involved in livestock production, 54,3% in poultry production and 60,5% in grains and food crops – mostly for subsistence – and 34,2% in fruit and vegetables (AgriSETA, 2010).

RESEARCH METHODOLOGY

Both deductive logic and inductive reasoning were applied to analyse the data and to make conclusions. The study relied on a comprehensive literature study for the gathering of secondary data. A combination of techniques, both qualitative and quantitative were applied to obtain primary data. Structured questionnaires, individual interviews with experts, extension officers and farmers and as well as group discussions were used to obtain primary data and inputs. More than 350 farmers and 200 extension officers participated and provided inputs into the research.

The drought risk assessment methodology as proposed by Jordaan (2011) was initially used as a basis for drought risk assessment. This was later adapted to the risk assessment methodology as discussed in this paper.

METHODOLOGY FOR DROUGHT RISK ASSESSMENT

Although rainfall or the lack of rainfall is regarded as the main indicator for drought and most of the known indices are related to rainfall, the impact of drought and the way in which the affected sector can withstand the negative impacts of a dry period becomes the decisive factors when analysing drought risks (Wisner *et al*, 2004; Jordaan, 2011; Jordaan, 2014). Social, environmental and economic indicators are interrelated. For example the deterioration of the environment has a direct impact on the productivity of animals on the veld, which then impacts economically on the farmer. Because of economic stress the farmer then experiences the social impact of the disaster. If the farmer is not in a position to support the farm workers anymore the economic impact is then translated to the farm workers, and has a social impact on them. The same impact is experienced in the village or town where the local economy to a large extent depends on the well-being of the farmers.

The well-documented equation "*R=HxV/C*" as proposed by Wisner *et al* (2004) indeed argued for the socio-economic and environmental indicators for both vulnerability and coping capacity. This research however, proposed a more detailed classification of indicators according to the community capitals framework (CCF) as proposed by Flora & Flora (2010) and adjusted for this research.

The adjusted CCF provides a more detailed framework and is used to calculate resilience, meaning that indicators are grouped under (i) human capital, (ii) social capital, (iii) cultural capital, (iv) institutional capital, (v) political capital, (vi) financial capital, (vii) infrastructure capital, and (viii) environmental capital. The drought risk equation was then simplified to:

DR=H/Res

Where: DR = Drought risk
H = Drought Hazard (meteorological indicators – SPI)
Res = Resilience against drought

Where: $\text{Res} = \sum_{i=1}^{8} w_i C_i$

And

$$Res = f\left(w_1^{hum} C^{hum}, w_1^{soc} C^{soc}, w_1^{cult} C^{cult}, w_1^{pol} C^{pol} w_1^{inst} C^{inst} w_1^{fin} C^{fin}, w_1^{inf} C^{inf}, w_1^{env} C^{env}\right)$$

where: C^{hum} = Human capital coping/resisting drought hazard
C^{soc} = Social capital coping/resisting with drought hazard
C^{cult} = Cultural capital coping/resisting drought hazard
C^{pol} = Political capital coping/resisting drought hazard
C^{inst} = Institutional capital coping/resisting drought hazard
C^{fin} = Financial capital coping/resisting drought hazard
C^{blt} = Infrastructure capital coping/resisting drought hazard
C^{env} = Environmental capital coping/resisting drought hazard
w_i = Weight of indicator *i.*

Weighting of indicators and the capitals is important in the context of this research since composite indicators in most cases should bear a higher weight than individual indicators and the importance of all the capitals are not equal. Dwyer *et al.* (2004) reported that weight indicator values are determined according to subjective perceptions of the importance of some indicators. Davidson (1997) comes to the conclusion that *"no amount of clever mathematical manipulation will uncover the correct weights for social vulnerability indicators, because no single correct set of weights exists a priori"*. Some weighting techniques are derived from participatory methods such as analytical hierarchy processes (AHP) and budget locations; other methods include statistical models; a combination of statistical models and expert judgments; others from correlation analyses and problem tree analyses. Weighting can be very subjective in the absence of adequate data and proper modeling, but previous studies found that weights based on experience of the researcher as well as inputs from experts in most cases were better than applying no weights at all

(Dwyer, 2004; Damm, 2010; Jordaan, 2011). In the context of this research, weights were allocated arbitrarily after consultations and inputs from experts and affected farmers themselves. Selection of indicators and weighting was based on the following considerations:

Relevance of indicator
Impact and importance of indicator to vulnerability or resilience
Composite of single indicators (composite indicators have higher weights)
Data accuracy
The ability of an indicator to predict impacts that can be averted by management practices
Variability in response
The importance of the indicator to provide a basis for policy changes and action plans
The influence of the indicator to provide a basis for comparison across time and space

In confirmation of Dwyer *et al.* (2004), the researchers' experience and first hand knowledge of the topic attributed to the comfort of allocating weights (Jordaan, 2011). Dwyer *et al.* (2004) and Jordaan, (2011) mentioned the importance of experience and expert knowledge as prerequisites for weight allocation. The allocation of weights reflected the relative importance of each indicator, and that was discussed with and tested on farmers and other experts. Allocation of weights were tested by repeating weight allocation several times with the same respondents. Each new allocation was compared with the previous allocation in order to determine consistency. The method of repeated weighting ratifies the correctness of the arbitrary allocation and prevents impulsive decisions. Finally the weighting should provide an accurate result (Jordaan, 2011)

RESULTS

Deviation of precipitation from the mean expressed as the SPI value was used as the preferred index for drought risk assessment in this study. The most influential factors contributing to the hazard rating in this study are exceedence probability, intensity and duration. The 12-month SPI was used as the hazard index for drought hazard. SPI <-1.5 is an indication of severe drought whereas SPI <-2 indicates extreme droughts. The assumption of drought based on a specific SPI value or any other meteorological indicator for that matter, must be challenged since vulnerabilities and drought impacts differ from region to region, from system to system or from community to community. Communal farmers farming on degraded land with no resources, for example, are much more vulnerable to dry periods of SPEI<-1.5 and might experience *man-made-droughts* already at SPEI<-1.2.

We calculated drought severity according to the method proposed by McKee *et al.* (1993) as follows:

$$DM = -\left(\sum_{j=1}^{x} SPI_{ij}\right)$$

where j starts with the first month of the dry period and continues to increase until the end of the dry period (drought) (x) for any of the *i* time scales. The DM (dry months) has units of months and will be numerically equivalent to dry period duration if each month of the dry period with SPI = -1 (McKee *et al.,* 1993). The logic behind the use of magnitude or severity as a measure of drought is that the longer the dry period persists without a water recharge, the worse the magnitude is, as evapotranspiration continues to occur (McKee *et al.,* 1993).

McKee *et al.* (1993) calculated drought hazard by multiplying exceedence probability with drought severity to determine drought hazard as follows:

$$D^H = P^{SPI<-1.5} x D^S$$

where: D^H = Drought Hazard
$P^{SPI<-1.5}$ = Exceedence probability for SPI <1.5[6]
D^S = Drought Severity

Drought severity is then calculated for each period with 12-month SPI by combining the duration or dry-month period with the intensity of the drought. For example, the area on the SPI graph below SPI -1.5 for a given period represents the drought severity. Therefore: Drought severity = Duration x Intensity

$$D^S = T^{SPI<1.5} I^{SPI<-1.5}$$

where: D^S = Drought Severity (magnitude)
$T^{SPI<-1.5}$ = Number of dry-months with SPI < -1.5
$I^{SPI<-1.5}$ = Intensity of dry period with SPI <-1,5

The above-mentioned methodology was applied to calculate drought severity for the total period of measurement for all catchments. Through these calculations the sum of severity could be calculated and used as an indicator for the drought hazard.

Severity sum was calculated for all quaternary catchments. The sum of severity was indexed on a scale of 1 to 5 and the drought hazard profile was developed for the three districts, Cacadu, Joe Gcabi and ORTambo. See Figure 2.

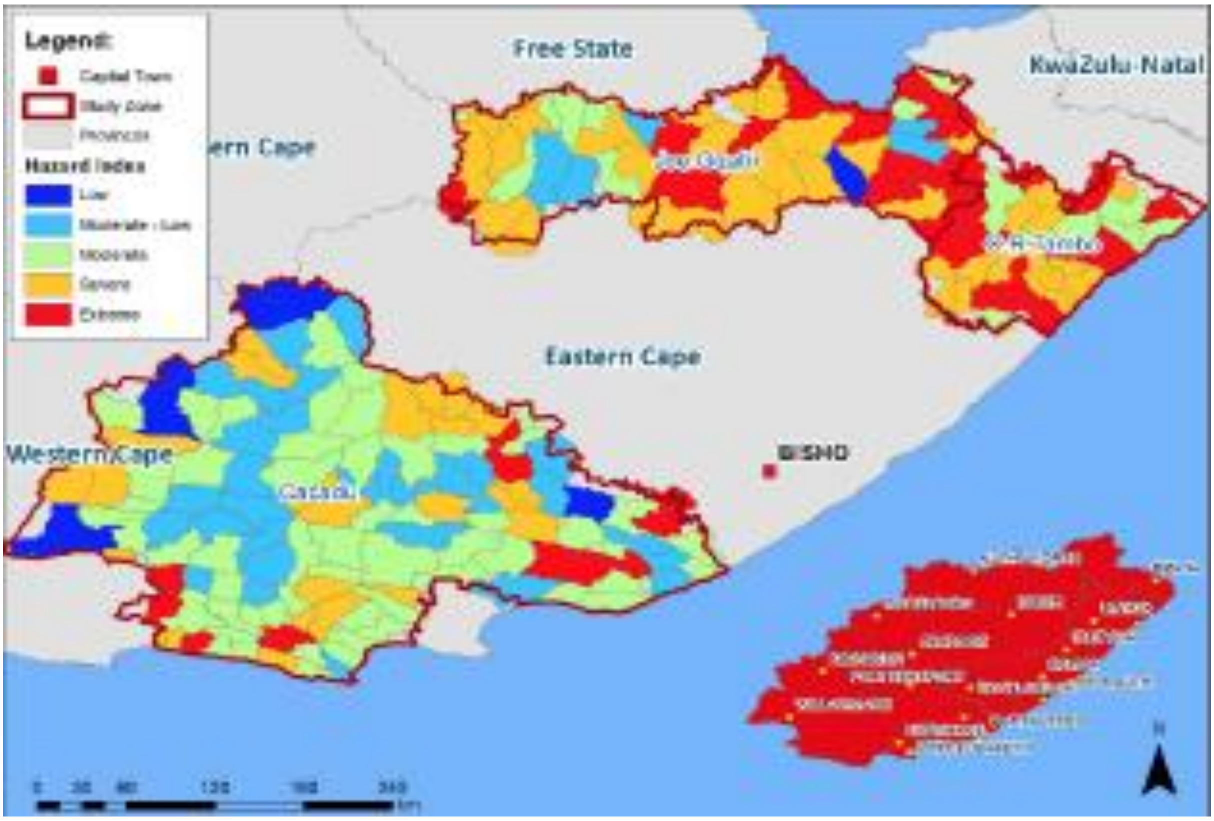

FIG. 2. LIVESTOCK SECTOR DROUGHT HAZARD MAP FOR EASTERN CAPE

This map only shows the probability and intensity of dry periods based on historical meteorological data. More important for future forecasts for decision-making and policy adjustments is the assessment of the impact of droughts and lack of drought resilience that causes dry spells to be droughts (Jordaan, 2011: Jordaan, 2014).

In spite of the relatively high precipitation in ORTambo district, resilience against drought is the lowest as a result of low resilience linked to (i) human, (ii) economic (iii) institutional, and (iv) infrastructure capital. This is also true for the Sterkspruit region in Joe Gcabi district. Communal land belonging to municipalities are not clearly illustrated on the maps due to the scale in relation to catchment size but all communal land have the same characteristics and even worse than the Sterkspruit area in Joe Gcabi district. These areas are highly vulnerable with extremely low resilience against dry periods. The high dependency on government support amongst communal farmers is one of the key contributors to drought risk. As a result of government dependency communal farmers do not plan properly and they apply bad agricultural practices with the anticipation that "*government will assist when drought comes*".

Catchments with high drought resilience are those well- developed commercial farming catchments with access to irrigation since farmers then have alternative income sources and they can provide own feed and fodder during dry spells (Figure 3).

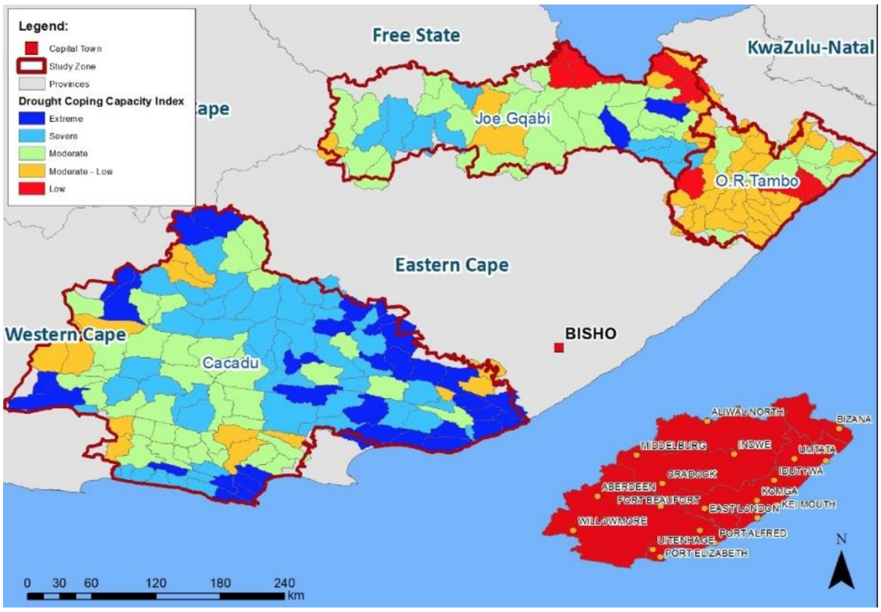

FIG 3: DROUGHT RESILIENCE MAP FOR CACADU, JOE GCABI AND ORTAMBO.

All values for hazard severity and resilience was indexed according to the Likert scale from 1 to 5 for all quaternary catchments. The index for drought risk was then calculated using the equation *DR=H/Res.* The result for drought risk is illustrated in Fig 4.

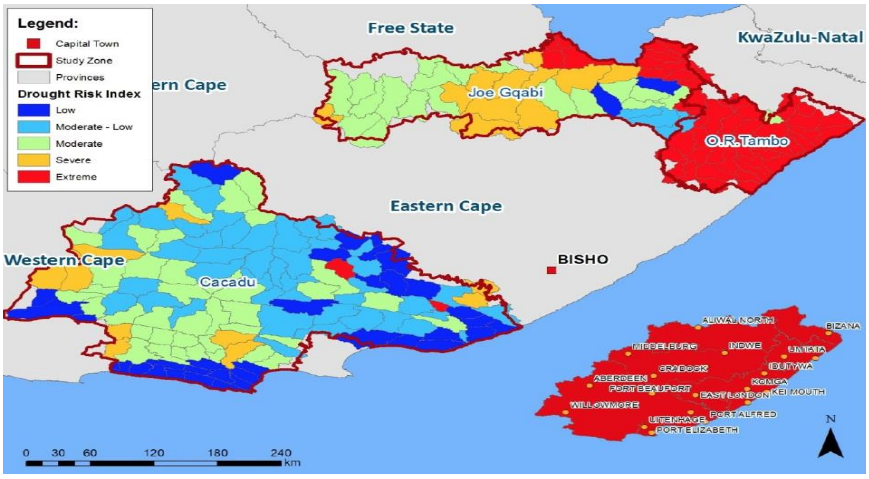

FIG 4: DROUGHT RISK MAP FOR CACADU, JOE GCABI AND ORTAMBO DISTRICTS.

CONCLUSION

The results for drought risk assessment clearly highlighted the importance of vulnerability and coping capacity, which is in this case combined as drought resilience as essential elements in drought risk. The importance of the drought risk assessment is not in the final result illustrated in the maps, but rather in the identification of indicators that contribute to drought resilience. It is important for extension services and development agencies to identify these indicators and address the gaps in extension programs and development plans.

The Department of Agriculture as well as the Department of Land Affairs should take note of the factors increasing drought vulnerability since that might impact on sustainable land reform. Extension managers should identify these factors and build it into extension programs. The low level of drought related knowledge amongst extension officers is of concern since they are responsible to train farmers and support farmers to activate measures for drought risk reduction.

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ENHANCING NETWORKS FOR RESILIENCE – UNDERSTANDING FORMAL AND INFORMAL NETWORKS IN A RURAL SETTING

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The National Strategy for Disaster Resilience (Australia) defines a resilient community as one that uses personal and community strengths, and existing community networks and structures: a resilient community is enabled by strong social networks that offer support to families in a time of crisis. Quantifying and characterising networks and their specific contributions to resilience remains a challenge.
Enhancing Networks for Resilience (EN4R) incorporates semi- structured interview and survey data together with social network maps to investigate the characteristics of formal and social networks of the Southern Grampians Glenelg Primary Care Partnership (SGGPCP) members to disaster resilience. SGGPCP is a partnership of 20 health and community agencies across two local government areas in Victoria. The analysis will consider how network dynamics and bridging, bonding and linking social capitals', correlate with community resilience and disaster management
The research seeks to help practitioners understand how informal and formal relationship contribute to resilience, including types of social capital, barriers and enablers to relationships and if and how relationships can be supported. It critically examines the level of network comprehension required to prevent exacerbating existing vulnerabilities or inequalities.
The work builds upon existing qualitative studies by providing visual maps and empirical data that highlight pathways for information, collaboration, and service access and capacity development.

KEY WORDS: community, networks, resilience

POST-DISASTER RECONSTRUCTION IN CHRISTCHURCH: A 'BUILD BACK BETTER' PERSPECTIVE

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The 2010/11 Canterbury earthquakes were one of the most devastating events in New Zealand's history. Due to the large scale of disruption and losses, the central government created a separate body, the Canterbury Earthquake Recovery Authority (CERA), to manage and oversee recovery activities. Working with local authorities and stakeholders, CERA plays a major role in driving the recovery in Christchurch. This paper analyses CERA's decision-making process and the effects of some of its critical decisions on the recovery outcomes by adopting a 'Build Back Better' (BBB) perspective. Lessons learned from the Canterbury experience in terms of recovery best practices are reported. CERA's recovery policy is intended to give confidence to the community and renew and revitalise the damaged city. The community-driven Recovery Strategy and a multi-stakeholder approach proved to work well. Other critical decisions aligned with the BBB vision including land zoning, empowering community, and integration with existed developmental plans have enhanced the efficiency of recovery measures in an innovative way. It is recommended that BBB can be used as a tool for the implementation of recovery and restoration measures following a large disaster. However, a set of indicators to measure the level of BBB is needed for future research and practice.

KEYWORDS: Build Back Better (BBB), best practices, recovery, reconstruction, resilience

TEXT MINING FOR DISASTER RESILIENCE DPROF PROGRAMME

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ABSTRACT

CADRE (Collaborative Action towards Disaster Resilience Education) aims to address current and emerging labour market demands in the construction industry to increase societal resilience to disasters and develop an innovative professional doctoral programme (DProf). In the framework of the CADRE project, a new iterative eight-stage text mining methodology was developed for the selection of the most rational, integrated text material from a library of documents. Text mining is a widely known methodology; however, this methodology has not yet been used in conjunction with the application of integrated multi-alternative design and multiple criteria analysis methods. Text Mining for Disaster Resilience Dprof Programme (TEMIDR) integrates information retrieval, statistics, machine learning, and text mining and uses open educational resources. Courses developed by text mining are based on individual learning and personalised instruction. A personalised student learning model is created to adapt the studies to individual needs. In doing so, the Disaster Resilience Dprof Programme ensures that the explicit knowledge of disaster and disaster resilience in the built environment are integrated with the developed course. This article also looks at ways to identify the most popular keywords for the developed text mining system with practical and scientific applications in mind.

Keywords: CADRE Project, Dprof Programme, research methodology and method, personalised learning, text mining.

INTRODUCTION

The CADRE (Collaborative Action towards Disaster Resilience Education) project funded by the European Commission's Lifelong Learning Programme aims to develop an innovative professional doctoral programme (DProf) that integrates professional and academic knowledge in the construction industry to develop societal resilience to disasters. This DProf programme addresses the career needs of practicing professionals, particularly those in, or who aspire to, senior positions within the construction industry with the aim to develop societal resilience to disasters.

Extant research shows that various important areas of text analysis have been investigated in depth (Loshin 2013, Li et al. 2011, Lloret and Palomar

2013), including entity recognition and extraction (Nothman et al. 2013, Loshin 2013), retrieval systems and intelligent libraries (Du 2012, Li et al. 2012, Ropero et al. 2012). The purpose of this research was to develop a system of Text Mining for Disaster Resilience Dprof Programme (TEMIDR) that would be more flexible and more informative in selecting and integrating electronic information by the desired area and by coverage. It would allow the actual users to participate and influence the operation by automatically designing, evaluating and selecting the most suitable information for themselves. Existing intelligent libraries, text analysis, entity recognition and extraction, retrieval systems cannot develop text alternatives (i.e. perform a multi-variant design), perform multiple criteria analysis, automatically select the most effective variant or calculate utility degree and market value. However, the TEMIDR can perform all of the aforementioned functions. To the best of the knowledge of the authors, these functions have not been previously implemented in combination and thus, this is the first attempt to do so.

RESEARCH METHODOLOGY AND METHOD

The purpose of this research is to develop a text mining methodology for disaster resilience field. The text mining methodology supports the selection of the most personalised disaster resilience text with a brief explanation of the multi-variant design and multiple criteria analysis procedures, *criteria system* and its weighted tree structure applied to the selection of the most rational text. Implementation of the proposed methodology is beneficial when designing, evaluating and selecting the most rational text variant, enabling different stakeholders to more effortlessly receive the required information on the issues related to disaster resilience.

The methodology describes an iterative eight-stage methodology framework for the selection of the most rational, integrated text material from a library of documents. The essence of this methodology involves the TEMIDR that is designated to select the most rational, integrated text material from a library of documents. The methodology covers the input of a bag of concepts space; selecting, processing and indexing information in accordance with the input bag of concepts space and user model; formulating the results of the retrieval and, finally, showing them to the user. Further, after selecting, processing and indexing documents, it covers the selection of composite parts (chapters/sections/paragraphs) of the documents under analysis and, after that, performing the multi-criteria analysis of the composite parts. This is followed by the designing of alternative variants of the selected information and performing a multi-criteria analysis of the summarised, integrated alternatives of the text by which the retrieval results are then formulated.

The text mining method used is student-centered. We aim to develop PhD student autonomy and independence by giving students responsibility for the learning path focusing on skills and practices that enable independent problem-solving. With text mining, the students choose what they will learn and how they will assess their own learning using an intelligent knowledge assessment sub-system. This method emphasizes each student's interests, abilities, and learning styles. The professor acts as a facilitator of learning for individuals rather than for the class as a whole. The student-centered text mining method covers information retrieval, information extraction, machine learning, and statistics methods, and incorporates the following methods developed by the authors (Kaklauskas 1999): method for a complex determination of the weights of the criteria taking into account their quantitative and qualitative characteristics; multiple criteria method for a complex, proportional evaluation of text materials; method for a multi-criteria, multi-variant design of summarised, integrated text variants; and a method for the determination of the utility degree and market value of the text materials. The method creates the challenge to understand, explore, and support new essential dimensions of learning such as: (1) self-directed learning, (2) learning on demand, (3) collaborative learning, and (4) organizational learning. These approaches need innovative text mining technologies to be adequately supported. The method based on the knowledge triangle refers to the interaction between research, education and innovation, which are key drivers of a knowledge-based society.

TEXT MINING FOR DISASTER RESILIENCE DPROF PROGRAMME

The TEMIDR comprises of the following components: the Database Management Subsystem and Databases, the Equipment Subsystem, the Model-base Management Subsystem and the Model Bases with User Interface.

The Database contains the developed Database of bag of concepts space, Database of keywords and their weights, Historical statistics database, User database, Agent database, Developed conspectus database. Students are offered personalised learning materials in the form of courses, course materials, content modules and best practices such as case studies and techniques.

The Model-base consists of the following models: Module for selecting, processing and indexing information, User Model, Agent Subsystem, Statistics Module, model for determining the initial weights of the keywords (with the use of expert methods), model for the establishment of the weights of keywords, model for multi-variant design of an alternative text, model for multiple criteria analysis of an alternative text and setting of the priorities, model for determination of alternative text utility degree, model for providing the most rational content of a conspectus for a specific PhD student and the Intelligent Knowledge Assessment Sub-system.

A brief analysis of the system follows as an example: bag of concepts space, initial requirements for a search and User Model, identification of the most popular keywords.

Bag of concepts space

A number of academics have analyzed c*oncept-based* information retrieval and bag of concepts in Wikipedia representation. In our research, the bag of concepts space (including synonyms and retrieval restrictions) is represented as a hierarchical weighted tree structure. Bag of concepts space, divided into individual concepts, occupies the top level. The concepts are subdivided into sub-concepts which, in turn, contain subsets of the objects. A subset of the objects is defined by a system of keywords (see Figure 1). All components in the bag of concepts space are interrelated, weighted and form an integrated whole.

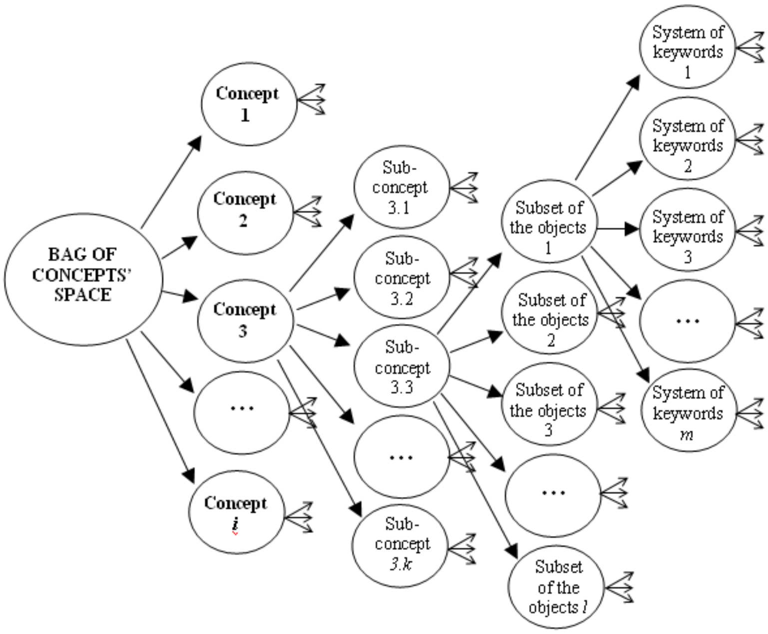

Figure 1. Bag of concepts space as a hierarchical weighted tree structure

The next step is to develop a system of concepts, taking the bag of concepts space "Disasters" as an example. By concept we mean a single Wikipedia article. Wikipedia's category "Disasters" includes different concepts, namely Earthquakes, Floods, Heat waves, Landslides, Storms, Tsunamis, Climate change, Meteorological disasters, etc. As suggested by experts, we have also added seven qualitative crisis-management concepts from Wikipedia categories to the bag of concepts space, namely Education, Social, Culture, Ethics, Psychology, Emotion, Security (see Figure 2). Thus the system of selected quantitative and qualitative concepts presents a comprehensive description of the bag of concepts space word "Disasters". Even without an analysis of available literature related to the bag of concepts, it will be spontaneously obvious to the majority of people that these concepts are important to the word "Disasters". The bag of concepts (including synonyms and retrieval restrictions) labels also show a level of semantic connection and relatedness to the input title that extends simple synonymy.

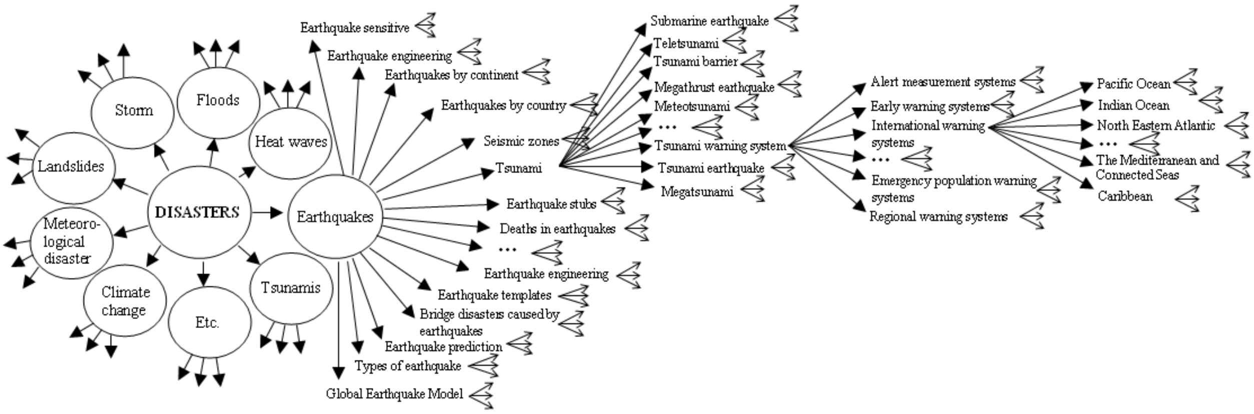

Figure 2. Development of the BCS concepts and interrelations between its various levels

Other levels in the bag of concepts space (BCS) are built likewise. The Wikipedia's category "Earthquakes" is divided into the following main categories as shown in Figure 2: earthquakes by continent, earthquakes by country, bridge disasters caused by earthquakes, deaths in earthquakes, earthquake engineering, seismic zones, types of earthquake, earthquake templates, earthquake stubs, earthquake prediction, earthquake sensitive, global earthquake model. These categories are allocated hereafter into upwards detailed categories and concepts. Figure 2 shows the tree organization of the bag of concepts space "*Disasters*", showing a break down of a branch within the top-level concept of *disasters*. In the illustration, the category of *Pacific Ocean* belongs to the concept of *international warning systems*, which is a part of the more general concept of *Tsunami warning systems*, which is part of the even more general concept of *tsunami*, etc.

The weighted tree structure, thus, provides a comprehensive description of the target of search, establishing linkages and relationships among the concepts (including synonyms and retrieval restrictions) in question. Weights are set for the entire bag of concepts space. The weights represent search objectives and the experience of various users. Chapters and subchapters in modules are also ranked by their difficulty in the module's context. Search volume is non-fixed, i.e. a search can be as long as required (a sentence, a paragraph, or even more can be submitted as a search). Future incentives for using the text mining methodology can be anticipated, given the evolution of the bag of concepts space and weighted tree structure in order to thoroughly evaluate the area of disaster resilience.

Initial requirements for a search and User Model

At the beginning of a search, a user is able to submit the following kinds of search requirements: the user indicates the goal or goals for the search – research, practical or cognitive. The user notes the possibilities of interest to him/her while conducting the search: research literature (books, academic articles and the like), practical literature or popular literature.The user requests or selects a bag of concepts space (see Figure 4) and the user establishes various limitations (volume of the material under search by pages, desired time for reading a lecture in minutes and the like).

a) b)

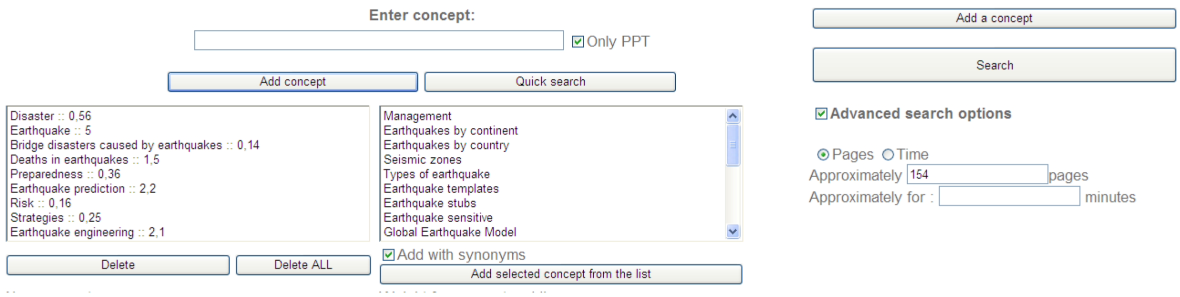

Figure 4. User window of the Text Mining for Disaster Resilience Dprof Programme (TEMIDR): a) Fragment of the User window, b) Advanced search options

To limit the number of search results showing the pages that include the concepts in question (or to restrict the search by the duration of reading), the user can tick the option *Advanced search options* below the button *Search*. Additional fields appear: *Aproximately ... pages* and *Approximately for: ... minutes*. The user will also see options buttons to perform the search either by the number of pages (default) or by the duration of reading (see Figure 4b).

The Agent Subsystem accumulates information about a user and stores his/her individual data. This information can be explicit (year of birth or university graduation) or implicit. The main skills of a user are implicit. They consist of informal and unregistered knowledge, practical experiences and skills. Such data are very important because they describe a user's experience. Information about a user's existing education, needs and the like accumulate in the Agent Subsystem.

As a user's historical search information is being analyzed, his/her initial search requirements can be refined (or made more specific). In this case, the user's behaviour is under analysis; for example, which documents the user does or does not select for review, how often a document is viewed and how much time is spent looking at it along with the use of the drag function are all under observation. This may partially be called the analysis of user conducted searches, the agent function. The Agent Subsystem accumulates statistical information about the previous searches conducted by a user in a matrix form: bag of concepts space of a search; results of a search; how many times a user modified the initial search before suitable results were gained; the most popular resources and internet website addresses employed by the user; how many times did a user read the selected material and how much time was spent doing so.

This way the automatic search is actually personalised by applying the historical information gathered by the Agent Subsystem. The bag of concepts space under search is refined (or made more specific); information about the user's education, work experience and search needs are considered; the user's most frequently employed resources, internet website addresses and authors are considered; the user's opinion regarding the significance of the documents gained by the results of a search are considered.

A user could be dissatisfied with the results of an initial search and desire an additional search. There can be several reasons for this. For example, it could happen that, at the time of the initial search, no documents are found that correspond to a minimal density of keywords in accordance with the search bag of concepts space the user has provided. In such a case, a modified search is undertaken to upgrade the search (i.e. by supplementing the search bag of concepts space).

The goal during the time of the search for information is a text selected for maximal satisfaction of the user's needs. At times researchers attempt to select appropriateness, usefulness, interrelationship and other, similar concepts by appropriate types such as by appropriate topics or by the appropriateness for the user. (It is claimed that a document can have an appropriate topic, thus being suitable, but a user cannot or does not want to use it: perhaps the language is incomprehensible, the user already has such a document, the document is too complicated, or the like).

Feedback regarding the appropriateness of a found document relates with methods like modifying a search inquiry in accordance with the user's assessment of the appropriateness of the preliminarily found document. Generally, an initial search is conducted according to the bag of concepts space that a user provides. The results of such an initial search are provided to the user along with an assessment questionnaire, wherein preliminary assessments of the appropriateness of the found documents to the needs of the user are provided. Then the initial search parameters are modified by employing the user's answers (for example, providing greater weight to the successfully used terms and lessening or eliminating the weights of less appropriate terms). Thereby a second search is conducted. Such an interaction may continue as long as a user wants it to.

The essence of the feedback on the appropriateness of a retrieved document is taking the initial results according to the submitted questionnaire and formulating a new questionnaire in light of the appropriateness of the results. The feedback function employed by this method is the electronic intelligent analysis function. Once the questionnaire parameters are filled out (the feedback regarding the appropriateness of the retrieved document), other, more suitable documents are found during a subsequent search, which had been excluded during the initial search; thus improving overall effectiveness. Naturally, the effect of such feedback very much depends on the quality of the terms selected to supplement the search and their weights. Besides, if the words submitted with the initial questionnaire are not related to the topic of the query or the weights attached to them are inappropriate, the quality of the search can prove to be poorer. Nonetheless, the opposite is true also.

The results may give a user new ideas and thoughts for improving this search. The user then submits such information (desired authors, literature and internet resources; bag of concepts space) for a repeat search. The user can also indicate the appropriateness of the selected text directly by using a *point system* to rank usefulness. Usefulness is assessed on a 10-point scale (for example, where zero points means "inappropriate", four points means "somewhat appropriate, six points – "appropriate" or ten points "very appropriate". Information about the reaction regarding appropriateness needs to be included in the initial questionnaire for the search to operate more effectively.

Identification of the most popular keywords for the developed text mining system with practical and scientific domains in mind

Practical tests of the text mining were aimed at identifying keywords that are the most popular in practical and scientific domains of disaster resilience in the built environment. Later these most popular keywords were suggested to students, who could then enter their combinations into the text mining system and get personalised lecture notes that best suit their needs. For that purpose, keywords from the following books were used in Google (practical) and Science Direct (scientific) search: Post-Disaster Reconstruction of the Built Environment: Rebuilding for Resilience (Amaratunga and Haigh 2011); Disaster Policy and Politics; Emergency Management and Homeland Security (Sylves 2014); Disaster Nursing and Emergency Preparedness: for Chemical, Biological, and Radiological Terrorism and Other Hazards (Veenema 2012); Introduction to International Disaster Management (Coppola 2011); Disaster Preparedness and Management (Beach 2010); Disaster Management & Continuity of Operations Planning (Briscore 2013); Disaster Management: Enabling Resilience (Masys 2015); Emergency Planning, Crisis, and Disaster Management (Dillon et al. 2014); Disaster Emergency Management: The Emergence of Professional Help Services for Victims of Natural Disasters (Saban 2015); Innovative Thinking in Risk, Crisis, and Disaster Management (Bennett 2012); Disaster Planning and Control (Kramer 2009); Environmental Hazards: Assessing Risk and Reducing Disaster (Smith 2013); Emergency Management and Social Intelligence: A Comprehensive All-Hazards Approach (Epstein et al. 2014) (see https://www.amazon.com/). Figure 4 shows the Google search results (practical search) generated using the keywords taken from the content of these books. As we see, the most popular words in sources accessible via Google are "disaster management" + response (10,400,000 results), "disaster management" + future (9,940,000 results) and others.

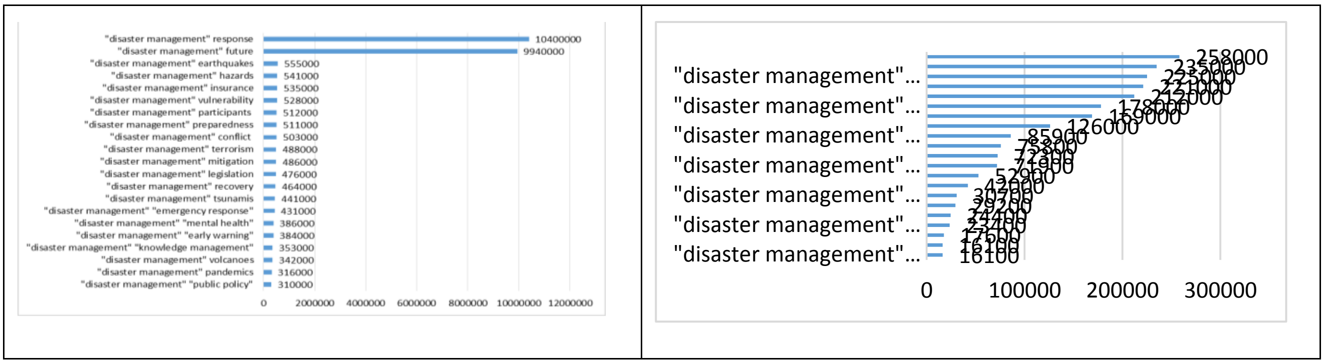

Figure 4. Google keyword search results (practical search)

The keywords from the books listed above were also used to search for content in the scientific Science Direct database (see Figure 5). The most used terms in the Science Direct database are "disaster management" + "disaster planning" (3,770 results), "disaster management" + response (3,676 results) and others.

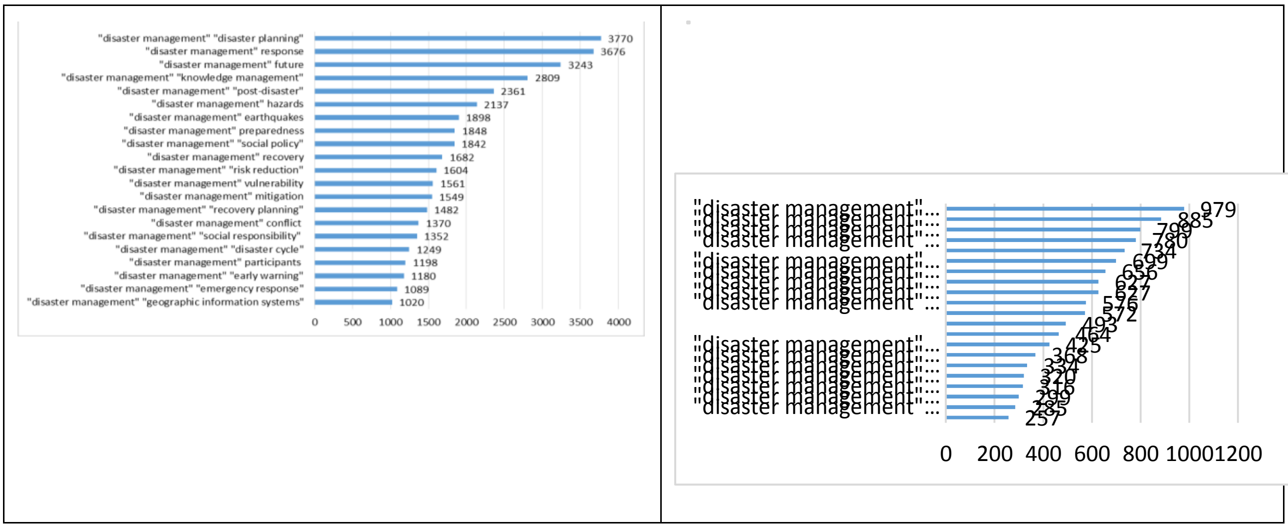

Figure 5. Keyword search results in the Science Direct database (scientific search)

CONCLUSIONS

Extant research shows that various important areas of text analysis have been investigated in depth including entity recognition and extraction, retrieval systems and intelligent libraries. However, existing systems cannot develop text alternatives, perform multiple criteria analysis, automatically select the most effective variant or calculate utility degree and market value. In order to increase the efficiency and quality of the delivery of training, teaching and research activities: a TEMIDR has been developed which performs all of these functions. In the future it is intended to integrate TEMIDR with biometrics technologies.

ACKNOWLEDGEMENT

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INTELLIGENT MOOC FOR THE DISASTER RESILIENCE DPROF PROGRAMME

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Abstract

The CADRE Project offers Intelligent MOOC for the disaster resilience DPROF programme (MOOC-DPROF). MOOC-DPROF aims at unlimited participation and open access via the Virtual Environment for the Built Environment Research to reduce knowledge shortfalls across the EU. PhD students registered in MOOC-DPROF differ by their knowledge levels, preferences, interests, goals, cognitive styles and learning styles. The basis of MOOC-DPROF is individual learning. The design of MOOC-DPROF is for it to run within the Moodle platform. PhD students are offered personalised learning materials in the form of digital textbooks, videos, audios as well as calculators, software, computer learning systems, an intelligent testing system, affective intelligent tutoring system, etc. A personalised MOOC-DPROF adapts the studies to individual needs. Upon completing the analysis of globally developed resilience management MOOCs, it was noticed that there is still no MOOC developed by applying biometric and intelligent systems in an integrated manner, something that has already been implemented with the MOOC-DPROF. The subsystems and a Case Study are briefly analysed in this paper.

INTRODUCTION

Local and international organizations throughout the world, such as the United Nations Environment Programme (UNEP), Center for Natural Resources and Development (CNRD) along with universities, such as the Cologne University of Applied Sciences or Global Universities Partnership on Environment for Sustainability (GUPES) are developing resilience (disaster) MOOCs. Such MOOCs appear in the Internet as separate systems (MOOC 2014) or MOOC List Directories. For example, by undertaking a search in the MOOC List Directory (https://www.mooc-list.com/) by the keyword “resilience”, the finding totalled 285 results and, by the word “disaster”, 200. Certainly, not all of these systems fall into the area of resilience (management), but some actually do. Next, there are brief descriptions of three, serving as examples, of these MOOC List Directory systems (Building Resilience; Introduction to Sustainability, Resilience and Society and Disasters and Ecosystems). Building Resilience learning outcomes are as follows: students will be able to define resilience, risk factors and preventative factors; explain the benefits of resilience; demonstrate the ability to utilize specific skills to optimize their well-being and develop a resilience map for utilizing in college and life after college. The course "Introduction to Sustainability, Resilience, and Society" introduces the complex but critical concepts of sustainability and resilience, and proceed to include a self-analysis of your impact on our environment and a case study of a societal evolution in sustainability. Emphasis will be on translating theory to individual impact and comprehension. Disasters and Ecosystems MOOC enhances knowledge and skills for tackling complex issues such as resilience and transformation, sustainable development, ecosystem management, disaster risk reduction, climate change adaptation and how they can be operationalized. The course is delivering through a series of lectures and case studies, quizzes, peer-reviewed exercises, along with additional study materials provided to the students. Students will be provided the opportunity to enhance their critical thinking through real life and fictitious problem solving exercises. Each week will feature an international expert who will be available to respond to questions and interact with students.

Population growth, environmental degradation and climate change will likely exacerbate disaster impacts in many regions of the world. What role do ecosystems play in reducing disaster risks and adapting to climate change? This is the topic of a Massive Open Online Course, "Disasters and Ecosystems: Resilience in a Changing Climate". It was developed jointly by the UNEP, the CNRD and the CUAS. This is UNEP's first MOOC, developed through its engagement with universities worldwide including the GUPES. The MOOC covers a broad range of topics from disaster management, climate change, ecosystem management and community resilience. Students have the opportunity to enhance their knowledge through quizzes, real life and fictitious problem-solving exercises, additional reading materials, videos and a discussion forum (MOOC 2014).

Currently the Intelligent MOOC for the Disaster Resilience DPROF programme (MOOC-DPROF) encompasses one module, "Knowledge management". Special attention regarding this module is paid to community resilience by multiple criteria decision making for a built environment by applying biometric and intelligent technologies. However, a DPROF programme can operate at full capacity by supplementing MOOC-DPROF subsystems—Domain Model, Student Model, Tutor and Testing Model and Database of Computer Learning Systems—with respective information. One more module will be supplementing the MOOC-DPROF in the nearest future named "Multi-stakeholder approach, inclusion and empowerment". Upon completing an analysis of globally developed resilience management MOOCs, it can be asserted that not a single "Knowledge management" MOOC with special emphasis on integrated intelligent and biometrics technologies has been developed in the areas of resilience or disaster. Furthermore there have not been any MOOCs developed that would apply biometric and intelligent systems in an integrated manner. This would be innovative on a global scale.

Numerous intelligent tutoring system (ITS) definitions are used in practice as well as in scientific research. For example, Neji et al. (2008) states that ITS is a computer-based educational system that provides individualized instruction like a human tutor. A traditional ITS decides how and what to teach based on the learner pedagogical state (Neji et al. 2008). Kazi et al. (2012) ITS defines as interactive software applications that present a problem to the students in a particular domain. Verdú et al. (2012) states that ITS are efficient tools to automatically adapt the learning process to the student's progress and needs. According to Salvucci (2014), ITS are computer-based tutors that aim to infer a student's knowledge during all stages of the learning process.

A variety of affective tutoring systems definitions could also be found in literature. For example, according to Sarrafzadeh et al. (2008), affective tutoring systems are ITS, that are able to adapt to the affective state of students. According to Mao and Li (2010), affective tutoring system is an ITS incorporating affecting computing, which refers to the process of learning where the emotional status of the student is monitored and the feedback and reactions are given when appropriate so to correct individual's state of emotion during learning. As reported by Moga et al. (2014), the concept of Affective tutoring system involves both collecting the emotion (which has an affective time from seconds to 3 minutes) and collecting the mood (which may last from minutes to days or weeks).

Intelligent tutoring systems application in MOOC has not yet been widely analyzed. Conforming to Wasfy et al. (2013), Intelligent Tutoring Massively Open Online Courses (ITMOOCs) can seamlessly deliver entire curricula while ensuring that students achieve and maintain the required level of proficiency in every curriculum topic. The ITS continuously adapts the course's delivery to the needs of each student by skipping over topics that the student demonstrates proficiency in, and reviewing topics that are determined to be the cause of assessment failures in downstream course nodes. Ketamo (2014) presents a next generation ITS, Learning Fingerprint. Learning Fingerprint enables conceptual level Learning recommendations in real-time in order to help student with his/her metacognitive skills and motivation. Aleven et al. (2015) presented a case study in which a widely used ITS authoring tool suite, CTAT/TutorShop, was modified so that tutors can be embedded in MOOCs. Specifically, the inner loop was moved to the client by reimplementing it in JavaScript, and the tutors were made compatible with the learning tools interoperability e-learning standard. The feasibility of this general approach to ITS/MOOC integration was demonstrated with simple tutors in an edX MOOC "Data Analytics and Learning" (Aleven et al. 2015). The developed MOOC-

DPROF integrates the main MOOC components for intelligent and affective tutoring systems (Kaklauskas et al. 2015). These are described next.

INTELLIGENT MOOC FOR DISASTER RESILIENCE DPROF PROGRAMME

The analysis at the start of the development of the MOOC-DPROF involved naming the platform that could be used to build the module "Knowledge management". The MOOC-DPROF platform is whatever the MOOC-DPROF is designed to run within, in line with its constraints, while making use of learning management systems facilities. The analysis involved five free widespread alternative MOOC platforms (EdX, Moodle, CourseSites by Blackboard, Udemy and Versal) according to six indicators—maximum class size, brandable, user analytics, monetization, mobile and hosting—for building a MOOC-DPROF for oneself.

Harvard and MIT use EdX to offer courses to 100,000+ students, allowing users to use plug-ins to expand the core functionality. Moodle allows users to build and offer online courses. CourseSites by Blackboard has most of the features that Moodle has, including extensive teaching tools, reporting features and SCORM compliance. Udemy is specializing in the private MOOC. Instructors can build and host their own courses on the Udemy platform and then offer them to users for free or for a fee. Open source Versal major strengths are a sleek, intuitive user interface and a robust drag-and-drop functionality. Versal cannot fairly be called a MOOC platform, because it lacks certain MOOC elements, such as a forum or discussion functionality (Swope 2014). The Moodle platform was selected. Now MOOC-DPROF utilizes the Moodle platform to deliver available modules.

Descriptions of MOOC, intelligent and affective tutoring systems consisting of typical MOOC-DPROF components appear in Chapter I. Intelligent and biometric subsystems were also integrated, as the traditional elements of the MOOC, intelligent and affective tutoring systems were being combined into the MOOC-DPROF. Psychological, physiological, ethical, emotional, religious, ethnic, legislative, infrastructural and other aspects were analyzed for the "Knowledge management" module. The diversity of aspects under assessment should follow a diversity of ways for presenting data needed for decision making. Suitability of the form for education is also a factor, because presentation of the learning process can be in different forms. Therefore, the following media and subsystems are used in Intelligent MOOC for Disaster resilience DPROF programme (MOOC-DPROF): digital textbooks, video, audio, as well as calculators, software, computer learning systems, intelligent testing system, affective intelligent tutoring system (Kaklauskas et al. 2015), computer conferencing, computer networks, discussion forum and 'face-to-face' contact (see Figure 1). Students can select the most effective format, because these different media and systems formats can represent the same learning process differently.

The MOOC-DPROF consists of six subsystems (see Figure 2): Domain Model, Student Model, Tutor and Testing Model, Database of Computer Learning Systems, Text Analytics, Decision Support Subsystem and Graphic Interface. These subsystems are similar to existing MOOC, intelligent and affective tutoring systems (Kaklauskas et al. 2015). The subsystems are briefly analysed below.

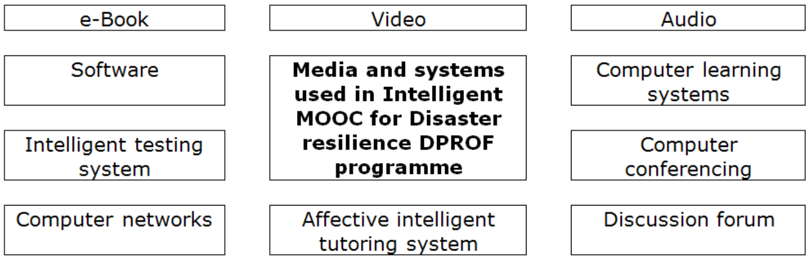

Figure 1. Media and systems used in MOOC-DPROF

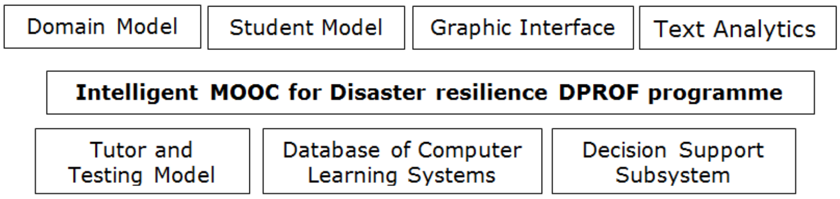

Figure 2. An Intelligent MOOC for Disaster resilience DPROF programme

Domain Model contains information and knowledge that the tutor is teaching. The system can offer study materials to students according to the repetitive key words. Curricula" is adapted to each individual learner's needs, depending on their knowledge level, age, habits and difficulties. The personalized scenario is dynamically generated with emphasis on the weakness of each PhD student. In this case the knowledge acquisition is efficiently facilitated by interaction with the system under the control of the learner. Mixed initiative interaction between user-student and system affords the student substantial control in exploring areas for which he or she may require a tutor.

Student Model stores data that is specific to each individual student. The Student Model is used to accumulate information about the education of a student, his/her study needs, training schedule, results of previous tests (if he/she has studied earlier in the above-listed e-learning MSc programmes or qualification improvement courses) and study results. Therefore, the Student Model accumulates information about the whole learning history of a student. The Student Model starts by assessing the student’s knowledge of the subject or what the student already knows. Student Model uses that data to create a representation of the student's knowledge and his/her learning process and represents the student's knowledge in terms of deviations from an expert's knowledge. On the basis of these deviations the system decides what curriculum module, or chapter (subchapter) of a module should be incorporated next, and how it should be presented (text, multimedia, computer learning system, etc.).

Decision Support Sub-system is used in mostly all components of the MOOC-DPROF (Domain Model, Student Model, Tutor and Testing Model, and Database of Computer Learning Systems) by giving different levels of intelligence for these components. Decision Support Sub-system was developed by applying multiple criteria decision making methods developed by authors (Kaklauskas 1999). Decision Support Sub-system aids and strengthens some kinds of decision processes.

Database of computer learning systems enables the use different Web-based computer learning systems. Further, the Desertification Modelling Computer Learning System (DM-CLS) is described briefly. By means of DM-CLS students can accumulate necessary experience in desertification modelling field. Using DM-CLS such experience can be accumulated faster than in real life activities and without unnecessary financial loss.

DM-CLS consists of the Domain Model and the Computer Learning System. The Domain Model provides theoretical knowledge related to desertification modelling, and the Computer-aided Learning System helps to master the knowledge practically. Information and knowledge contained in the Domain Model is provided in the form of e-books, video materials, calculators, open source software. Practical training is a critical issue for stakeholders responsible for the efficient desertification life cycle. With a well-designed DM-CLS, the need for a lecturer is minimized and the student may readily and efficiently take, in real-time the modelling of desertification modelling with appropriate messages he (she) gets from the system.

DM-CLS is a Desertification Modelling Computer Learning System that was developed by the authors and can be found at the following web address: http://iti.vgtu.lt/ilearning/simpletable.aspx?sistemid=690). Major BR-KDDSS functions include creation and maintenance of user�begs personalized desertification modelling objectives, preferences, and evaluation criteria; participation of various stakeholders in joint determination of criteria defining desertification (criteria system, values and weights); search for desertification project’s components according to the user requirements; find alternatives and make an initial negotiation table; multiple criteria analysis of the desertification project’s components; provision of recommendations (see Table 1); make electronic negotiations based on real calculations; determine the most rational desertification project’s components; develop up to 100,000 whole desertification modelling scenarios; multiple criteria analysis of all desertification modelling scenarios and selection the most efficient versions; what should the value of the Use Drought Tolerant Lawns be for this project to be the best among those under deliberation (see Table 2).

The fragment of recommendations for bettering the desertification alternatives under comparison appear in Table 11. If, for example, it would be possible to increase the degree of protection for alternative "Switch to crops that consume less water" a_5 (28.57%) from the 7 points up to the best 9 points, then the utility degree N_5 for a_5 would increase by 2,765%.

Table 1. A fragment of quantitative recommendations submitted in a matrix form

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Quantitive and qualitative information pertinent to alternatives												
Criteria describing the alternatives	*	Measuring units	Weight	Compared alternatives Possible improvement of the analysed criterion in % Galimas alternatyvos rinkos vertės padidėjimas %, įtakojamas pirmiau padidėjusios kriterijaus vertės								
				Replacing water-hungry turf grass	Grass removal	Use Drought Tolerant Lawns	Drought Tolerant Landscaping	Switch to crops that consume less water	Consider alternative on-farm related businesses	Poison All Alfalfa Crops	Biochar As An Alternative to Irrigation	Race the price for water
Investments	-	$/sq. ft.	0,93	1,44 (0%) (0%)	50 (97,12%) (48,56%)	3 (52%) (26%)	3,75 (61,6%) (30,8%)	1000 (99,86%) (49,928%)	1000 (99,86%) (49,928%)	1000 (99,86%) (49,928%)	135 (98,93%) (49,4667%)	400 (99,64%) (49,82%)
Potential profit	+	$/sq. ft.	0,29	2011 (190,4%) (29,6865%)	790 (639,24%) (99,6665%)	3750 (55,73%) (8,6896%)	5840 (0%) (0%)	1143,75 (410,6%) (64,0184%)	1450 (302,76%) (47,2043%)	1203,5 (385,25%) (60,0661%)	168,5 (3365,88%) (524,787%)	3510 (66,38%) (10,3498%)
Income shares	+	Points	0,19	7 (14,29%) (1,4593%)	7 (14,29%) (1,4593%)	7 (14,29%) (1,4593%)	7 (14,29%) (1,4593%)	8 (0%) (0%)	8 (0%) (0%)	8 (0%) (0%)	7 (14,29%) (1,4593%)	8 (0%) (0%)
The degree of protection	+	Points	0,18	9 (0%) (0%)	9 (0%) (0%)	9 (0%) (0%)	8 (12,5%) (1,2097%)	7 (28,57%) (2,765%)	9 (0%) (0%)	7 (28,57%) (2,765%)	9 (0%) (0%)	6 (50%) (4,8387%)
Poverty rate	+	Points	0,06	8 (12,5%) (0,4032%)	8 (12,5%) (0,4032%)	8 (12,5%) (0,4032%)	8 (12,5%) (0,4032%)	7 (28,57%) (0,9217%)	8 (12,5%) (0,4032%)	8 (12,5%) (0,4032%)	2 (350%) (11,2903%)	9 (0%) (0%)
Per capita income	+	Points	0,07	8 (12,5%) (0,4704%)	8 (12,5%) (0,4704%)	8 (12,5%) (0,4704%)	8 (12,5%) (0,4704%)	8 (12,5%) (0,4704%)	9 (0%) (0%)	8 (12,5%) (0,4704%)	8 (12,5%) (0,4704%)	9 (0%) (0%)

What should be the value of the Use Drought Tolerant Lawns for this project to be the best among those under deliberation? The calculations in this example are the approximation e cycle to determine what the value x11 cycle e of Use Drought Tolerant Lawns a1 should be for this project to become best among those under deliberation a1-a9. The price of this project continues being reduced until N3e becomes equal to 100%. It can be stated that this project can become the most effective among the projects under comparison once the value x11 cycle e of the Use Drought Tolerant Lawns reaches 1.7 $/sq. ft.

Table 2. The investment value calculations of Use Drought Tolerant Lawns for this project to become the best among those under deliberation

Investment value $x_{11\ cycle\ e}$ ($/sq. ft.)	**Utility degree**								
	N_{3e}	**N_{1e}**	**N_{2e}**	**N_{4e}**	**N_{5e}**	**N_{6e}**	**N_{7e}**	**N_{8e}**	**N_{9e}**
3	62.98%	100%	16.63%	59.70%	14.60%	18.10%	16.22%	12.71%	22.44%
2	88.80%	100%	18.30%	62.14%	16.39%	20.32%	18.21%	14.14%	25.17%
1.8	88.80%	100%	18.30%	62.14%	16.39%	20.32%	18.21%	14.14%	25.17%
1.7	100%	94.98%	18.40%	60.51%	16.66%	20.65%	18.51%	14.31%	25.57%

The use of multiple criteria computer learning systems in solving various problems encountered in the course projects and thesis was also aimed at determining: student's knowledge that is acquired at the university, student's general level of education, student's keenness of mind, student's ability to quickly and adequately respond to changing situation.

The Tutor and Testing Model presentation appears below in brief. The Domain Model presents frames to the student. The Tutor and Testing Model provide a model of the teaching process and supports transition to a new knowledge state. For example, information about when to test, when to present a new topic, and which topic to present is controlled by this model. The Tutor and Testing Model reflect teaching experiences of associate professors or professors. The Student Model is used as input to this component, so the Tutor and Testing Model's decisions reflect the differing needs of each student in optional modules.

The Tutor and Testing Model formulates questions of various difficulties, specifies sources for additional studies and helps to select literature and multimedia for further studies and a computer learning system to be use during studies. A student can select the level of difficulty at which the teaching takes place. For example, the chapters of modules with mathematical orientation are quite difficult for some students. Traditional testing systems evaluate a learner's state by giving them a mark and do not provide a possibility to learn about one's own knowledge gaps or to improve knowledge in any other way. The Tutor and Testing Model compares the knowledge possessed by a student (test before studies) and knowledge obtained by a student during studies (test after studies) and then it performs a diagnosis based on the differences. By collecting information on a history of a student's responses, the Tutor and Testing Model provides feedback and helps to determine strengths and weaknesses of a student's knowledge, and his/her new knowledge obtained during studies is summarized and then various recommendations and offers are provided. After giving feedback, the system reassesses and updates the student's skill's model and the entire cycle is repeated. As the system is assessing what the student knows, it is also considering what the student needs to know and which part of the curriculum is to be taught next. Also, there are options for selection of the following question in a test, which depends on the correctness of answers to the previous questions. Correct answers lead to more difficult tasks, incorrect – to easier ones.

The obtained knowledge is the difference between the possessed knowledge (test before studies) and the final knowledge (test after studies). The Tutor and Testing Model also explains why one or another answer is correct/incorrect and offers certain additional literature and multimedia related to the incorrectly answered question/s. Tutors can monitor their students' progress and communicate with their students during the course.

The system provides information on testing process in a matrix and graphical form: information on correct and incorrect answer, time distribution to every question, number of times a student has changed an answer to each question of a test, etc. An incorrect answer is evaluated by zero and a correct is evaluated by one (see Figure 3 (*right*)); intermediate answers score from 0 to 1, the difficulty of a question is determined on the basis of the results of previous tests taken by other students (see Figure 3 (*left*)), links to the study material that is related to the question and time allocated for testing.

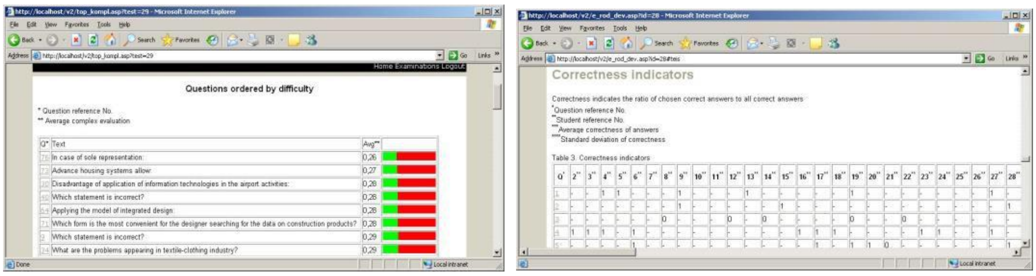

Figure 3. Questions sorted according to difficulty (*left*) and information on the correctness of an answer (right)

By using statistics provided by the Tutor and Testing Model, students can see the question's difficulty, average the evaluation of the whole group and learn about their position in the group before and after studies. Saving the data on a question's difficulty provides the opportunity of giving easier questions first of all and later moving on to more complicated ones. Similarly the topics can be selected – from the simpler to the more difficult by repeating the most complicated topics.

MOOC-DPROF has a graphic interface: icons in windows opened in the computer screen show data, models and other objects available in the system. The expert review method of graphic interface usability testing was applied for this work. Fourteen experts evaluated the graphic interface and justified it as the most suitable.

CONCLUSIONS

The e-learning Master degree studies "Construction Economics" were introduced at Vilnius Gediminas Technical University (VGTU) in 2000. Different multimedia and communication means are used during these studies, namely: electronic format of textbooks, video and audio, as well as computer-software, computer learning systems, intelligent testing systems, intelligent tutoring system, computer conferencing, computer networks, a discussion forum and 'face-to-face' contact. In order to increase the efficiency and quality of e-learning studies, an Intelligent Tutoring System for Construction Economics Master Degree Studies (MOOC-DPROF) was developed. MOOC-DPROF consists of six subsystems: Domain Model, Student Model, Tutor and Testing Model, Database of

Computer Learning Systems, Decision Support Subsystem and Graphic Interface.

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QUANTIFICATION OF SEISMIC EXPOSURE AND VULNERABILITY OF HISTORIC BUILDINGS IN METRO MANILA

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ABSTRACT

Structures such as buildings are at risk to the natural hazards such as earthquakes. Damage and loss of these structures may cause not just human lives but cultural heritage to be lost as well. This study aims to look into the exposure and vulnerability that deal with how many historic buildings in Metro Manila there are, how they are classified, and how susceptible these buildings are to damage due to a certain amount of ground motion. Inventories for exposure were conducted according to structural material, height, and vintage. The building typologies of HAZARDS US Multi-hazard and UP Institute of Civil Engineering were used and modified in this study. It was concluded that there are about 54 historic buildings present in Metro Manila as of 2012. Reinforced concrete moment frames comprised the majority of historic buildings at about 44.5% of the population. Because of this, three buildings, specifically the Central United Methodist Church (CUMC), Ellinwood-Malate Church and Ermita Church, were modeled and analyzed with the aid of ETABS. The Capacity Spectrum Method from ATC-40 was carried out on these building models. Using the performance points and capacity curves derived from the Nonlinear analysis, vulnerability was quantified by coming up with a vulnerability curve that expresses damage as a function of ground motion. Among the three, CUMC responded the strongest and Ermita Church responded the weakest. These structures differ in performance and thus needed to be evaluated individually. The more vulnerable structures are then in need to be strengthened against potential hazards.

Key words: exposure, nonlinear anlaysis, reinforced concrete, vulnerability.

INTRODUCTION

Metropolitan Manila, composed of 13 cities and 4 municipalities by its administrative boundaries, is the political, economic, and cultural center of the Philippines. Geographically, Metropolitan Manila is located on the Luzon Island (JICA, 2004). Numerous earthquake sources are located in and around it. One of these faults, the Valley Fault System, is considered to potentially cause the largest impact to the Metropolitan Manila area should it generate a strong earthquake. Many research studies indicate that active phases of the Valley Faults are approaching and the estimated magnitude may be around 7 or more (JICA, 2004). Structures such as buildings are at great risk to the potential effects of the said scenario. Damage and loss of these structures will definitely cause human lives, businesses, livelihood and cultural heritage to be lost as well.

On October 15, 2013, a magnitude 7.2 earthquake struck Bohol and 14,500 structures were destroyed such that majority of historical buildings are in rubbles. This is one of the reasons why historic buildings must be carefully considered in risk management and disaster mitigation in order to manage potential earthquake disasters.

In this research, the seismic exposure and vulnerability of historic buildings was quantified. Presently, there are no consolidated inventory and standard classification of historic buildings that directly reflect the structural type of these buildings according to their height or to their main structural material. For these reasons, this research aims to quantify the exposure and vulnerability of historic reinforced concrete buildings in Metro Manila. For exposure, the classification and inventory of these buildings are done using various data and field surveys. Also, by adapting and modifying present building classifications, historic buildings will be incorporated in the proposed typology. Vulnerability is then determined and correlated with the aid of ETABS Nonlinear software. A vulnerability curve is then plotted to illustrate the susceptibility of a certain building to ground motions.

MATERIALS AND METHODS

The historic buildings to be studied are based on the list given by National Historical Commission of the Philippines (NHCP). The inventory involves a building classification according to the structural material, height, vintage, and cultural significance while the quantification of vulnerability is limited to three historic mid-rise reinforced concrete buildings given that this building type is the greatest in quantity which may be in need of the most attention for risk estimation.

For the quantification of vulnerability, structural plans were gathered from agencies such as NHCP, DPWH, NAP and Manila City Hall. From the results of exposure, three historic concrete buildings will be modeled and analyzed with the help of ETABS Nonlinear software. The Capacity Spectrum Method, as presented in ATC-40, will be applied to the structural model. Capacity will be defined by the nonlinear static curve generated by the software. Demand will be based on the design response spectrum from the National Structural Code of the Philippines (NSCP) 2010, which is adapted from the Uniform Building Code (UBC) 1997.

Vulnerability curves will then be plotted using the data obtained in the analysis.

The damage index will be obtained by using the formula of Powell and Allahabadi (1988):

$$DI_p = \frac{u_{max} - u_y}{u_0 - u_y} = \frac{\mu_{max} - 1}{\mu_0 - 1}$$

where μ_{max} is the maximum displacement ductility demand for an earthquake history calculated by dividing the maximum displacement (u_{max}) by the yield displacement (u_y); μ_0 is the maximum displacement ductility capacity under monotonic loading, calculated by dividing the u_0 by the yield displacement; u_{max} is the maximum displacement response of the component for a given earthquake history; u_0 is the maximum displacement capacity of the component when subjected to monotonic loading.

EXPOSURE

Building Inventory

Out of 420 historic sites and structures listed in NHCP, 75% are buildings. Metro Manila has the most number which amounts to 27.39% of the historic buildings. These buildings are also classified according to their city location which is given in Figure 1. The graph shows that the majority (74%) of historic buildings in Metro Manila lies in the city of Manila.

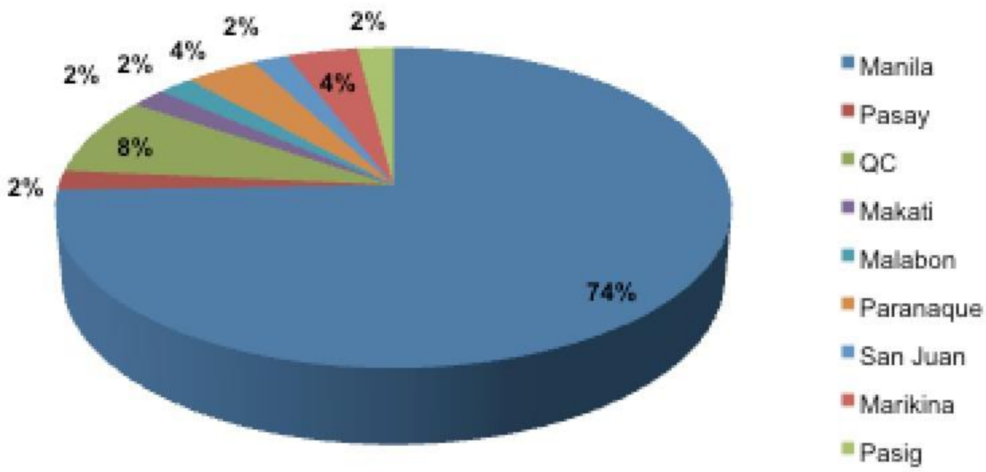

Figure 1. Historic Buildings in Metro Manila according to their City Location

The historic buildings in NCR were further classified according to their structural material type specified in Table 1.

Table 1. Summary of Historic Buildings in Metro Manila per Structural Material Type

TYPE	NO. OF UNITS
Masonry	21
Wood	1
Concrete	30
Steel	2
Total	54

Building Typology

The buildings were further examined and classified using the building typology adapted and modified from UPD ICE and HAZUS-MH to incorporate the historic buildings. Thus, buildings may be classified using the following notations:

Building Type – Height – Vintage

For historic buildings, vintage may be followed by an asterisk to differentiate it from other buildings. The height and vintage was specified in Table 2.

Table 2. Classification of Buildings by Height and Vintage

Height	Vintage
L : Low-rise	1 : High code
M : Mid-rise	2 : Low code
H : High-rise	3 : Pre-code

Using this typology, the data of historic buildings in NCR was summarized and tabulated in Table 3. The city of Manila has the greatest number of historic buildings therefore it is more exposed to seismic hazards. Reinforced concrete buildings especially C1 comprises the majority (44.5%) of the historic buildings in Metro Manila. Out of these historic concrete buildings, mid-rise buildings are the greatest in number, thus, will be given focus on the vulnerability part.

Table 3. Summary of Historic Buildings in Metro Manila according to the Proposed Building Typology and the Location.

Material	Type	Manila	Pasay	QC	Makati	Malabon	Paranaque	San Juan	Marikina	Pasig	Total	%
Wood	W3-L-3 *	1	0	0	0	0	0	0	0	0	1	1.9
Masonry	URM-L-3 *	7	0	0	1	0	2	1	1	1	13	24
	URM-M-3 *	2	0	0	0	0	0	0	0	0	2	3.7
	RM1-L-3 *	1	0	0	0	0	0	0	0	0	1	1.9
	CHB-L-3 *	1	0	0	0	0	0	0	0	0	1	1.9
	MWS-L-3 *	2	0	0	0	0	0	0	0	0	2	3.7
	URA-L-3 *	1	0	1	0	0	0	0	0	0	2	3.7
Concrete	CWS-L-3 *	2	1	0	0	0	0	0	1	0	4	7.4
	C1-L-3 *	7	0	1	0	1	0	0	0	0	9	17
	C1-M-3 *	14	0	1	0	0	0	0	0	0	15	28
	C2-M-3 *	1	0	0	0	0	0	0	0	0	1	1.9
	C4-H-3 *	0	0	1	0	0	0	0	0	0	1	1.9
Steel	S1-M-3 *	2	0	0	0	0	0	0	0	0	2	3.7
TOTAL		41	1	4	1	1	2	1	2	1	54	100

VULNERABILITY

Definition of Terms

Vulnerability is the susceptibility or weakness of the elements exposed to the hazard. A vulnerability curve illustrates the susceptibility of a certain structure to ground motion and is defined as the relationship between the hazard and the average damage (Giovinazzi et. al., 2002). Spectral displacement (S_d), in this study, is defined as the representation of the maximum displacement experienced by a building upon the influence of a given earthquake. Peak Ground Acceleration (PGA) is a measure of earthquake acceleration on the ground while Spectral Acceleration (S_a) describes the maximum acceleration in an earthquake on an object. Nonlinear hinges are points along the member of a building where all deformations are assumed to occur.

Building Analysis

Given the result of the exposure, the buildings chosen were all from the city of Manila since Manila has the greatest number of historic buildings in NCR. These historic buildings were the Central United Methodist Church, the Ellinwood Malate Church and the Nuestra Senora de Guia Church commonly known as Ermita Church. Also, these buildings were all classified as reinforced concrete specifically C1 and were all Mid-rise since it comprises the majority of C1 historic buildings.

In performing the pushover analysis, first we placed nonlinear/plastic hinges on the beams and columns. Flexural moment hinges (M3) were assigned at the ends of the beams while axial moment hinges (P-M-M) were placed at the ends of the columns (Cinitha, et. al.).

Nonlinear static load cases were also modified such that the gravity loads were applied on the structure in a load-controlled manner and the lateral loads were applied in a displacement-controlled manner. In geometric nonlinearity effects, P-delta effects were taken into account.

Vulnerability Curves

Using the formula by Powell and Allahabadi, damage indices were obtained and were plotted against the PGA and Intensity and then a hyperbolic tangent was fitted.

The vulnerability curves generated for the Central United Methodist Church, the Ellinwood-Malate Church, and the Ermita Church are given in Figures 2,3, and 4.

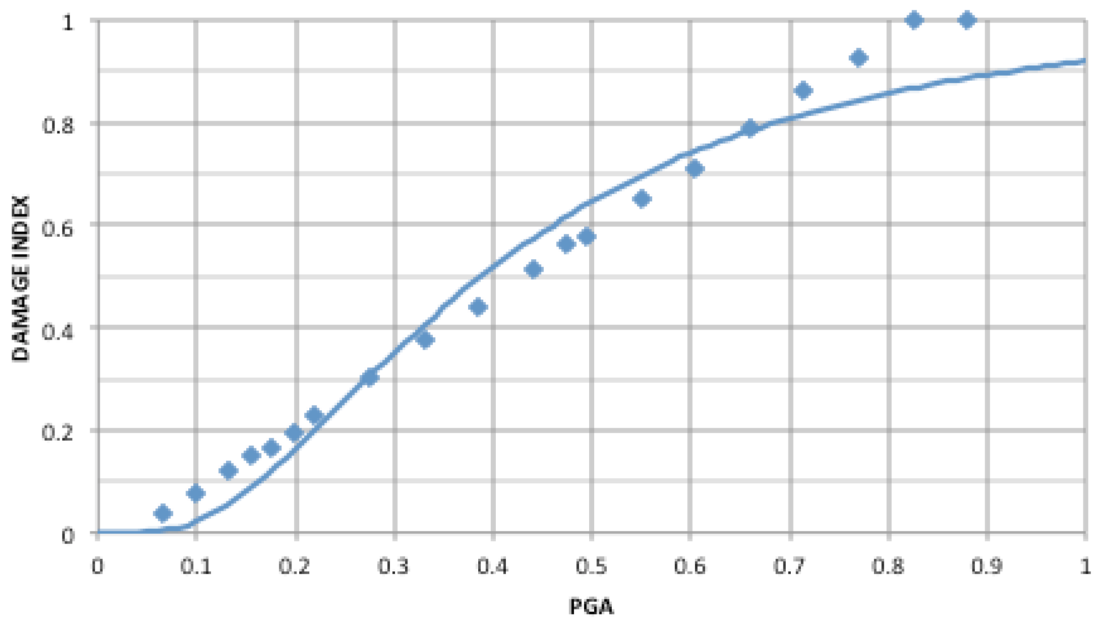

Figure 2. Vulnerability Curve in PGA of CUMC

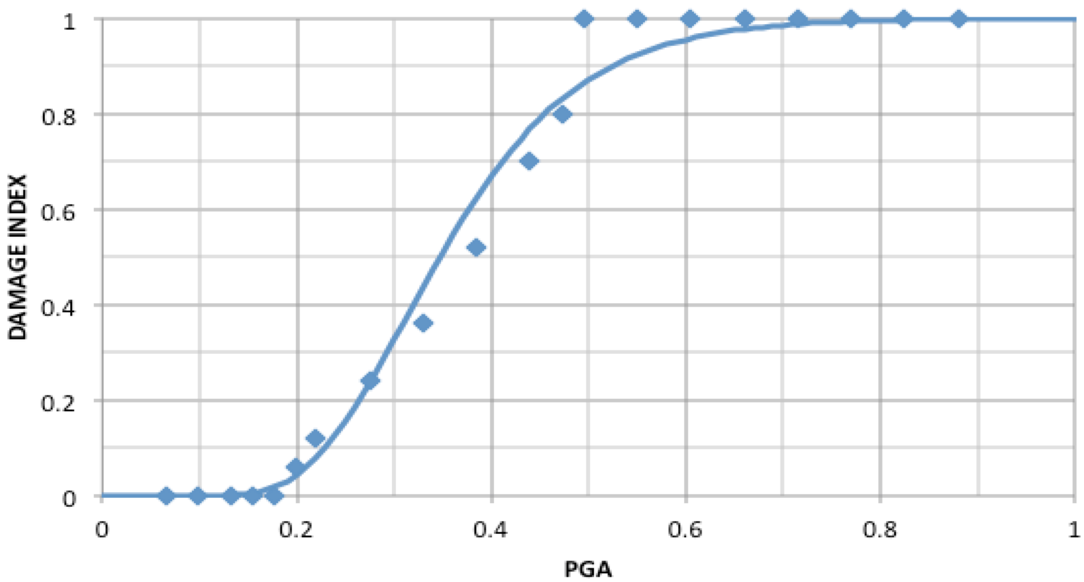

Figure 3. Vulnerability Curve in PGA of Ellinwood-Malate Church

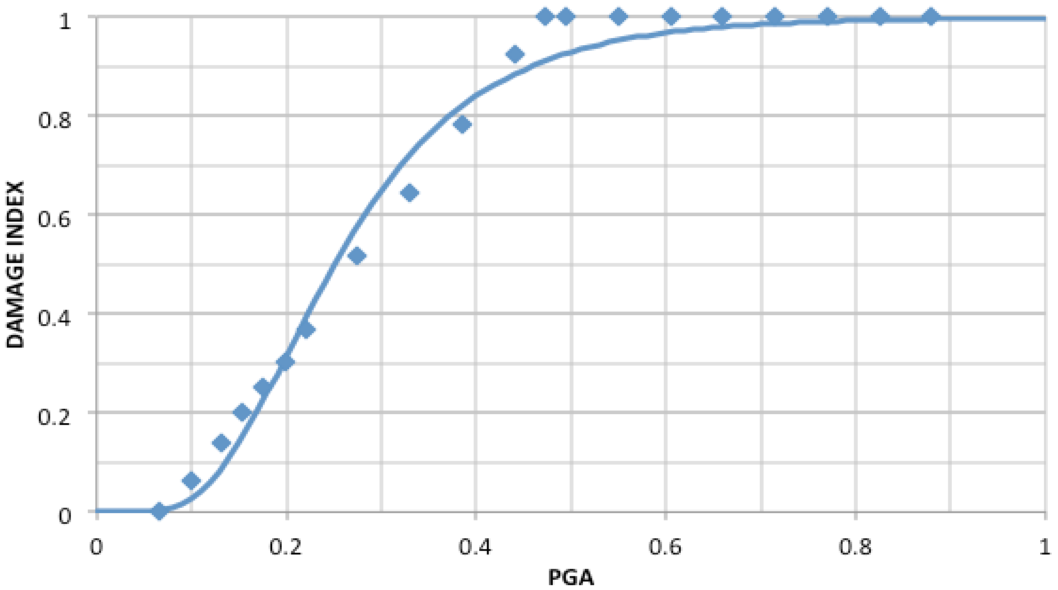

Figure 4. Vulnerability Curve in PGA of Ermita Church Using the

equation by Gutenberg and Richter (1942):

$$\log a = I/3 - .5$$

where a is the acceleration and I is the intensity, we converted the Peak Ground Acceleration to Mercalli Modified Intensity,

$$I = (\log a + .5) \times 3$$

The vunerability curves are given on Figure 5 along with the UPD ICE Vulnerability curve for pre-code midrise buildings.

The capacities of the building modeled obtained using ETABS is given in Table 4 along with the capacities for Pre-code mid-rise buildings by Miura et. al., HAZUS and UPD ICE.

Table 4. Building Capacity Curves: Pre-Code Mid-Rise

	Yield Capacity Point		Ultimate Capacity Point	
	Dy (m)	Ay (m/s/s)	Du (m)	Au (m/s/s)
Miura et. al.	0.019	2.740	0.067	4.210
HAZUS	0.007	0.510	0.088	1.530
UPD ICE	0.023	2.990	0.096	3.169
CUMC	0.003	0.922	0.069	12.790
Ellinwood	0.024	4.150	0.074	5.150
Ermita	0.012	1.754	0.091	7.995

The damage states were adapted from Park and Ang (1985) seismic damage state thresholds given in Table 5.

Table 5. Damage State Thresholds (Park and Ang, 1985)

Range of Damage Index	Damage state
DI ≤ 0.1	None
0.1 < DI ≤ 0.20	Slight
0.20 < DI ≤ 0.40	Moderate
0.40 < DI < 1.00	Extensive
DI ≥ 1.00	Complete

The vulnerability curves are compared to the UPD ICE vulnerability curve for Pre-code mid-rise buildings and are given in Figure 5. The 3 vulnerability curves obtained from the analysis are near the predicted UPD ICE vulnerability curve. The Central United Methodist Church responded almost similar to the UPD ICE but a little bit stronger than the latter as it exhibits a slight damage at an intensity of around 8.5 and a median higher than the three curves. The Ermita Church, however, is the weakest among the 4 vulnerability curves since its median is the lowest among the three curves. Also, it shows a ductile to brittle behavior in the graph. The Ellinwood-Malate Church which is still strong at an intensity of 8, shows a brittle behavior such that a small increase in intensity of the earthquake results to a larger damage.

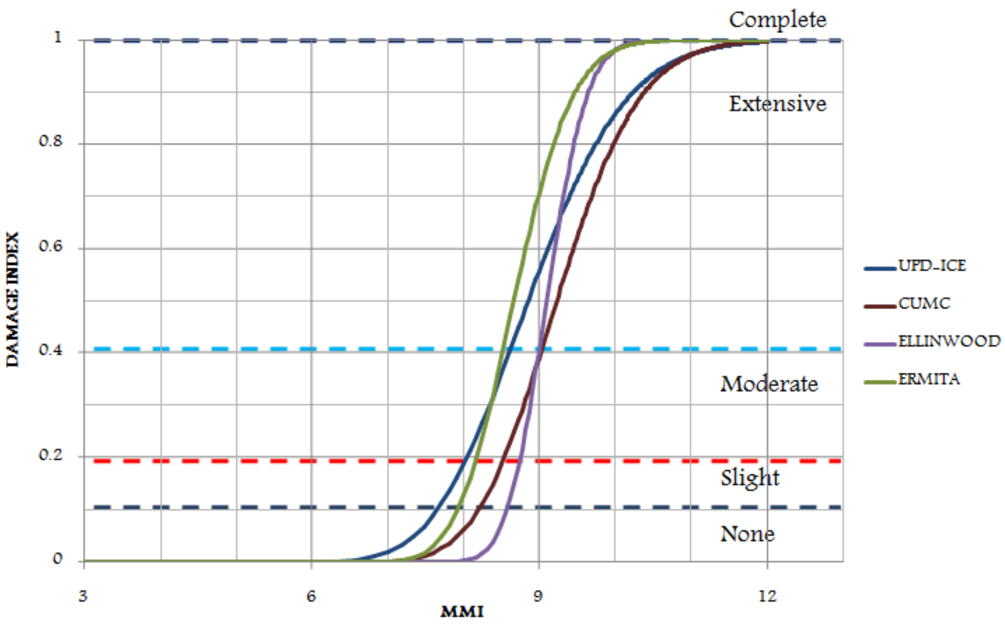

Figure 5. Comparison of Vulnerability Curves

CONCLUSIONS

Exposure of Historic Buildings in Metro Manila

Presently, there is no inventory or database of historic buildings in the Philippines specifically the Metro Manila area that reflects their structural types, according to their main structural material, building height and vintage. It was concluded that there are about 54 historic buildings present in Metro Manila as of 2012 and an increase will probably happen decades after. Reinforced concrete moment frames (C1) comprised the majority of historic buildings at about 44.5%, thus, given priority in this research.

In the inventory building per structural material type, concrete comprised the majority as it covered almost 55.6% of the building population of historic buildings followed by masonry (38.9%), steel (3.7%), and wood (1.8%). This emphasized that historic concrete buildings in Metro Manila are of main significance when it comes to risk assessment because of their high population.

Vulnerability of Historic Mid-Rise Reinforced Concrete Buildings

Predicting the seismic vulnerability of a historic reinforced concrete structure is not an easy task due to lack of experimental and empirical data. However, several researches have been carried out on the behavior of the components of these structures resulting in considerable data on the behavior of these components. Thus, it is more feasible to assess the seismic vulnerability of these structures based on its components. Vulnerability curves of specific buildings can be obtained by performing pushover analysis using ETABS Nonlinear software to obtain the spectral displacements and plotting it against damage by using the formula for damage index of Powell and Allahabadi (1988). Using the results mentioned earlier, the more vulnerable structures such as the Ermita church are then in need to be strengthened against potential hazards such as earthquakes.

By extending this study to other building types, thus quantifying the exposure and vulnerabity of all the historic buildings in Metro Manila, risk can be assessed and will eventually lead to disaster risk reduction by retrofitting and rehabilitation. Furthermore, this shall promote the preservation of cultural heritage such as these remarkable buildings in the country.

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CALM OVER CALAMITY: THE EFFECT OF KNOWLEDGE NETWORKS ON RESILIENCE

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ABSTRACT

Being located in the Kalu river basin, the city of Ratnapura is frequently exposed to some of the highest annual rainfall totals and riverine floods, hence the city's Public Administration Officers (PAOs) often deal with flood management activities. The main purpose of this study is to examine the effect of knowledge networks of Public Administration Officers in Ratnapura district towards the enactment of resilience. A constructivist, case study research design and grounded theory data analysis methods were used to guide data collection and analysis. Data was collected through lengthy semi-structured face-to-face interviews with the participation of nine PAOs attached to district secretariat, and divisional secretariat of Ratnapura. The Glaserian strand of Grounded theory was closely followed in the analysis of audio recorded interviews through constant comparison method. The three-phased rigorous coding method suggested the theoretical model of calm over calamity postulated from PAOs' ability to stay calm over calamity, which is linked to their endurance and the task delegation practices in knowledge networks.

Keywords: *Constant Comparison, Public Administration Officers, Knowledge Networks, Resilience, Social Capital*

INTRODUCTION

Since the adoption of the Hyogo Framework for Action (2005–2015) and Sendai Framework for Disaster Risk Reduction (2015–2030), academics and practitioners started to develop resilience-based approaches for disaster risk management (DRM) (UNISDR, 2015). The transformation from the traditional loss-reduction approach to resilience-based approach highlights, the necessity of developing social capacity through effective knowledge transfer in social networks (Bodin & Crona, 2009; Hughes & Evans, 2007; Janssen et al., 2006).

Phelps, Heidl, and Wadhwa (2012) recognized a fast-growing research trend which integrates characteristics of social networks with knowledge processes such as knowledge transfer, absorption, and application. They defined the term knowledge networks as "a set of nodes— individuals or higher level collectives that serve as heterogeneously distributed repositories of knowledge and agents that search for, transmit, and create knowledge—interconnected by social relationships that enable and constrain nodes' efforts to acquire, transfer, and create knowledge" (p. 1117). Despite the critical need to illuminate the role of knowledge networks for information and knowledge exchange to promote resilience during disasters, empirical literature integrating these two concepts (knowledge networks, and resilience) is scarce.

In order to fill the aforesaid research void, this paper attempts to answer the research question: How do Public Administration Officers (PAOs) of the city of Ratnapura disseminate knowledge within and across social networks during a flood situation and how that impact their resilience? The prime objective of this paper is to examine the effect of PAOs' knowledge networks to the enactment of resilience. This paper is organized in five main sections; (1) Introduction and background, (2) a brief literature review on the integration between knowledge networks and disaster resilience, (3) methodological approach, (4) findings, and (5) conclusions.

Background to the study

The repercussion of Indian Ocean Tsunami in 2004, led to establish legislative and institutional arrangements for disaster risk management in Sri Lanka. The Ministry of Disaster Management (MoDM) formalized a coordinated, inter-instructional approach for provincial councils, district secretariats, and divisional secretariats through a DRM framework (DMC-SL, 2005). However, the empirical gap of literature to evaluate the execution of this framework is still evident in provincial and district administrative divisions.

"Kalu" is known to be the second largest river basin in Sri Lanka which spans 2766 km^2 in the western slope of central hills (A.D.Ampitiyawatta & Guo, 2009), flows through central, Sabaragamuwa and western provinces. The city of Ratnapura, the capital of sabaragamuwa province spans in 2218.4 hectares consisting of 15 local administrative wards (Liyanarachchi & Chandana, 2004). Every year, the town experiences floods usually in the month of May with the start of southwestern monsoon season. The Ratnapura Municipal Area (RMC) is subject to floods “when river level rises up to 18m.msl” (p. 104) and the city significantly affected by floods in 1913, 1940, 1941, 1989, 2003 and most recently in 2016 May. In 2003 May floods, the estimated damage to RMC was LKR 1,140 Mn, affecting 34,473 families and a 122 deaths toll (Rajapakse, 2007). The next section provides a brief discussion on the theoretical concepts used in the paper.

KNOWLEDGE NETWORKS AND RESILIENCE

The central idea of networks of social relationships is derived from the historical conceptualization of social capital (Coleman, 1988; Putnam, 1993). Basic consensus of social capital is derived from the network of relationships possessed by an individual or social unit (Nahapiet & Ghoshal, 1998). Social capital “comprises both the network and the assets that may be mobilized through that network"(p. 243). Coleman (1988) believed that social capital exists inside the structure of relations between actors and among actors. For Putnam (2000, p. 19), structural view of social capital is referred to as “connections among individuals”. The new economic perspective suggests that the process of transferring knowledge from one organization or person to another via relationship links is vital for surviving and development (Argote & Ingram, 2000; Kogut & Zander, 1992). Network or the structural perspective of social capital is a powerful theory explaining how individuals or firms access knowledge resources through relationships (Adler & Kwon, 2002; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). The concept of “knowledge networks” is suggested by Phelps et al (2012). As previously defined in this paper, knowledge networks constitute of characteristics of social relationships by which individuals and collectives create, access, transfer, and apply knowledge. Hansen (2002) discussed the concept of task-specific knowledge networks, which “comprise not only those business units that have related knowledge for a focal task unit, but also the established direct and indirect interunit relations connecting this subset of business units” (p.233).

The theoretical origin of ‘Resilience’ is rooted from ecological literature (Holling, 1973), which is later extended to community studies (Aldrich & Meyer, 2015; Aldunce, Beilin, Handmer, & Howden, 2014; Chenoweth & Stehlik, 2001; Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008; Paton, Millar, & Johnston, 2001). Paton et al. (2001) defined resilience as “the capability to bounce back and to use physical and economic resources effectively to aid recovery following exposure to hazards" (p.158). Chenoweth and Stehlik (2001) stated that communities are considered resilient when they respond to crises in ways that strengthen community bonds, resources and capacity to cope. Adapted from Paton et al. (2001), this paper defines disaster resilience as the degree of ability of PAOs to bounce forward and to use physical, human and economic resources effectively to aid recovery. There is a significant absence of theoretical and empirical research explaining the effect of knowledge networks towards resilience.

METHODOLOGICAL APPROACH

A constructivist, case study research design (Myers, 2009) and grounded theory data analysis methods (Glaser & Strauss, 1967) were used to guide data collection and analysis as there remains limited theoretical explication of PAOs' effect of knowledge networks to the enactment of resilience. Decided on interpretive, theoretical perspective and inductive research approach to carry out, this research, employs a single case study research design and grounded theory analytical methods. The constructivist approach includes flexible yet rigorous analytic procedures that promote the reflexivity of the researcher (Charmaz, 2006), thereby allowing the exploration of the concepts of resilience and knowledge networks and the construction of a related theory, with the realities of the participants. One of the primary features of case study design is the ability to explore multiple perspectives that rooted in a specific context. The quality of interpretive case studies explained by the plausibility of the story and the overall argument rather than the validity and reliability as in positivist case studies (Myers, 2009).

Participants

Using purposive sampling, nine Public Administration Officers (PAOs) based in Ratnapura District Secretariat and Ratnapura Divisional Secretariat were enlisted for this study, considering the political importance of their role. Discomforting characteristics of flood incidents makes it impractical to conduct real time interviews and observations. Hence, primary data was collected through scenario based structured interviews with PAOs (2-women, 7-men). All participants were in the age range 40 to 55 years, all belonged to a common ethnicity (Sri Lankan – Sinhalese), and religion (Buddhism). All participants were holding executive positions in Sri Lankan Public service, with higher administrative designations including Additional District Secretary, Divisional Secretary, Assistant District Secretary, Chief Accountant, Directors for Planing, Operations, Rural Development and Disaster Management.

Data Collection and Analysis

Nine face-to-face semi-structured interviews were carried out on 9th May 2016 portraying a recent flood scenario. A researcher-developed, semi-structured interview guide was used to facilitate the conduct of interviews. Each interview which lasted for 10 to 15 minutes, were digitally voice recorded (using open-source iscream software on a MacBook Air), yielding 115 minutes of digital audio records. Data collection and analysis occurred simultaneously; therefore, immediately after each interview, the digitally recorded interview voice records were transcribed, and translated from the Sinhala (national language of Sri Lanka) to English and analyzed using the constant comparison method of Glaser and Strauss (1967).

Glaser and Strauss (1967) invented the grounded theory as a theoretical approach that systematically bases itself on the empirical world in order to find emerging theories that can then be applied to interpretation. They defined it as the "the discovery of theory from data – systematically obtained and analyzed in social research" (p. 1). Currently, Grounded theory is implemented as a distinct research design which has a strong sense of interpretivism. However in this research, it is not intended to follow complete grounded theory as the research design. Instead, Constant comparison analysis technique is used as an analysis tool for the chosen case study. As explained by Urquhart (2013), "constant comparison is simply the process of constantly comparing instances of data labeled as a particular category with other instances of data in the same category" (p.9) which is recognized as the 'heart of grounded theory method'. It can be seen two competing versions of GT analysis methods, this research closely adopts the coding guide suggested by Urquhart (2013) in the book "Grounded Theory for Qualitative Research - A practical guide" which follows the Glaserian strand of GTM.

The constant comparison is fundamentally described on the three coding mechanisms (open coding, selective coding and theoretical coding). Open coding is first described by Glaser (1978, p. 56) as "coding the data every way […] possible". Urquhart (2013) suggests that open coding is "about attaching initial labels to your data", which are subsequently grouped into larger codes. Glaser (1978) defined selective coding as the stage which coding is limited to only those categories that relate to the core category. Urquhart (2013) suggested that selective coding occurs when there are no more new open codes emerge. Glaser (1978) describes theoretical coding as how substantive codes are related to each other. Urquhart (2013) suggested that theoretical coding covers how to relate the codes to each other and the nature of relationships between those codes to build theory. Glaser (1978) suggested several coding families such as the 6 Cs, dimension family, process family, type family, and strategy family etc. indicating how these categories might be related. These coding families are much useful when recognizing relationships between categories.

Coding Process

Interview transcriptions were analyzed using RDQA, an open source R package for textural qualitative data analysis, on the Mac OSX platform through an iterative process of constant comparison of data from one participant to another (Glaser & Strauss, 1967). The three coding phases (‘open’, ‘selective and ‘theoretical’) of GTM were rigorously followed as described above. Open coding was implemented on interview transcripts of each participant. Line-by-line coding generated 37 initial codes. After 9 interviews, theoretical saturation was achieved as no new categories were emerging. In the next selective coding phase, open codes were prudently synthesized with an analytic sense to regroup them into concepts and categories, by reducing them to 6 categories. Table 1 indicates how 37 open codes were synthesized to generate 6 major themes from interview data. These selective categories were taken into the consideration in the theoretical coding stage to derive relationships among themes. Moving from selective coding to theoretical coding was not a direct linear process. This process included memo writing in parallel to constant comparisons between categories, memos, and field notes. Further analysis through constant comparison revealed that the social process ‘Calm Over Calamity’ through knowledge networks unified other selective categories and explained the effect of PAOs' knowledge networks to the enactment of the resilience of PAOs in RMC.

Table 21: Main categories emerged from data

Selective Codes (Main themes emerged)	Definition	Open Codes which selective codes are derived from
Task Delegation	Delegation of the assignment of certain tasks and responsibility to specific person or a group of people to carry out specific activities	Belief that disasters need to be handled divisional level, Bottom Level stakeholders, Responsibility Delegation, Role Delegation
Knowledge Appropriation and Extension	The extension is the transfer of knowledge from lower to higher agency levels. Appropriation can be understood as transfer of knowledge from higher organizational levels to lower levels through suitable channels, which is the opposite of extension (Hedlund, 1994)	Bottom-Up knowledge Transfer, Top-Down Knowledge transfer, Variation of the knowledge acquisition
Knowledge Articulation and Internalization	Articulation makes tacit knowledge articulated to explicit knowledge at different organization levels. Internalization refers to transforming articulated knowledge to tacit knowledge (Hedlund, 1994).	Belief that indigenous knowledge is important, Clear knowledge links, Personal experiences, Role of media, Speed of knowledge transfer, Verify knowledge from couples of sources, Wasted knowledge links
Calm Over Calamity	The absence of confrontational activity within a place or group during a disaster.	Belief that people know how to respond during a disaster, Disasters create temporal situations of togetherness, Optimistic view about existing facilities, Reciprocity experiences, Resilience indicators, Role of trust, Sense of belonging, Sense of responsibility
Relief Mentality	The characteristic attitude of mind that disaster victims are heavily dependent on	Agitation for funds, Belief that government's contribution is not enough, Belief that government is responsible,

	flood-aids and relief donations from outsiders.	Belief that people don't try to overcome a disaster, Belief that the main post-disaster responsibility is funding, Belief that vulnerable community is relief dependent, Utilizing disaster as a mean of income,
Endurance	The ability to carry out a difficult process over a long period of time with limited resources.	The belief that people don't learn from past experiences, Belief that other parts of the system are not operational, Overestimating disaster losses by some parties, Overlap of responsibilities, Personal Biasedness, favoritism and fraudulence, Relief funds are not used for rebuilding, Understanding the vulnerability of current process, Variation of reciprocity.

SUMMARY OF THE FINDINGS

This section is comprised of the summary of main themes emerged from data and the development of the theoretical model of ‘Calm Over Calamity’ through knowledge networks by PAOs.

Task Delegation

Analysis revealed that all stakeholders considered are assigned specific tasks to carry out, in different phases of a disaster. PAOs are strictly following the tasks delegated to their individual roles defined in the pre-agreed district disaster management protocol. Participants commonly used the term ‘we’ instead of ‘I’, which indicates that responsibility is delegated to work groups. For example, participant 7 commented “we need not get involved at the initial stage. At the initial level, our main responsibility is to collect all information and link to higher level authorities”. Participant 8 clarified the overall task delegation in RMC:

“We have a pre-planned mechanism related to this. There's a committee and job responsibilities are divided till the grass root level from District Secretariat, Divisional Secretariat, Grama Niladari (village officer), and people. There is a network of different institutes who are assigned to facilitate during a flood”.

It was also found that, participants were not ready to take over a responsibility that is not mandated unless it was assigned by a higher authority. There were common terms such as "I'm not directly involved", "we don't have to do that", "there is no use of we get involved", "there is a separate team for that" etc.

Knowledge Appropriation and Extension

Interview codings provided clear evidence of middle-up-down knowledge flows in the hierarchy of administrative levels. From the initial interviews of high rankers in district secretariat, a perception was created that appropriation is mostly evident, rather than extension. However, as moving with interviews with mid-level PAOs, the perception was changed such that knowledge flows mostly initiated the form of extension, which will be later converted to middle-up-down knowledge transfer in the knowledge network. Participant 6 commented:

"Usually, Grama Niladari will take the main role in communicating to village level information with divisional level officers. In villages, Grama Niladari officers have developed committees for disaster management. The first information regarding a flood comes from rain gage readings from village relief officers (Sahana Niladari), who will pass the message to Grama Niladari".

These interviews revealed that knowledge is transferred in various cycles in the network hierarchy is both directions, while key roles recognized in the network will be feeding and extracting knowledge in their designated task level.

Knowledge Articulation and Internalization

While some knowledge flows in the formal inter-institutional network present in the explicit form (i.e. mandates, documents, news, memos, letters, digitized data etc.), participants revealed that in networks of PAOs, more knowledge is kept and passed in the tacit form. Tacit knowledge flows such as experiences and indigenous knowledge were found to dwell in networks and actors, some of which the articulation is kept the minimum. There were also cases where some articulated knowledge does not enter to certain actors in the network. For example participant 3 indicated, *"After most of the floods, we make inundate maps of areas in villages. But sadly these maps do not go to people"*. Most PAOs confirmed that they are ready to accept and use tacit and explicit knowledge in decision making as long as they come from designated sources. If knowledge comes from unofficial sources, POAs anticipated going through a verification process. The current method of communication using telephone leads to deprivation of articulation, knowledge loss and duplication. It is seen that articulation and internalization are not designated as delegated tasks. Hence, PAOs network knowledge storage and retrieval were disoriented in the long run.

Calm over Calamity

The social process termed as 'Calm Over Calamity' is the main category emerged from data which connects all categories. It is defined as the absence of confrontational activity within a place or group during a disaster. PAOs were accustomed to practicing standard DRM processes with less emotional disturbances when facing a disaster. The PAOs are surprisingly calm in the way they handle delegated tasks during a flood due to three reasons. First, most PAOs believed that vulnerable communities know how to counteract as floods occur regularly during monsoons. For example participant, 1 commented, *"Most people now know what to do and where to go when a flood comes. Most villages are prepared now"*. Secondly, PAOs trusted that community and donors carry an unbelievable level of reciprocity immediately after a disaster. For an example, participant 6 stated, "*When a flood occurs, everybody will help. We will not be able to do this without the help of others. If everything is to be done by the government, it will not be possible at all. People's helping nature assist us significantly when fighting against a flood".* The third reason for this tranquility among PAOs is their optimistic view about existing community facilities. Participants commonly believed that manifested task delegation function works well even while some difficulties exist. Also, some participants indicated a state of overly optimistic perceptions like *"if phone lines are disconnected, then we can communicate with mobile phones. We have not experienced losing all these connections. So far such has not happened"* (participant 8).

Relief Mentality

All respondents commonly pursue the belief that disaster victims are heavily dependent on flood-aids and relief donations from government and donors. In interview transcriptions, phrases such as *"if they lost 50 Rupees, they ask for 5000 Rupees", "they are expecting the government will do everything", "dependent on what they receive for free*" were commonly seen. Some participants believed that flood victims turn agitate if reliefs are not issued, *"for every small thing they do picketing*" (participant 2). Some PAOs supposed that one of their main responsibility is to issue flood relief. They collectively argued that most victims do not build back, even though reliefs and funds received. Some participants made strong comments such as *"people love to be flooded"* (participant 4), *"they use floods as an income"* (participant 9).

The relief mentality category presents anti-resilient features of the intended community.

Endurance

This category refers to the ability of PAOs to carry out DRM processes despite current challenges in the system. Interview transcripts indicate that PAOs conduct disaster management activities 'enduring' limited resources, challenges from political entities, and loopholes in the inter-institutional setup.

Development of the Theoretical model

The outcome of the analysis which resulted in further refinement of the categories used in the development the theoretical model of 'Calm Over Calamity' through knowledge networks by PAOs. Figure 1 illustrates how six main categories discovered in this study are related. The theoretical development revealed 'calm over calamity' as the central category and is defined by community's ability to respond, community's reciprocity, and PAOs' optimistic perceptions towards the existing system. The 'calm over calamity' category emanates from 'task delegation'. Clear delegation of tasks and responsibilities to designated people has made PAOs to be well-focused on the assigned task. 'Task delegation' created the main strength of the current system, which helped them to stay tranquil when facing a disaster.

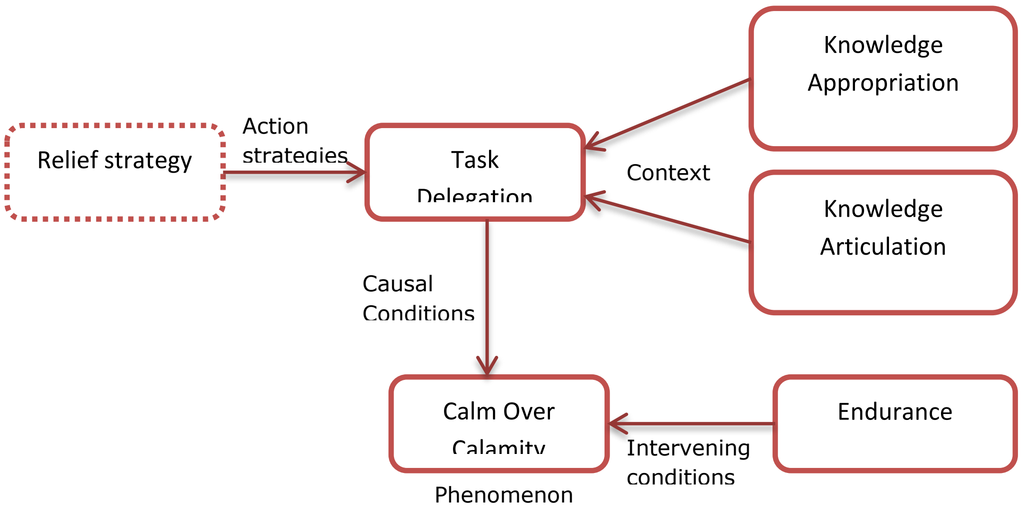

Figure 16: The Grounded Theory of Calm over Calamity

The two knowledge-based categories emerged from data, generates the knowledge power-base for strategizing task delegation in hierarchical knowledge networks. Smooth middle-up-down knowledge transfer through different network levels (appropriation & extension) and continuous interaction between tacit and articulated knowledge (articulation & internalization) collectively facilitate task delegation of PAOs. The ‘endurance' ability, which facilitates PAOs to carry out challenging DRM processes with limited resources enables the ‘calm over calamity’ condition. The ‘endurance’ capacity of PAOs and the ‘calm over calamity’ category collectively influence the resilient behavior of their DRM system. As the ‘relief mentality', category presents anti-resilient features of the community, the model of ‘Calm Over Calamity' suggests to optimize the flood relief activities by designating relief strategy tasks into knowledge networks. Hence, regulating and developing relief strategies contributes to the enactment of resilience mediating through ‘Calm Over Calamity'. The theoretical model depicts the effect of knowledge networks, and relief strategy to enhance the task delegation, and how task delegation foster resilience of PAOs through calmness over calamity and endurability. The coding family Six C’s was altered to relate selective codes to develop the theory of calm over calamity (Glaser, 1978).

CONCLUSION

This study discovered that resilience of the PAOs' knowledge networks, postulated from their ability to stay calm over calamity, which is linked to their task delegation and endurance in the face of a disaster. The effectiveness of task delegation in a knowledge network is critically determined by knowledge appropriation, extension, articulation and internalization processes. The study showed that developing strategies to delegate relief tasks among PAOs to assist people to build forward by enforcing community strengths should not be overlooked. The observable behavioral actions of PAOS to 'endure' loopholes in DRM Strategy such as limited communication resources, duplications of responsibility, and threats from the political system in the district generate the power of calm over calamity. Therefore, this paper concludes that the strategies for effective pre-disaster and post-disaster community development embody in the power of knowledge networks to foster resilience in the context. Further research is suggested to study the effect of community knowledge networks to the enactment of resilience.

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DO GREEN BUILDING RATING TOOLS ADDRESS SUSTAINABILITY? A PARADIGM SHIFT

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ABSTRACT

The global population increase brought forth pressure on two interlinking areas – first one is the dwindling availability of natural resources and impact of built environment to ecological balance and another is increasing vulnerability to natural disasters. In response to the first area of concern, there were more than 600 green building rating system tools that were developed and being used globally for the past twenty six years, towards achieving "sustainability." But do they really address such? This paper deals with leading green building rating systems that were utilized by more than 50% of green construction projects worldwide, and investigates if these assessment systems also address physical absorptive capacity with respect to natural calamities. Mixed methods research which includes extensive literature review on building green and/or sustainable rating systems versus their life cycle analysis (LCA) scope, face-to-face interviews and a survey on beliefs and practices among certified green building professionals were conducted with reference to integrating natural disaster resiliency in a typical green building project. Findings indicate that there is a disconnect between the green building professionals' belief and value systems versus their actual practices on, and with the so-called "green" rating systems that they use, with respect to addressing uncertainties and disaster risks caused by natural calamities. Proposed qualitative enhancements to these green rating system criteria were then presented in this study.

Key words: disaster resiliency, green building rating systems, sustainability, absorptive capacity, life cycle analysis (LCA)

BACKGROUND

The much used and abused "sustainability" concept was originally applied in agricultural production and maintenance of soil nutrients which dictated the survival and decline of different civilizations (Bell *et al*, 2008), until *sustainable development* was formally defined by Brundtland (1987) as responsible stewardship of natural resources by current generation without sacrificing the needs of succeeding generations - in response to the bourgeoning population exerting increasing pressure on rapidly-depleting natural resources. The swift population increase, coupled with growth in economic assets and building stock, increases exposure and vulnerability to natural hazards (Hisser *et al*, 2014) which often lead to disasters especially in poorer regions. (Steele, 1997), which includes the Philippines (Dilley, 2015). Sustainable development is based on three interlinked elements – environmental protection, economic growth and social equality which need to be carefully balanced (International Union for the Conservation of Nature, 2006). Moreover, the concept of sustainable development has been employed by various disciplines, thus, in this paper, it will be discussed in the context of the physical assets and built environment with respect to natural disaster resiliency. Sustainability assessment frameworks (SAFs) thru green and/or sustainable building rating systems thus emerged in response to the call for "sustainability." Berardi (2013) stressed out that "green" buildings have been usually equated with "sustainable" buildings, causing vagueness in the meaning and scope of being "sustainable." Greenness is a way of positively addressing environmental issues (Burnett, 2007). Guy *et al* (2001) presented five co-existing logics (ecological, smart, symbolic, comfort, community and interaction, *respectively*) for 'green buildings' with their particular design strategies (reduce ecological footprint, maximize flexibility, express nature, living building, create identity and adapt to climate change/natural disasters, *respectively*), while Ǿyen *et al* (2009) added a sixth dimension, *climate change adaptability*. Attempts were made in identifying the scope and measure level of "sustainability," as evidenced by more than 600 plus assessment tools that were developed and being used by different sectors worldwide, which however does not address completely "sustainable development." (Roberts, 2006; Jensen *et al*, 2007). Ǿyen *et al* (2009) said that comparing among these is complicated, but not impossible. Difficulty stems out from the nature and varied geo-climatic conditions why these tools were formulated for different types of buildings at different phases of the life cycle (Haapio *et al*, 2008) with some attempting to assess level of "sustainability" of entire cities (Barbosa *et al*, 2014). Basically, these assessment tools are classified as energy modelling software, environmental LCA tools (or *performance based tools*), environmental assessment frameworks and rating systems (or *building rating tools*), environmental guidelines or checklists for design and management of buildings and environmental product declarations, certifications and catalogues (or *knowledge-based tools*) (Haapio *et al*, 2008; *in parenthesis:* Fenner *et al*, 2011)

PREEMPTIVE AND PROACTIVE APPROACH IN REDUCING DISASTER RISKS

Meanwhile, numerous study show that the greater extent of poorly-planned built environment sprawl has a direct relationship with higher degree of disaster risk caused by natural calamities (Brody *et al*, 2007). This can be avoided through an integrated approach (McEntire *et al*, 2010) as early during the conceptualization and design development phases among the built environment professionals and stakeholders in reducing vulnerability of the said built environment to natural disasters, thus preemptively addressing possible future risks in a proactive manner and making the built environment "resilient" (Bosher *et al*, 2007). Integrated Design Process (IDP) originated from Canada in early 1990s through its C-2000 Program. Kibert (2008) stressed out that IDP is facilitated by an external consultant (IDP professional), which involves high-levels of interactive collaboration from all stakeholders (client, architect, engineers, technical consultants and suppliers) and teamwork that help differentiate a green building design from the "linear" design process found in a conventional project in the entire project life cycle (PLC). A typical PLC covers from materials sourcing, construction, building usage, up to demolition and disposal. which preemptively address possible issues and concerns in a project from all aspects, which should include potential physical damage caused by natural calamities. Efficient communication among multi-disciplinary stakeholders is required (Retzlaff, 2008; Seño, 2014). Moreover, pre-design and/or programming phases of green building design process were not emphasized among leading green building assessment tools (Bunz *et al*, 2006) and utilizing IDP in a green building project will demand more lead time in its entire project life cycle (Bernstein, 2013). In response to these, some green rating systems already integrated the "management" part in their rating criteria (LEED and CASBEE) but green building professionals (from construction and engineering companies) still need further training on project management (Wu *et al*, 2010) with limited involvement by structural and/or civil engineers (Chaudhary *et al*, 2013) where the engineers generally view that these rating systems did not provide opportunities for them to significantly contribute (Rodriguez-Nikl *et al*, 2014). Building information modelling (BIM) tools were only used to simulate building performance based from some green building criteria (Azhar *et al*, 2011). These attempts did not cover 'uncertainties' brought upon by natural calamities. Only CASBEE and German Sustainable Building Council (DGNB) addressed the quality of building location with respect to natural hazards, with the latter as "optional" added points only (Achour *et al*, 2015). Resiliency of building stock should be addressed in order to achieve sustainability (Bocchini *et al*, 2014), and deal with climate change risks (O'Brien *et al*, 2006). Resilience capacity is divided into three phases, namely absorptive capacity (stability), adaptive capacity (flexibility) and transformative capacity (transformational response) of systems when subjected to adverse and external stresses (Béné *et al*,2012) which is similar to Jackson *et al* (2013) who deconstructed resilience into four attributes - namely capacity (absorption), flexibility, tolerance and cohesion. The integral part of resilience is hazard mitigation, where negative impacts to the social and economic networks of a community would also be addressed as well (Gordon, 2010). To illustrate how these relate to the SAFs, a comparison of the leading and Philippine-based rating tools based on their absorptive and adaptive capacity criteria, together with their respective IDP implementation, are shown in Table 1. Thus, Charoenkit *et al* (2014) emphasize the need to enhance and upgrade these assessment tools in terms of disaster resiliency. As such, this paper has three objectives: firstly, determine if the disaster resiliency specifically *absorptive capacity* has been considered in these building assessment rating systems thru literature review, secondly, measure level of beliefs/values and practices among certified green building professionals in dealing with physical disaster risks and lastly, the results in the first two objectives will serve as inputs to propose basic enhancements in typical green building projects in terms of the rating systems, materials testing and certification processes.

Table 1. Comparison of leading Sustainability Assessment Frameworks (SAFs) based on Absorptive and Adaptive Capacities and Integrated Design Process Practice

					Absorptive Capacity Criterion per calamity is evident in - (Explicit/Implicit)				Generally, for Absorptive Capacity Criterion -		Adaptive Capacity Criterion		Integrated Design Process (IDP) Implementation Criterion	
Extensive Global Usage[A]	SAF (for New Construction /Buildings)	Year Started	SAF Type	Country of Origin	FL	T	E	SLR	Is it Required?	As Optional (Additional Point Credit)	Is it Required?	As Optional (Additional Point Credit)	Is it Required?	As Optional (Additional Point Credit)
	BERDE®	2010	1	Philippines	▦	▦	■	▦						
	GREEEEN®	2012	1	Philippines	▦					▦				
YES (1)	**LEED®**	1994	1	USA	▦									▦
YES (3-4)	**CASBEE®**	2007	1	Japan	■		■							■
YES (2)	**BREEAM®**	1990	1	UK	▦			■						
	GREEN GLOBES™	2000	1	Canada	▦							▦		■
	BCA GREEN MARK	2005	1	Singapiore	▦									
YES (3-4)	**GREEN STAR®**	2003	1	Australia						■		■		
	ENVISION™ 2.0	2012	1	USA	■	■	■	■		■		■		■

Remarks: 1- Performance-based, 2-Building Rating-based, 3-Knowledge-based FL-flood, T-typhoon, E-earthquake, SLR-sea level rise

A - Green/sustainable building rating systems used by more than 50% of construction projects globally.(World Green Building Council, 2008)

▦ ***- Implied/Suggestive***

■ ***- Clearly Stated***

METHODOLOGY

This study employed mixed methods approach, which lasted for five (5) calendar months. Extensive literature was made concerning green building rating systems, focused mainly with their life cycle analysis (LCA) scope. Combined e-survey and hardcopy forms were disseminated and distributed equally among certified green building professionals that were affiliated with different national green building associations, representing more than 50% of green construction projects globally. Of the 1,600 e-survey forms disseminated, there was roughly 20% auto-email return rate. These were due to conceived electronic spam email filters. Of the 1,250 survey forms that were accepted thru emails, there was a response rate of 16% (200 valid responses). E-survey forms were supplied with additional blank spaces for possible additional comments. The survey form consists of two (2) parts - firstly the respondent's profile in terms of their personal email addresses, age range, gender, nationality, cumulative gross project value of these projects, and nature of professional engagement (as owner or as employee/consultant). The first part also allowed multiple responses in terms of - profession type (e.g., architect, engineer, other professions), project location/s, and green building rating system used. The second part covers their current belief/values systems (5 statements-namely, (I) *I know in detail how Integrated Design Process (IDP) works*, (II) *I believe that the structural resilience design of a particular building should not be the exclusive domain of a structural/civil engineer*, (III) *I believe that all certified green buildings designed and built has a normal structural "shelf life." Thus, it should preemptively address uncertainties (natural disasters),* (IV) *I believe that certified green building rating systems should also address disaster-resiliency and should be present among its score criteria,* and V. *I believe that current "green" building rating systems have already explicitly and completely addressed disaster-resiliency issues*.) with a Likert score range of 1-4 (*Do not agree, Somewhat Agree, Agree and Highly Agree*), and their actual practices during pre-design (3 statements, namely – (VI) *I have strictly and faithfully employed IDP (integrated design process) in my green building projects* (VII) *I have personally witnessed/worked with the structural/civil engineer in the design conceptualization, with the project architect*, (VIII) *In the Life Cycle Analysis (LCA) which I conducted, it should have included as well associated costs related to disaster-proofing or making the structure disaster-resilient (based on local geo-climatic conditions), aside from the energy and maintenance costs.*), design (3 statements, namely – (IX) *I see to it that as part of my decision-making process in approving and/or specifying building materials - I have always considered hard and specific "structural limitations" data (shelf life against wear and tear and resistance to natural disasters) of building materials that were already certified as "green" by reputable third party green building certifications, aside from its impact to health, environment and carbon footprint*, (X) *I see to it that the structural/civil engineer was involved during the site planning design, together with the project architect/urban planner* and (XI) *I have personally witnessed and/or have building simulation programs/software employed (showing multiple scenarios) in testing the natural disaster resilience of a building being designed*) and construction phases (1 statement, namely – (XII) *I see to it that safe building practices were strictly enforced during construction phase in making it sure that it will not be negatively affected by any natural disasters*) also answerable by a four-scale Likert-based response of 1-4 (*Never, Sometimes, More often than Not, Always*), focusing on addressing possible physical damage due to natural calamities (absorptive capacity *in* Béné *et al*, 2012; Jackson *et al*, 2013). Face-to-face interviews were conducted as well for further verification. ANOVA was used to compare differences on survey results among respondents that were grouped based on the green rating system which they used. PEARSON R was employed to determine any significant relationship between overall beliefs/values and actual practices among these green building professionals with respect to disaster risk in their green building projects.

RESULTS, FINDINGS AND DISCUSSION

Majority of the valid respondents are male (80%, 160), and whose age range are between 31-35 and 41-45 years of age (at 25%, 50 each) followed by those between 26-30 (20%, 40), 36-40 and 40-45 (at 10%, 20 each), and between 21-25 and 45-50 (at 5%, 10 each). Respondents are mostly Southeast (SE) Asian nationals (40%, 80), followed by South Asians, Middle-Eastern, Americans (at 15%, 30 each), and South Americans, Europeans and Australians (at 5%, 10 each). Only 25% own their companies which offer green building-related services. Mostly have been in active practice with green building projects between 0-3 years (55%), followed by 6-10 years (20%), 4-5 years (15%), and more than 10 years (10%). Cumulative green building project costs handled range between USD 500,000 to USD 1 Bn. For multiple response-type of survey responses in terms of finished and/or on-going green building project locations, majority are based in South East (SE) Asia (35%), followed by USA (30%), Singapore (20%), Europe (10%) and the remaining ones in South Asia, Australia, Canada, South America, and Middle East (at 5% each). Majority of the respondents use LEED rating system (70%), followed by other rating systems (assorted – e.g. QSAS, GRESB, BERDE, GREEEN, IGBC) (45%), GREEN MARK (20%), while the rest use BREEAM, GREEN GLOBE and GREEN STAR (at 5% each). The respondents are predominantly licensed architects (60%), followed by other professions except engineering (35%), structural engineers and urban/city planners (at 10% each) and mechanical engineers (5%).

Table 2. Survey results on Green Building Professionals' value and belief systems with respect to natural disaster risk reduction

BELIEFS / VALUES SYSTEMS	Freq.	Don't Agree (1)	Freq.	Somewhat Agree (2)	Freq.	Agree (3)	Freq.	Highly Agree (4)	Freq.	Total (%)	Weighted Mean	Std. Dev
I	12	6	12	6	38	19	138	**69**	200	100	**3.51**	0.856
II	NA	NA	52	25	90	**45**	58	29	200	100	**3.03**	0.743
III	NA	NA	28	14	82	41	90	**45**	200	100	**3.31**	0.705
IV	10	5	20	10	100	**50**	70	35	200	100	**3.15**	0.794
V	34	17	110	**55**	56	28	NA	NA	200	100	**2.11**	0.663

Interpretation: 1.00-1.49 Don't Agree / 1.50-2.49 Somewhat Agree / 2.50-3.49 Agree / 3.50-4.00 Highly Agree

As shown in Table 2, belief and values systems among green professionals with regards with handling disaster risks, indicate overall mean score ranges between 2.11 (*somewhat agree*) up to 3.51 (*highly agree*). Majority of respondents *highly agree* that they understand how IDP works (statement I, 69%, mean-3.51, std-0.856) while they generally *agree* that all certified green buildings should preemptively address uncertainties (natural disasters) (statement III, number of respondents between those who *agree* and *highly agree* are almost identical with std-0.705). Meanwhile, respondents generally *agree* that building resilience should not be exclusive to the structural engineer (statement II,mean-3.03, std-0.743) and that the green rating systems should also address disaster resiliency and be present in the assessment criteria (statement IV, mean-3.15,std-0.794). The respondents are unanimous that they *somewhat agree* that current green rating systems have addressed natural disaster resiliency issues (statement V, mean-2.11, std-0.663). ANOVA results for any differences in overall belief system level with regards to disaster risk reduction among users of different green building assessment tools are not significant due to p-value = 0.453 > α = 0.05.

Table 3. Survey results on Green Building Professionals' actual practices with respect to natural disaster risk reduction

ACTUAL PRACTICES	Freq.	Never (1)	Freq.	Sometimes (2)	Freq.	More Often than Not (3)	Freq.	Always (4)	Freq.	Total (%)	Weighted Mean	Std. Dev
Pre-Design Phase												
VI	8	4	82	**41**	70	35	40	20	200	100	**2.71**	0.83
VII	30	15	40	20	70	**35**	60	30	200	100	**2.80**	1.032
VIII	30	15	56	28	84	**42**	30	15	200	100	**2.57**	0.922
Design Phase												
IX	30	15	60	30	90	**45**	20	10	200	100	**2.50**	0.868
X	40	20	40	20	50	25	70	**35**	200	100	**2.75**	1.138
XI	100	**50**	48	24	32	16	20	10	200	100	**1.86**	1.023
Construction Phase												
XII	34	17	50	25	76	**38**	40	20	200	100	**2.61**	0.987

Interpretation: 1.00-1.49 Never / 1.50-2.49 Sometimes / 2.50-3.49 More Often than Not / 3.50-4.00 Always

On the other hand, in Table 3 above, in terms of actual practice, average overall mean scores are lower, ranging between 1.86 (*sometimes practiced*) to 2.80 (*more often than not practiced*). During pre-design phase, majority of respondents *more often than not* conducted IDP in their green building certification processes which was almost identical with the number of those who *sometimes* used it (statement VI, mean-2.71,std-0.830). On the other hand respondents generally *more often than not* have witnessed structural engineers being part of design conceptualization with the project architect (statement VII, mean-2.80, std-1.032) and that their life cycle analysis (LCA) had taken into consideration costs associated with natural disaster-proofing the structure (statement VIII, mean-2.57, std-0.922) which is slightly above the borderline mean (2.50) for doing it *more often than not*. During design development phase, structural "shelf life" with relation to possible natural calamities for commercially "certified green" materials were barely considered with its borderline mean score of 2.50 (statement IX, std-0.868), while concerned engineers were generally present *more often than not* during site planning with the project architect as observed by the respondent (statement X, mean-2.75, std-1.138) which is slightly above borderline mean score of 2.50 for *more often than not* practiced. Building simulations in terms of a proposed structure's disaster resiliency were *barely* to *sometimes* conducted (statement XI, mean-1.86, std-1.023) which is barely above borderline score of 1.50 for *somewhat practiced*. During construction phase, respondents generally *more often than not* considered possible natural disaster risks that might undermine the project (statement XII, mean-2.61, std-0.987) which is slightly above the borderline score of 2.50 within this range. ANOVA results for any differences in overall disaster risk management practice level among users of different green building assessment tools are not significant due to p-value = 0.845 > α = 0.05. Overall, there is no significant relationship among green building professionals' belief/values versus their actual practices with regards to preemptively addressing natural disaster in green building design, as evidenced by PEARSON r-value of +0.433 (weak uphill linear relationship). It means even though the respondents generally believe on core concepts and specific strategies on preemptively addressing disaster risks in their typical green building projects, these were not translated fully in terms of their actual practice. Detailed further, statement I (*highly agree*) survey results are incompatible with statement VI (*more often than not practiced*) where despite full knowledge on IDP (Table 2), it was not regularly practiced (Table 3), leaving room for possible overlooked issues that give room to natural disaster risks. There is a high possibility that the structural engineer was not regularly consulted in the entire green building assessment process (statement VII). Meanwhile respondents generally *agree* certified green buildings should also preemptively address uncertainties (statement III) where natural disaster resiliency should be integrated in the green rating systems (statement IV). Current assessment tools however fell short of addressing natural disaster resiliency (statement V) since LCA and its tools are somewhat limited only to the building's impact to energy, human health, resource consumption and ecology (statement VIII), which corroborates with utter lack of building simulation activities that were ideally to be conducted in the presence of a green building professional, in terms of the building's response to natural calamities (statement X), since these were not required nor expressly indicated by these rating systems in terms of absorptive capacity criterion (stability). Interview results indicate green building professionals tend to perceive sustainability during their life cycle analysis (LCA) in terms of the proposed project's least possible negative impacts to its natural environment setting (e.g. low embodied energy, recyclability, use of reclaimed materials, low toxicity) during the normal course of building life. Inversely, uncertainties like the negative impact of the natural calamities to the structure was not the focus and is not part of its LCA scope. Repair and new construction brought upon by a natural disaster aftermath exhausts new materials that have additional embodied energy and exerts additional pressure on the limited natural resources, which makes it unsustainable in the long term. There is a need then to define the terminus of these green building assessment tools and systems in the context of "sustainability," addressing divergent questions such as "how long can a building avoid obsolescence to be considered sustainable?," versus the perceived environmentally-friendliness of these buildings which should naturally degrade when not needed anymore and decommissioned (recyclability, reclamation) back to its source. Ideally, it should address both.

CONCLUSION AND RECOMMENDATIONS

Study results generally indicate a need to reinforce a holistic mindset in designing high performance green buildings, where the green building professional has to redirect his/her approaches in carrying such project – from just being a "third party external auditor" who checks and credits sought-after green rating points, to being a prime green building design facilitator, in critical partnership with the project architect. The following are therefore recommended. *Firstly*, All certified green building professionals have to be trained with conducting IDP, as a necessary prerequisite. IDP professionals have to be different from project managers, since the former is in itself a tedious process-based activity. *Secondly,* technical specifications of certified "green" building materials should already indicate perceived "shelf" life in their product brochures taking into consideration performance of these in response to natural calamities, institutionalized with respect to national material testing bodies (e.g. American Society for Testing and Materials (ASTM), Philippine National Standards (PNS), etc.). Enforcement of this translates to faster decision-making. *Thirdly*, to simplify, the rating system of any green building assessment tool should clearly indicate as a *pre-requisite criterion*: a.) that IDP has to be faithfully and methodically carried out in each of its criteria, which should also consider *natural disaster resiliency* (absorptive capacity, physical stability) and b.) that the engineer/s concerned should be present and/or consulted in all phases of the green building assessment process in terms of structural stability issues. *Fourth,* SAF tools should already integrate simulated building performance in the face of future natural disaster risks, without compromising their impact along their entire life cycle scope (cradle to grave analysis). *Fifth,* further research can be made in developing specific green building assessment criteria which address also *adaptive capacity* (flexibility) and *transformative capacity* (transformational response) of building systems as well and *lastly,* future studies can be made on assessing actual structural performance of these certified "green" buildings after having been exposed for the past five to twenty years.

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A REVIEW: CRISIS INFORMATICS AND MOBILE APPLICATIONS IN BUILDING RESILIENCE

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ABSTRACT
How members of society interact during disasters has significantly changed because of technological advancements and new media evolution. The modality changes in crisis communication pose risks to public misinformation and confusion if not adopted and addressed. This review, therefore, looks at the literature of crisis informatics from the perspective of the changing dynamics of an interconnected world.

The purpose of this review is to summarise the involvement of mobile applications (apps) in crisis informatics and to scope opportunities for further research on mobile apps for disaster resilience. The scoping review follows Arksey and O'Malley's (2005) five-step process. The review process starts at a broad matter, follows the research trend, and develops inclusion/exclusion criteria to scope the size and nature of a particular topic.

This review discusses the typology of mobile applications in disaster, the broad functionalities covered by literature, the public's role as users, and the apps' roles in the disaster life cycle. Then the paper concludes with recommendations for future research to improve the apps' capabilities to disaster resilience. Areas for future research include (1) usability of mobile applications, (2) public's motivation to use applications, and (3) apps contribution beyond the response phase of the disaster lifecycle.

Keywords: crisis informatics, mobile applications, disaster lifecycle

INTRODUCTION
Communication is a crucial component in managing disasters, as communication can aggravate or alleviate the impact of disaster situations (Haddow & Haddow, 2014; Rodriguez, Diaz, Santos, & Aguirre, 2007). It is the most basic ingredient in responding to disasters (Andersen & Spitzberg, 2009). In disaster scenarios, numerous people and agencies become linked creating complex information demands in constrained supply capacities thus creating large and unique problems (Andersen & Spitzberg, 2009). This review looks at the use of information communication technology (ICT) in society during disasters through scoping crisis informatics literature; particularly, research opportunities in building disaster resilience through mobile technology.

How members of society interact during disaster situations has significantly changed because of technological advancements and new media evolution (Andersen, 2016). With the ubiquitous presence of social media and mobile devices in our networked world, the influence of ICT on social phenomena cannot be ignored (Ngai, Tao, & Moon, 2015).

Two important movements in communications have given rise to crisis informatics: (1) the shift from a top-down approach to a bottom-up interaction, and (2) the growth of socio-mobile capacities (Lopatovska & Smiley, 2014). The increasing interconnectedness of our society challenges the traditional one-way dissemination of disaster communications: from authority to news media to the public (Andersen, 2016; Purohit et al., 2014). The rising trend of social media has created a communications world that has become "more complex than linear" (Andersen, 2016, p.128). In the highly interconnected world, the public is no longer seen as passive; rather, citizens have the capacity to self-organize, network communications and provide ongoing assistance amongst each other during disaster events (Palen, Hiltz, & Liu, 2007).

This paper structures as follows. First, the study briefly discusses crisis informatics and its themes. The paper then presents the methodology. The discussion and analysis portion shows the current research trends for mobile applications (apps) in crisis informatics. The paper concludes with a summary of recommendations for future research.

CRISIS INFORMATICS

Crisis informatics, first coined by Hagar (2006), has been a growing research field of interest (Starbird, Muzny, & Palen, 2012). Crisis informatics looks into the socio-technical aspects of emergency management with particular focus on the interaction between people and organisations involved (Hughes, Peterson, & Palen, 2014). It seeks to understand online behaviour and social computing during disaster events (Palen et al., 2010). The study of crisis informatics aims to contribute in updating theories, developing informed policies, and innovating technologies to better disaster resilience (Palen, Vieweg, & Sutton, 2007; Pipek, Liu, & Kerne, 2014). Crisis informatics integrates three main topics: (1) emergency management, (2) ICT, and (3) socially generated and/or processed content. Crisis informatics covers a wide scope of disciplines and within it branches into several notable themes of study (See Table 1). These themes are not mutually exclusive and may overlap.

In line with the rise of social media usage for disaster communications, mobile technologies also have proliferated. It is through these mobile technologies that users have unparalleled access to social media (Haddow & Haddow, 2014). "Mobile computing is a new arena for innovation and how much personalised and social devices can become gateways to increase communications between stakeholders" (Barrenechea, 2014, p.5). This paper seeks to contribute to the literature of 'improving technical capacities' by reviewing the role of mobile applications in crisis informatics.

Table 1. Crisis Informatics Themes of Study

Themes	Description	Examples of Papers
Social media analytics	A bulk of literature in crisis informatics quantitatively and/or qualitatively assesses data produced by the public through social media to understand the socio-behavioural phenomena. These studies often involve recommendations on improving quality mining of social media data (such as Twitter tweets or Facebook posts) during the immediate timeframe of the disaster.	(Barrenechea, Anderson, Aydin, Hakeem, & Jambi, 2015), (Cameron, Power, Robinson, & Yin, 2012),(Bruns & Stieglitz, 2012)
Adaptation and utilisation	Another area of crisis informatics research looks into how individuals and organisations adopt and use social media and technologies during disaster situations	(Hughes, St. Denis, Palen, & Anderson, 2014), (Kavanaugh et al., 2012), (Lindsay, 2011)
Information sharing behaviour	This area looks at the socio-behavioural aspect of information sharing of people and organisations during disasters. It looks at the motivations behind information seeking and sharing to allow crowdsourcing to work.	(Shaw, Burgess, Crawford, & Bruns, 2013), (Secretan, 2011),(Palen, Hiltz, et al., 2007)
Improving technical capacities	This research area focuses on technological aspects. These papers present technological developments and innovations to improve disaster management capabilities. The studies look at a wide technical range: from infrastructure to modalities that will be resilient during disasters.	(Soden, Budhathoki, & Palen, 2014). (Adam, Shafiq, & Staffin, 2012), (Shih et al., 2013)

METHODOLOGY

This review uses the 'scoping' typology. Scoping reviews, also known as mapping reviews, tries to frame the nature of existing literature on a particular topic (Paré, Trudel, Jaana, & Kitsiou, 2015). Scoping reviews have been conducted and accepted in the information systems field. For example, Sjøberg et al. (2005) and Venkatesh et al. (2007) published well-cited scoping studies that have helped frame the literature in their respective fields of software engineering and technology adoption (Kitchenham, Budgen, & Pearl Brereton, 2011; Paré et al., 2015). The scoping review usually starts at a broad level, follows the research trend and develops inclusion/exclusion criteria to scope the size and nature of a particular topic (Kitchenham et al., 2011; Paré et al., 2015). This study follows Arksey and O'Malley's (2005) five-step scoping review process: (1) defining the research question (2) identifying relevant studies, (3) selecting, (4) charting the data, and (5) analysing and collating the results.

The purpose of the review is to find research opportunities for mobile applications in the crisis informatics literature. The review starts with the broad problem: 'Are mobile applications represented in crisis informatics literature?'

The scan for relevant academic publications started with using the EBSCO Discovery Service – a unified indexed search service that simultaneously searches through multiple high indexed databases and collections. Additional searches were conducted on Scopus and Web of Science to ensure coverage of major publications on the topic. Search criteria include the following keywords 'crisis informatics' and 'mobile'. The search also included variants of these keywords. Alternate search for 'crisis informatics' used a search combination for disaster management (or emergency management or crisis management) and social media (or web 2.0, or citizen science, or crowdsourcing). Substitute keywords for 'mobile', on the other hand, included the words: platform, device, instrument, tool and phone. The initial search resulted in 1,166 hits.

Further filtering removed duplicates within and between databases. Furthermore, the selection included only peer-reviewed journals and conference proceedings. Finally, only publications written in English were considered. The process reduced the number to 373 unique publications. The paper then employed inclusion/exclusion criteria (see Figure 1) to filter relevant papers. Articles included in this scoping study totals to 49.

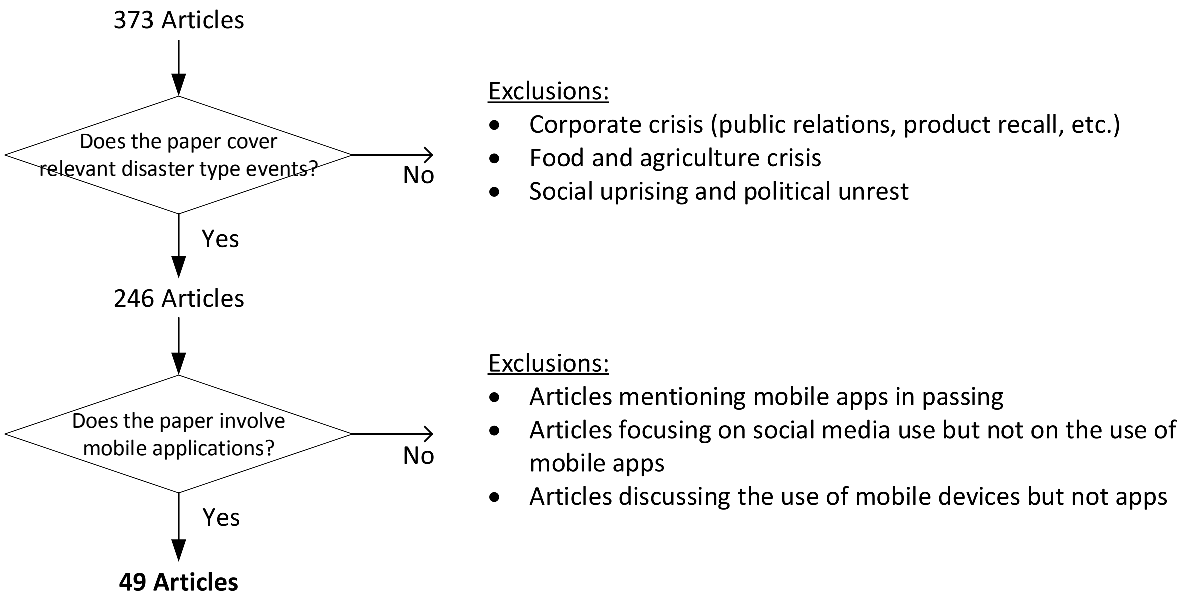

Figure 1. Inclusion and Exclusion Criteria

The remaining articles were subjected to thematic analysis that seeks to answers a broad question: How are mobile apps used for crisis informatics? Unlike other systematic literature typologies, in scoping reviews, the research questions are allowed to be generic (Kitchenham et al., 2011). The thematic analysis reveals important subtopics.

ANALYSIS AND DISCUSSION

The analysis and discussion chapter has three subsections: (1) nature and functions of mobile apps, (2) users of mobile apps, and (3) mobile apps in the disaster cycle.

Typology and Functionality

Different types of mobile apps were presented or reviewed in the 49 articles (See Table 2); what is common is that all apps try to foster better information exchange between and within the public and authorities during the disaster lifecycle. The functionality and design of the app depend on the interaction it tries to foster.

The apps may be made specifically for emergency scenarios and may also be apps used for normal day-to-day activities (e.g. social media apps and news apps). During disasters, social media apps like Twitter and Facebook are popularly used to gather and communicate information; people tend to favour familiar platforms that they have frequently used before the disaster occurrence (Haddow & Haddow, 2014; Nilsson & Stølen, 2011). However, disaster management authorities have concerns in promoting the use of general purpose platforms for emergency situations; many issues arise such as privacy, information quantity and content quality (Schimak, Havlik, & Pielorz, 2015). To circumvent these difficulties, multiple efforts have been made to create apps specifically to channel curated emergency information needs of the public and authorities (Schimak et al., 2015). From the 49 articles considered in this review, 38 articles discussed various apps built specifically for emergency purposes with varying functionalities; while the remaining 11 reviewed the role of social media and mobile apps in a more general manner without pinpointing particular apps. From the 38 articles, a total of 54 disaster mobile apps were introduced; ranging from widely used mobile-version mapping-platform Ushahidi, to experimental apps, to discontinued apps. Table 2 shows the type of apps encountered in the literature and the form of interaction between the public and authorities.

Poblet et al. (2014) conducted a review of web-based and mobile-based disaster crowdsourcing platforms. Their study highlighted that there are two technology approaches in platform functionalities development: (1) data-oriented and (2) communication-oriented. This study observes similar findings; multiple papers focus on data-oriented functionalities where discussion centralises on technical data capacities such as enhancing geo-referenced data quality (e.g. Szczytowski, 2015) as well as systems for mining and processing of multimodal data (e.g. Adam et al., 2012). On the other hand, other papers discuss communication-oriented functionalities where the focus is on building seamless interaction between stakeholders. These include resilient alerting/notification services (e.g. Romano, Onorati, Aedo, & Diaz, 2016), structure for bridging seeker-supplier information (e.g. Shih, Han, & Carroll, 2015), and systems for streamlined crowdsourcing (e.g. Ludwig, Reuter, Siebigteroth, & Pipek, 2015). In most of the papers, however, data- and communication- oriented functionalities are discussed complementarily as part of a whole architecture (e.g. Meissen & Fuchs-Kittowski, 2014).

Table 2. Apps and Interaction used During Disasters

Interaction	N*	Emergency purpose apps	General purpose apps
Many to many	7	Community apps where interest groups (e.g. neighbours or firefighters or mappers) can share information with each other.	Social media apps such as Twitter, Facebook, etc. Messaging apps where a group of people can send messages to each other
One to many	15	Alert apps where authorities send information to public Notification apps where a person can send emergency information to his/her contacts	News apps where a news agency publishes news to public Weather apps where meteorological agency publishes weather information
One to one	2	Notification apps where a person can send information to authorities	Messaging apps where a person can send personal message to another
Many to one	12	Processing apps where a central source processes information from the public.	
One to many to one	10	Crowdtasking apps where a source requests volunteers to send information; information is then processed centrally.	
Many to one to many	8	Crowdsourcing apps where information from the public is aggregated then redistributed to the crowd.	

**Number of emergency purpose apps mentioned in the review literature that falls into the category. ∑N = 54*

Moreover, this review observes a third emerging functionality orientation in the literature (See Figure 2). Though not discussed as frequently, a few papers have addressed the visualisation and interface capacities of applications (e.g. Estuar, De Leon, Santos, Ilagan, & May, 2014). Even if data- and communication- functionalities are in place, mobile applications for disasters must be intuitive at first usage; as users must be able to operate the device and access information in complex disaster situations (Nilsson & Stølen, 2011; Romano et al., 2016). For example, using maps and images may enhance users' awareness as opposed to using text formats (Ludwig et al., 2015; Reuter, Ludwig, Funke, & Pipek, 2015). Research work has not yet particularly focused on the usability of the applications (Imran, Castillo, Diaz, & Vieweg, 2015; Romano et al., 2016)

Mobile App Users

The topic of user-friendliness of the apps brings about the question: who are the 'users' of disaster mobile apps? Although wary of information integrity; according to Adam et al. (2012), authorities (agencies, organisations and responders) find benefit in using smartphones during disasters as the applications permits them to receive real-time situational awareness reports, request updates from citizens and provide effective information response.

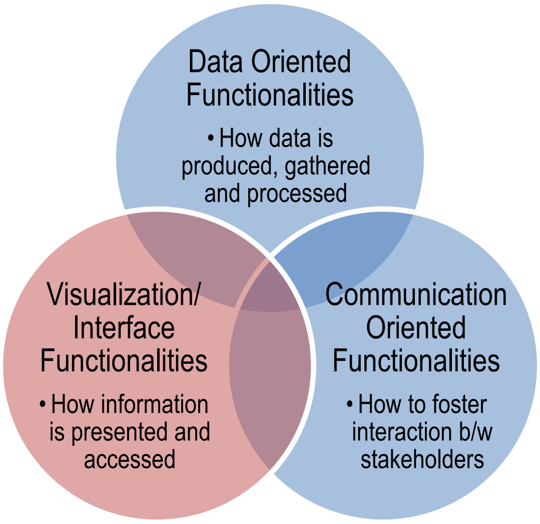

Figure 2. Disaster Mobile Apps Main Functionalities

The public, on the other hand, because of the ubiquity of social media, now play different roles that may include proactive action. From the various articles we have reviewed, the public is usually perceived to take on the following functions: (1) as victims, (2) as targeted receivers of information, (3) as in-situ sensors, and (4) as offsite volunteers. In earlier literature, the public is often only seen as information recipients that requests for assistance and/or receives updates and advisories through mobile phones (Adam et al., 2012). However, as social media evolved and as technologies become more mobile, the citizens are now also seen as potential participating sensors that could give information or perform tasks to aid in disasters.

However, limited literature has looked into how the public is engaged in sharing information through disaster mobile apps. Often, the public uses readily available platforms such as social media apps due to their ease of use, simplicity and familiarity (Antoniou & Ciaramicoli, 2013). Use of built-for-purpose emergency apps may not receive the same traction. Most of the papers in this review presented theoretical or prototype systems where user-participants were recruited for the experimentation or prototyping. With mobile apps, the public's motivation behind downloading and adapting technology would be a useful insight to ensure the apps are fully utilised. Further research is needed to look into the public's motivation and adaptation of disaster mobile applications.

Apps in the Disaster Cycle

Houston et al. (2015) conducted a comprehensive review of academic and non-academic literature and had found that social media use exists throughout the disaster life cycle; the study summarised the functions of social media pre-event, event and post-event. Similarly, ICT developments, such as mobile apps, look to improve disaster management at the various stages of the disaster cycle through minimising uncertainty and augmenting capabilities. All the articles reviewed discussed the apps' multiple contributions and potential influence in managing disasters in all articles reviewed. Table 3 summarises the contributions apps provided at the various stages.

Table 3. Apps' Contribution in the Disaster Cycle

Disaster cycle	%*	Mobile apps contribution
Response	82%	Allows for fast and wide distribution of information Allows for diffused data gathering – crowd as sensors Allows for fast and timely processing – crowd as microtaskers Allows for localised distribution of alerts and warnings
Recovery	27%	Allows for seeker-supplier interaction for donation/information Allows for providing recovery information post-crisis Allows for crowdsourced disaster effects/ damage assessment
Mitigation/ Reduction	27%	Allows for crowdsourced damage assessment Allows for crowdsourced hazards monitoring
Preparedness/ Readiness	27%	Allows for disaster risk education and preparedness learning Allows for gathering of digital volunteers prior occurrence Allows for providing early warning notifications

*% of total 49 articles discussing the role of mobile applications at the particular stage

Articles were not limited to discussing just one stage of the disaster cycle; often the discussion overlaps between phases. However, the majority of the literature focuses on the response stage; as expected, because of the sheer interest on data generated during disaster response. Building disaster resilience capacities should move beyond response, and should be interwoven throughout the disaster life cycle. Further research is encouraged to seek apps utility in the disaster cycle beyond response.

CONCLUSION

Communication paradigms are moving towards the crowd. Mobile technology is the frontier for innovation in improving public preparedness and strengthening the link between citizens and authorities during disaster response (Veil, Buehner, & Palenchar, 2011). This review discussed the various types of mobile apps engaged in crisis informatics, the apps main functionalities, the public's role as users, and the apps' contributions in the disaster life cycle. Through the review, areas for future research are revealed. These include (1) usability of mobile apps, (2) public's motivation to use apps, and (3) mobile apps contribution beyond the response phase of the disaster lifecycle. To fully augment resilience through technology, it is important that future research should engage in user-centred studies to gain more insights into citizens' needs, motivations, expectations, experiences, and limitations when using technology, such as mobile apps, throughout the entire disaster lifecycle.

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COMMUNITY OBLIGATIONS IN SHARED RESPONSIBILITY: POLICY PATHWAYS FOR RESILIENCE

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ABSTRACT

Shared responsibility lies at the heart of the Australian National Strategy for Disaster Resilience; disasters are no longer solely a government responsibility as all societal actors are charged with some obligations for disaster mitigation, response and recovery. However, shared responsibility carries with it certain legal and policy ramifications: for responsibility to be shared across the community, it must be specified, accepted and complied with.

The community is a central concept in the NSDR, as community resilience and empowerment are its stated goals. While research so far has focused on responsibility-sharing between different levels of the government and on the role of the individual, we focus on the much more problematic community. Communities can be place-based (as in a specific locality or region); or interest-based (a group of people within society sharing common characteristics such as ethnicity, religion, recreation or industry); or a combination of these. In disaster resilience the starting point for consideration is a community of place, within which lie multiple, diverse, competing and overlapping communities of interest.

In this study, we break down a hypothetical place-based community into its component parts (households, businesses, government and various types of community organisations) to examine the responsibilities that are (or conceivably might be) placed on them by the NSDR and associated policies. We identify what types of policy instruments (regulation, price signals, moral suasion) are used to ensure, or at least promote compliance and cooperation with identified responsibilities. We then discuss what these policy instruments mean for the achievement of community resilience.

Key words: community resilience; policy instruments; shared responsibility

INTRODUCTION

Shared responsibility is about distributing obligations amongst different actors in society (McLennan & Eburn, 2015). It has the potential to lessen community reliance on emergency services in favour of self-reliance (McLennan & Handmer, 2012, p. 12), reverse patterns of short-term thinking, divert investment into long-term disaster risk reduction and resilience, and promote proactive responses to all stages of disaster management (Goode et al., 2011).

The Australian 2011 National Strategy for Disaster Resilience (NSDR) is an aspirational document that sets out a general policy framework around how Australia should prepare for, respond to and recover from disasters. It envisions shared responsibility as 'political leaders, governments, business and community leaders, and the not-for-profit sector all adopt increased or improved emergency management and advisory roles, and contribute to achieving integrated and coordinated disaster resilience. In turn, communities, individuals and households need to take greater responsibility for their own safety and act on information, advice and other cues provided before, during and after a disaster' (COAG, 2011b, p. 2).

In this paper we present different policy instruments for disaster resilience, the explicit and implied responsibilities of various community actors as detailed in the NSDR and complementary government policies and relevant past reviews (COAG, 2011a; COAG, 2009; Commonwealth of Australia, 2010; Teague et al., 2010). We also offer some discussion of the implications of these.

POLICY PATHWAYS

A 'policy' is a position on an issue taken by a government which recognises a problem and explains what will be done to address it (Handmer & Dovers, 2013). Policies are thus government intentions, often developed in collaboration with non-government actors. The NSDR sets out a general policy framework around how Australia should prepare for, respond to, and recover from disasters. *Policy instruments* are the means that a government has in its disposal to implement its intentions; i.e. the *tools* used to implement policies and achieve policy goals. The NSDR, being aspirational, does not link responsibilities to specific policy instruments. Table 1 sets out the different classes of policy instruments relevant to disaster management, along with explanations and relevant examples. While the instruments are broadly applicable to many countries, the particular examples are Australia-specific and come mainly from the state of New South Wales. The list is illustrative rather than exhaustive. Closer examination of the table reveals that the categories of policy instruments are somewhat porous and a particular instrument could

Table 1: Policy instrument classes and their relevance to shared responsibility in disaster resilience

Policy Instrument Class	Explanation	Example Relevant to Disaster Resilience
Research & Development	General knowledge (basic research)	Research organisations such as universities and the Bushfires and Natural Hazards CRC (www.bnhcrc.com.au) (engage in both types of research) In-house research within agencies and government departments Parliamentary inquiries into individual disasters
	Specific knowledge (applied research)	
Creating & Improving Information & Communication Flows	Between research findings and policy imperatives	Bushfires and Natural Hazards CRC Australasian Fire Authorities Council (http://www.afac.com.au/home)
	Between and within government structures	Intergovernmental committees (e.g. COAG's Standing Council on Police & emergency Management; National Emergency Management Committee) State level: NSW Fire Services Joint Standing Committee; NSW Bush Fire Coordinating Committee Operationally: Australasian Inter-Service Incident Management System (AIIMS) (http://www.afac.com.au/insight/operations)
	Between researchers, government, industries and community	Industry and research-oriented conferences, seminars, workshops, public education campaigns at a community level
Education & Training	Public education (moral suasion)	Public campaigns run by emergency service organisations aimed at educating the public (e.g. Prepare Act Survive campaign (http://www.rfs.nsw.gov.au/plan-and-prepare);StormSafe campaign (http://stormsafe.com.au)
	Targeted education (sub-sets of population)	Specific bushfire advice for farmers: http://www.rfs.nsw.gov.au/plan-and-prepare/prepare-your-property/farm-fire-safety
	Formal education (schools, universities)	Disaster Resilience Education for Schools program https://schools.aemi.edu.au/
	Training (skills development)	Emergency service organisations (such as the SES and RFS) are Registered Training organisations delivering nationally accredited programs to their members (http://training.gov.au/) Organisations such as the Red Cross and St John Volunteers teach First Aid to the general public
	Education regarding other instruments	Public information regarding insurance, subsidies and statute laws provided by relevant government departments
Consultative Instruments	Negotiation	Land use planning: formal and informal negotiations between developers, councillors and the public through a submission process
	Mediation	Local government mechanisms such as the NSW Land and Environment Court, which deals with disputes relevant to natural hazard management (e.g. appeals in local development disputes or tree clearance)
	Dispute resolution	

	Inclusive institutions and processes	Government processes at all levels are usually open to submissions from the public and elected officials are open to petitions and delegations from concerned members of the public regarding specific matters
Agreements & Conventions	Inter-governmental agreements / policies	National Partnership Agreement on Disaster Resilience
	Memoranda of understanding	MOUs abound at many levels: between state governments, between the state and federal government and also between and within emergency service organisations. Examples: MOU regarding fire provision services between the federal and state governments; MOUs between emergency service organisations such as the RFS and SES. At the local level, NSW also has 85 Mutual Aid Agreements (MAA) between various organisations and departments to enable sharing of resources and the provision of a better services
	Conventions and treaties (national & international)	The Sendai Framework for Disaster Risk Reduction 2015-2030
Statute Law	New statutes or regulations under existing law	Every state and territory has statutes to provide for emergency planning and response and the creation of emergency service organisations. National building codes and standards provide standards that reduce natural hazard risks
Common Law	Application of doctrines such as negligence, nuisance, public trust	Common law provisions exist to allow action in emergencies; doctrines of necessity and negligence law that take into account all the circumstances of action including action in an emergency (Eburn, 2013)
Assessment Procedures	Systematic reviews of processes or outcomes	Planning and development laws have inbuilt processes for development proposals to take disaster risk mitigation into account
Self-Regulation	Codes of practice; codes of ethics	Professional codes have to take natural hazard risks into account (e.g. the General Insurance Code of Practice was recently changed to improve the insurers' handling of claims and disputes, particularly those relating to natural disasters (http://www.ndir.gov.au)
	Professional standards within an industry or profession	Emergency service organisations have standards set by AFAC (see: http://www.afac.com.au/insight/doctrine)
Community Involvement	Participation in policy formulation	Community members can take part in local land use planning through participation in local council processes, appeals to elected members at different levels of government and submissions to government inquiries such as Royal Commissions into individual disasters, and participation in the electoral process at all levels of government
	Freedom of information laws	Government jurisdictions have freedom of information legislation (NSW: Government information (Public Access) Act) which enable members of the public to obtain information on land use and other related matters.
	Rights to comment on development proposals	Major development proposals are often subject to public exhibition where local residents obtain information on the proposal and can make submissions (see the

		NSW State Significant Development process:
	Community implementation of programs	Emergency service organisations run public awareness programs within their communities
Price signals: (financial incentives and disincentives)	Taxes & Charges	Fire service levies, flood levies; fines for false callouts for fire services
	Use charges	Charges for fire-fighting services
	Subsidies	Natural Disaster Relief and Recovery Arrangements (see http://www.disasterassist.gov.au/NDRRADetermination/Pages/default.aspx). At a local level, government-funded emergency service organisations provide mitigation work to property owners such as clearing threatening trees or building temporary levies in advance of a flood
	Penalties	Fines for behaviours that may initiate a disaster or hinder recovery, such as penalties for lighting fires during fire ban days or ignoring temporary road closures in flooded areas
	Insurance	Insurance companies provide general and specific insurance for natural hazard risks to businesses and individuals. Government involvement in the insurance market
Institutional or Organisational Change	New or revised settings to enable other instruments or policy and management	Creation of the Inspector General of Emergency Management in Victoria following the Black Saturday bushfires (http://www.igem.vic.gov.au/home/)
Changing Other Policies	Removal or reform of distorting subsidies, conflicting policies or statutory objects	The '10/50 rule' for clearing native vegetation to lessen bushfire risk. Instituted nationally and subsequently modified following widespread misuse to clear vegetation in low bushfire risk areas to improve amenity (see McNally, 2013).
Inaction	Where justified by due consideration, and generally involving commitment to reconsider the issue at a later date	National flood insurance schemes – proposed & investigated in 1870s, 1950s, 1970s but not deemed to be ineffective or undesirable (see Box et al., 2013) Forced evacuations – suggested after major disasters and subsequently dismissed as unworkable

Source: Modified from Dovers & Hussey (2013); Handmer & Dovers (2013) fit into many categories; for example, a Royal Commission is an instrument of statute law, it can be used as a tool of research to gather specific knowledge and also works as a consultative instrument.

Some of these policy instruments are specific to particular stages of disaster management. For example, a Royal Commission is used in the post-disaster stage to find out what happened and recommend improvements. Public education campaigns are usually targeted at the preparation stage to mitigate risks and consequences, while regulation criminalising certain behaviours is relevant at all stages (e.g. penalties for starting bushfires, ignoring roadblocks during disasters or looting damaged homes during recovery). Most often a package of policy instruments is used to address a single issue. For example, individuals face regulatory mechanisms, such as fire bans which prevent people from burning leaves and litter during the fire season to prevent the possibility of accidently starting a bushfire. These regulations are enforced with fines and accompanied by other policy instruments such as public education about the fire season and what individuals ought to do. Public education is also undertaken by emergency service organisations (such as the Rural Fire Service) which recommend that people develop individualised fire plans for their households.

WHO HAS WHAT RESPONSIBILITIES?

The NSDR is clear that disaster resilience is everybody's responsibility and it aims to empower everyone 'to understand and take responsibility for their own risks, to make informed decisions and to take appropriate action' (COAG, 2011b, p. 14). In this section, we link community entities and their responsibilities as they are identified in the NSDR and supporting documentation to broad policy instrument classes. Instead of listing every single responsibility that these documents might mention (such as attendance at public meetings), we have grouped broad categories of responsibilities (such as 'the provision of public education' for governments), which imply a number of specific actions.

Table 2 provides a breakdown of different community entities, their responsibilities and the relevant policy instruments that can be used to enable and enforce them. While Table 2 presents the different community entities as separate categories, in reality the categories may be highly intertwined. Most individuals are members of some form of household and also take on roles as business (or government) employees and employers as well as members of community organisations. Similarly, while emergency service organisations are viewed as community organisations, legally they are part of the government, with the same rights and responsibilities as any government department.

Table 2: A breakdown of the different actors within a community that may be involved in or affected by a natural disaster

Community entities		Actual and Possible Responsibilities (incl. legal obligations)		Policy Instruments
Individuals (Households)	Homeowners, Renters (e.g. Families Share houses Sole occupants Owner Corporations -strata title)	**Preparation phase:** understand risks and adequately prepare for them by acting on advice received from government and other community sources	Availing oneself of relevant information and advice Taking out appropriate insurance Complying with specific legal obligations of homeowners & renters to maintain a property	Education & training Community involvement Price signals Statute law Common law Research & Development
		Preparation phase: become actively involved in local community disaster preparedness plans, or at least being aware of local disaster arrangements	Preparing a personal disaster (fire / flood) plan within the household and ensuring all household members know what to do during a disaster	
		Response phase: Assuming responsibility for vulnerable household members and own actions during disaster (whether it's evacuation or staying to defend)	Implementing own fire / flood plan Taking care of pets, children, people with disabilities	
Businesses	Small, local businesses (e.g. Bakery, Motel)	**Preparation phase:** Understanding the risks adequately prepare for them	Specific legal obligations to maintain a property Preparing a realistic disaster risk management plan that takes into account business needs & operational continuity	Education & training Statute law Common law Price signals Self-regulation Agreements & Conventions Consultative instruments Community involvement Research & Development Assessment procedures
	Farmers (e.g. Irrigation; dairy operations; grazing)	**Preparation phase:** Undertaking wide-reaching business continuity planning that links with security and emergency management arrangements	Maintenance of relevant competency, qualifications Adherence to relevant legislation and codes (e.g. National Construction Code for construction industry)	
	Sole traders (e.g. Plumbers; Roofers)	**Preparation phase:** Understanding available insurance policies, including what items are excluded or not covered	Taking out appropriate insurance	
	Regional / national businesses (e.g. Woolworths; Bunnings)	**Preparation / Response phase:** Ensuring that they are able to continue providing services during or soon after a disaster	Familiarity with emergency services' requirements for business participation in disaster response Provision of supplies and services during response phase Security provision for critical assets & infrastructure	
	Industries (e.g. Construction; manufacture; agriculture)			
	Owners and operators of critical infrastructure	**Response phase:** Compliance with	Following directions of emergency service	

	(e.g. Local power station, and its parent company)	emergency services' directives during disaster	organisations	
Governments	Federal government (may bring outside assistance to community)	**Preparation phase:** Provision of public education to allow all members of society to undertake good decisions **Preparation phase:** Strategic planning to minimise disaster risk	Provision of public education Land use planning Appropriate mitigation of risk factors Adherence to building codes	All of them
	State government departments (e.g. National Parks)	**Preparation phase:** Clarification of responsibilities to enable a whole of government approach to disasters, where different levels of government work together	Negotiations and inter-jurisdictional understanding of who does what in the event of a disaster Implementation of NSDR	
	Local government (e.g. Councils, Shires)	**Response phase:** Oversight of emergency services' management of disaster response	Provision of needed resources in disaster response phase	
Community Organisations	Local branches of emergency management organisations (e.g. Rural Fire Service, State Emergency Service, St John Volunteers, Volunteer Rescue Association)	**Preparation phase:** providing appropriate local information to individuals **Preparation phase:** maintenance of organisational readiness **Response Phase:** helping individuals to cope with, and recover from, a disaster **Recovery phase:** preserve community memory of catastrophic disasters	Provision of public education Each organisation has well-defined responsibilities in specific disasters Focus on protection of life and / or property Provision of needed resources in disaster response phase Training focused on lessons learned from past events	Agreements & Conventions Community involvement Education & training Statute Law Common Law Self-regulation Creating & Improving Information & Communication Flows
	Local branches of national and international disaster relief or interest-based organisations (e.g. Red Cross; Oxfam; Country Women's Association, RSPCA)	**Preparation phase:** providing appropriate local information to individuals **Response Phase:** helping individuals to cope with, and recover from, a disaster **Recovery phase:** preserve community memory of catastrophic disasters	Provision of public education on specific issues consistent with their area of interest Relief / Support / Response actions during disasters consistent with group's area of interest Longer-term financial / social support to rebuild / enhance economic and community resilience	

Source: Authors' construct. The policy instruments are adapted from Dovers & Hussey 2013 and Handmer & Dovers 2013

DISCUSSION

The two Tables clarify and illustrate the various obligations that are implicit in the NSDR and provide a more comprehensive treatment of shared responsibility and its policy implications than exists in policies advocating a shared responsibility approach. In this section we raise several interesting points that come out of this review.

Importance of preparation

As Table 2 shows, most of the responsibilities for all community entities mentioned in the NSDR focus on the pre-disaster stage and on preparing for a disaster in order to reduce the potential consequences (as opposed to mitigating the likelihood of disaster occurence, see Rose, 2007). This is consistent with the assumption that natural disasters are inevitable and likely to increase in frequency (COAG, 2011b; Crosweller, 2015). The focus on the pre-disaster stage is not accidental. The various tensions and conflicts that can occur during and after disasters (such as businesses ignoring regulations or not being able to take up opportunities during and post-disaster, or communities clashing with emergency services over their response) need to be addressed, negotiated and practiced before disasters occur.

Community responses that are not obligations

The focus of Table 2 has been on the legal obligations of various community actors rather than on the spontaneous, one-off community-driven responses to disasters. This is not because such voluntarily-taken actions are unimportant, however they usually occur within a certain communities-of-interest and are difficult to document as they are usually low-key and advertised through the particular community of interest's networks (or they are completely spontaneous) and may pass undetected (and therefore unacknowledged) by the official government-driven emergency response management.

Suitability of policy instruments

We have clarified and presented community responsibilities and policy instrument options without comprehensively evaluating their suitability. The NSDR, for example, focuses on insurance as an important policy instrument in shared responsibility, given its prominence in the recent Brisbane floods which triggered the Natural Disaster Insurance Review that highlighted both industry and government responsibilities in ensuring that appropriate and accessible insurance options exist for individuals and businesses. However, the focus on insurance does not mean that it is necessarily the best or the only mitigation option. For instance, the use of subsidies is under-utilized in Australian disaster mitigation and tends to be indirect (through the voluntary services of emergency organisations), rather than direct (such as discounts for fire-proof fencing to protect critical infrastructure in bushfire-prone areas). More research is needed to determine the appropriateness (or otherwise) of different policy instruments for disaster resilience.

Community empowerment

Empowerment is a stated goal of the NSDR; it is meant to ensure that communities and individuals are able to obtain relevant information and act on it. However, it is unclear whether communities and individuals will thus obtain greater power or authority to act towards disaster resilience outside of already existing channels (such as participating in local governance). The engagement strategy is government controlled and it is unclear how much influence individuals and communities will be able to exercise; the disaster response phase is very much controlled by government regulations that highlight public safety and may frustrate local efforts aimed at long-term resilience. It is thus incumbent on governments at all levels to enable genuinely inclusive governance that is more than just 'engagement' in pre-defined programs but greater social involvement 'from agenda-setting through to implementation and evaluation' (McLennan et al., 2014).

CONCLUSION

In this paper we have clarified and illustrated the responsibilities envisioned for different community entities and linked these to policy instruments, and highlighted the role of businesses and community organisations. While each aspect of this analysis (community entities, their responsibilities and policy instruments) could be expanded upon further, we have focused on presenting a clear framework of what is or might be expected from whom in a natural disaster scenario. The resulting discussion highlights the need for all community entities to work together at the pre-disaster phase and strengthen public involvement in disaster management.

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INTRODUCING THE CHRISTCHURCH BUILD BACK SMARTER INITIATIVE

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ABSTRACT

The results of disasters present opportunities.

When an earthquake has shaken the brick veneer off a house, there is a golden opportunity to install wall insulation as part of the repair process.

Residential repair and rebuild is a significant component of the recovery from the 2010 and 2011 Canterbury earthquakes where over 85,000 houses were damaged but considered to be repairable. Canterbury's housing stock, along with that of the rest of the country is known to contain a high proportion of cold, damp homes. While earthquake repairs are being completed, these housing problems can be solved at significantly lower cost than would be the case for addressing them separately. Improving the performance of walls, ceilings and floors can reduce occupant illness and inefficient residential use of resources. It is an opportunity which may not occur again in the lifecycle of many houses to improve their resilience and livability. This approach also reflects international practice to build back better as part of disaster recovery.

Build Back Smarter is a free advice service to Canterbury home owners to help them identify and prioritise improvements that can be made to the performance of their houses. The service is aimed initially at people whose houses need repairing, but is also available to all who want it. The service is jointly supported by Christchurch and Canterbury Councils and central government agencies.

This paper describes the service and its development through two years of planning, investigation, partnership, consultation and coordination with repair insurance and construction agencies.

Key words: Insulation, Insurance, Livability, Resilience.

INTRODUCTION

Build Back Smarter is a free service to Canterbury home owners with face to face advice on making homes warmer, drier, healthier, more resilient and cheaper to run. It is hosted on the Christchurch City Council website, and is a joint initiative of Christchurch City Council, the Ministry of

Business, Innovation and Employment, and EECA Energywise. (Build Back Smarter 2016 and 2016A) These three agencies are jointly funding the service for its first two years.

The principal objectives for developing the service were to improve the resilience and sustainability of houses in Canterbury following the earthquakes of 2010 and 2011. The need to repair damaged houses, involving often quite disruptive building interventions was seen as an opportunity to improve the thermal, seismic and weathertight performance of houses. It is also an opportunity to introduce features which would add resilience and independence for home owners, such as rainwater storage, efficient heating systems, solar hot water and photovoltaic electricity generation. These improvements are not regarded as repairs to be covered by insurance, but they are cheaper and easier to do while a household is disturbed by damage and repairs. The Build Back Smarter Service helps home owners to prioritise improvements they can make to their houses, and introduces them to financial assistance or mortgage extensions.

Since the Build Back Smarter Service was introduced in 2014 for people with damaged houses, the advice has also been sought by Canterbury residents whose houses are not undergoing earthquake repairs, but who would like advice on how to make their houses more comfortable and resilient.


Figure 1. Broken wall claddings and interior linings make an opportunity for installing wall insulation

BACKGROUND

The Build Back Smarter service developed from the work of the Canterbury Sustainable Homes Working Party (CSHWP).

The CSHWP was established in November 2011 in the Housing Programme of the Canterbury Earthquake Recovery Authority (CERA) as one of three groups influencing and guiding the residential built environment in Canterbury. The Working Party has some 22 members appointed to represent central and local government, energy, sustainability, commercial, social and cultural interests in Canterbury.

The author is a member of the Canterbury Sustainable Homes Working Party and on its establishment was appointed by the (then) Department of Building and Housing and CERA as its Chairman. He maintained that position for the first three years of the Working Party's activities during the period when the Build Back Smarter programme was being developed.

The purpose of the CSHWP is to encourage collaborative connections between organisations involved in the promotion, delivery or funding of sustainable, healthy and smart homes in Canterbury. In the years following the earthquakes, it has addressed its purpose by making recommendations to CERA aimed at improving the resilience of Canterbury houses.

CSHWP members were keen to extend its mandate beyond encouraging collaborative connections, and to work to initiate projects that would improve living conditions in Canterbury. Through workshop discussions and on evidence brought to it, they decided to concentrate on ways to improve residential indoor environment quality, as well as housing resilience generally.

Canterbury's housing stock contains a high proportion of cold, damp homes, and a substantial body of research shows that many houses throughout New Zealand are cold, with temperatures regularly falling below the World Health Organisation's recommendations (WHO 2009). Providing insulation improves comfort levels and reduces household energy costs (Grimes et al 2011), but more serious are the connections between cold humid living environments and critical respiratory diseases which have been well recognized for some time. Housing environments have direct impacts on human health through factors including room temperature, humidity, ventilation, overcrowding, affordability and fuel poverty.(Howden-Chapman et al 2008), (O'Sullivan 2015). Poor housing quality leads to poor health and wellbeing, inefficient resource use, pollution, expense to the home owner directly, and also to tax payers from, for example, high hospital attendances. A recent BRE study in the UK has confirmed a long-established and recognized relationship between poor housing and poor health. By far the biggest housing related cost to the national health system results from cold and damp houses. (Roys et al 2016). Through its membership of the CSHWP and participation in the development of the Build Back Smarter programme, the Canterbury District Health Board has also expressed strong concerns about the costs that poor housing imposes on its health service provisions.

A study by Beacon Pathway Inc described the opportunity and the case for making improvements to houses in Canterbury across a number of factors. In mid-2013, they estimated that some 50,000 houses were yet to be repaired, many of which had substantial damage, and that 90% of affected homes in Canterbury were expected to need at least insulation retrofits. (Easton 2013)

It is likely that over 60% of Canterbury houses were built before minimum insulation standards were introduced. The Local Government Amendment Act which came into force in 1978 required all new houses in New Zealand to have minimum levels of thermal insulation. Earlier initiatives by Waimairi County in 1971 and Christchurch City Council in 1972 required thermal insulation by law, and in 1975 the government introduced an interest-free loan scheme to encourage the insulation of houses to minimum levels. (Isaacs 2016). These initiatives notwithstanding, it is unlikely that many houses would have had insulated walls before houses newly built from 1978 onwards. Most pre 1978 earthquake damaged houses would have no wall insulation.

Retrofitting wall insulation to existing homes is most easily done when claddings or linings are being removed and replaced. There is a strong case therefore, for the implementation of a whole of house retrofit approach alongside the earthquake repair process. This includes stabilising indoor air temperatures and ensuring ventilation, adequate heating and heat transfer, maximising winter solar gain, and attending to window orientation and double glazing.

In addition to improving the indoor air quality and thermal performance of houses and the health prospects of their occupants, there are other resilience oriented measures which could be considered during repairs, for example:-

Replacing a broken tiled roof with a lightweight material such as steel or aluminium to reduce the seismic structural load on a house.
Installing more efficient water heating – including consideration of solar water heating to reduce reliance on mains power supply.
Installing rain water storage tanks to ensure a resilient water supply
Installing photovoltaic roof panels with storage batteries to ensure a resilient power supply.

Figure 2. Replacing roof tiles with lightweight metal will increase resilience

 

Figure 3. Photovoltaic panels and rainwater storage increase resilience

DEVELOPING THE BUILD BACK SMARTER SERVICE

Development of the Build Back Smarter service is the result of two years of investigation, partnership consultation and planning, including a Build Back Smarter Pilot project.

CSHWP members were aware of a pilot programme run by Beacon Pathway Inc., and ran workshops and open sessions, including public sessions at home shows, advising people how they could improve resilience. They recognized that it would be important to reach agreement with the Insurance companies and their project management offices (PMOs) about allowing improvement work to be done during the repair process. Understanding the processes used by insurance companies and their Project Management Offices (PMOs) and to investigate insurers' concerns and drivers relating to home improvements was an important first step. Although the proposal was, from the outset, based on homeowners paying for their improvements, the improvement work has to be coordinated with, and not obstruct the earthquake repair work.

There was widespread agreement between insurance agencies and their PMOs that many homeowners would like some improvements during the repair process and some were already allowing home owners to include improvements in their repair process if they could pay for them up front. However all of the PMOs were concerned about the risks of time and cost increases if additional work was to be undertaken while repairs were being made. With the large number of houses to be repaired and the sizeable labour forces to be managed, coordination with individual home owners' contractors could, they thought, disrupt their programmes. They were also concerned about older houses with degraded electrical insulation being disturbed, a range of health and safety aspects, and concerns about liability.

The responsibility of insurers is clearly to repair damaged building elements. The repair work must comply with the current Building Code, but if, for example, brick veneer is damaged, their responsibility is to repair the damaged brick work to current code standards, but not to upgrade the whole wall system (including insulation) to meet the Code. Eventually they agreed to allow for improvement work if it could be clearly separated contractually, and in terms of their programmes, from the insurance repair work. Following extensive negotiation with the CSHWP, a consistent approach from the insurance industry to home improvements was developed which allows home owners to have improvements made following their insurance assessment and before repair work starts.

The CSHWP decided to build on the success of a pilot programme where Beacon Pathway Inc had been working with the owners of some damaged Christchurch properties to include resilience and performance-enhancing features in repairs. (Easton 2013A, Easton and King 2013). Beacon Pathway Inc had previously undertaken extensive field studies of the effects and benefits from relatively minor and inexpensive performance-enhancing housing interventions. (Burgess et al 2009). They had also prepared a value case for Building Back Smarter (Easton 2013) which cites a clustering of multiple fuel poverty characteristics- higher rates of cold homes and under-heating, difficulty with energy bill paying, periods of disconnection and poor heating appliance effectiveness and efficiency. These were exacerbated following the earthquakes, demonstrating the very low level of resilience of Canterbury houses.

The service delivery plan for Build Back Smarter was developed by Beacon Pathway Inc (contracted to MBIE) and was reviewed by a Steering Committee with representatives from the CSHWP. A financial arrangement for providing the service for two years was brokered between MBIE and CCC and EECA.

Earlier, and while the concept was being developed, the idea and acceptability of making house performance improvements during the earthquake repair process was tested at public meetings, public presentations at home shows, and leaflets published by the City Council.

THE BUILD BACK SMARTER SERVICE

The Build Back Smarter service was commenced towards the end of 2014 with information about the Service available from the Christchurch City Council and on the Council website.

The Service employs knowledgeable and well-trained case managers who work with householders to ensure that key interventions, such as wall insulation, can be installed without disrupting the earthquake repair process. They are also providing long-term improvement plans for householders which go beyond the initial interventions. Build Back Smarter (2016)

The following organisations, which are represented on the Canterbury Sustainable Homes Working Party, have provided funding, management and governance for setting up and operating the service.

Energy Efficiency and Conservation Authority (EECA)
Ministry of Business, Innovation and Employment (MBIE)
Christchurch City Council (CCC)
Canterbury District Health Board (CDHB)
Environment Canterbury (ECan)
Canterbury Earthquake Recovery Authority (CERA)

The cost of providing the service excludes the cost of materials and installation, which are paid for by the householder, or the householder and others with a stake in improving outcomes. (E.g. Grants from the Ministry of Health, EECA, ECan, industry and finance companies). Case managers are able to advise householders on possible sources of finance, as well as assisting them with engaging relevant trade services.

At the end of the two year free service period, Build Back Smarter will be reviewed and terminated or proposals for funding its continued service will be explored.

DISCUSSION

In Canterbury, as in other places struck by disastrous destruction, there are discussions about the importance and ethics of demolishing and rebuilding or improving what was there before. There is also the question of what can people be told about fixing up their houses, and how should they be told. From experiences in other places, it was apparent that the most effective way is to provide people with full information about possibilities for improvements, and assist them to make decisions about priorities in terms of their personal resources. (Buxton 2016)
This is the principle on which Build Back Smarter is based, comprising a formal information and support service to enable homeowners to set their priorities in an informed way. (Easton 2013A).

Many people with damaged houses were unaware of what could be done to improve them, or where to start setting about getting the work done. In situations like these, Buxton (2016) has observed that supplying technical knowledge and training to help people help themselves is both enabling and motivating. Successful and enduring resilient reconstructions following disasters in other parts of the world have resulted from an emphasis on true collaboration with the community, and where professionals and technical experts have supplied technical knowledge and training to help people to help themselves and their neighbours.

An issue which remains pertinent throughout disaster reconstruction is whether to try to rebuild a more resilient version of what went before, or to use the tabula rasa as a chance to start anew with a fresh vision altogether. Clearly the latter was not an option the City of Christchurch and the government were prepared to consider, and building back with improvements has become the accepted option.

By the end of the 2015/16 financial year, some 1500 home owners were expected to have used the Build Back Smarter service. The main changes they have made have been fundamental and functional, including insulation, lighting, ventilation, improvements to curtains, window glazing and draft stopping. They have recognised the advantages of making their houses smarter than the code requirements under which they were built. Some aspects of the service appreciated by home owners included:

High quality of the advice (helpful, practical, relevant)
Quality of the advisors (knowledge, professional, prompt, thorough and courteous)
Free service (no charge and available to all)
Affordability of the recommendations (gave a range of recommendations, tips and behaviours, included recommendations about subsidies)
In home, face to face advice (assessors come to your home and can answer questions directly)

CONCLUSIONS

An increasing number of enquiries for the Build Back Smarter Service from owners of undamaged homes, suggests that this kind of service could have on-going application beyond earthquake repairs. It has the potential to address the problems of cold, damp underperforming homes in the New Zealand building stock, to reduce housing-related health and energy costs, while improving sustainability and resilience.
The next step will be to review the service delivery plan for Build Back Smarter, to modify the financial arrangements to enable the service to become self-supporting. The financial arrangements with the case managers, builders and material suppliers are such that it could be possible for the service to be continued as a self-sustaining business. The governing organisations are also interested to consider the possibility of expanding this advisory service to other towns and cities where there are still many underperforming houses. It would provide home owners across New Zealand with information and advice about how to improve the performance and resilience of their houses and advice to new home builders.

In parallel with the Build Back Smarter Service, a publication has now been produced providing free information and guidance for home renovations. This includes heating, insulation, ventilation and moisture management, lighting, as well as links to other future-proofing and resilience approaches including lifetime design. Another parallel publication has also been produced providing guidance for people planning a new home. This extends to advice on house orientation to maximize solar gain, selection and location of windows, heating and lighting systems. It also includes advice on building in resilience with solar hot water and power systems, rainwater collection, and lifetime design. (Build Back Smarter 2016 and 2016A)

Figure 4. Build Back Smarter home renovation and new home guides

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CAMPERVANS, TEMPORARY VILLAGES AND STUFF

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The February 2011 earthquake in Canterbury New Zealand, left hundreds of Christchurch people with broken houses. To provide immediate emergency temporary shelter, the Department of Building and Housing assembled 350 campervans on the Canterbury Agricultural Park and offered them for rent at reasonable rates. Only one campervan was used. The Department also arranged construction of 83 houses in three temporary villages where families could stay for up to 12 months while their houses were being fixed, or until they found new permanent homes. However the demand for temporary houses was far less than expected. Early planning envisaged that several hundred temporary houses would be necessary, compared with the 83 actually built. Several reasons have been cited for this low up-take of emergency shelter and temporary housing. Many families found private accommodation with friends and relatives. But a large number of families stayed with their damaged houses, even in conditions of extreme inconvenience with no water or sanitation, and loss of weathertightness. People in shock and facing uncertainty were reluctant to move away from their possessions and familiar locations, where they wanted to stay, sometimes with danger and great discomfort. Their behavioural response was to stay with their stuff. Understanding behavioural responses can assist resilience planning and allocation of resources following disasters. It can also inform processes for deciding what has to be abandoned and replaced, and what has to be retained.

KEY WORDS: behaviour, decisions, emergency shelter, temporary housing

REVIEW OF LEGISLATIVE CHANGES IN DISASTERS: NEW ZEALAND CASE STUDY

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ABSTRACT

It is apparent that a strong positive relationship exists between building and environmental legislation and recovery activities after disaster events. The pace of recovery is influenced by legislation and changes to legislation are very often required to cater for practical realities of recovery in disasters. A lot can be learned from this relationship as countries aspire for reduced vulnerabilities to disasters that they are exposed to. Therefore this study undertakes a review of legislative changes that took place during the Canterbury earthquakes (case study event) in New Zealand. A content analysis approach is adopted to the review of recovery reports to determine changes to building and environmental legislation necessitated by the earthquake. This approach is complemented with personal interviews with two disaster management practitioners to provide better understanding of the rationale for the identified legislative changes in New Zealand. From the analysis, the study suggests key areas of legislation that disaster management agencies could focus on in their reduction and readiness planning activities. It is anticipated that disaster management agencies could benefit from a reflective approach to real time disaster events (as determined from this study) and consequently become more proactive.

Keywords: Disasters, Legislation, New Zealand

INTRODUCTION

New Zealand is prone to several disasters, from natural to technological and to man-made hazards (ODESC, 2007). The Officials Committee for Domestic and External Security Coordination (ODESC) explain that there are no fewer than 17 hazards that could cause distortions to its natural environment. The devastation of Christchurch by two major earthquakes in September 2010 and February 2011 are testaments of New Zealand's vulnerability to natural events. The earthquakes resulted in over 140 deaths with about 10,000 buildings needing to be rebuilt or demolished. The events bring to the fore the significance of having in place, appropriate legislation that could facilitate early reconstruction and recovery activities. Furthermore, there is evidence from previous world disasters that legislation could become impediments to the pace of reconstruction that is very often desired after disaster events. Some of the impediments may be due to procedural constraints (Meese *et al.,* 2005) or overregulation (Burby *et al.,* 2006). Both examples make for burdensomeness, involve excessive rules and regulations and bureaucratic (mandatory procedures). There is a strong positive relationship between building and environmental legislation and the pace of recovery activities after disaster events (Martin, 2005). The pace of recovery is influenced by legislation, and changes to legislation are very often required to cater for practical realities of recovery in disasters (Rotimi, 2014). A lot can be learned from this relationship as countries aspire for reduced vulnerabilities to disasters that they are exposed to. This study undertakes a review of legislative changes that took place during the Canterbury earthquakes (case study event) in New Zealand. Before this, a brief review of literature on legislation and reconstruction; and the approach to the study is presented in the following sections.

BRIEF LITERATURE REVIEW

When disasters happen, recovery agencies coupled with individuals and communities desire an early return to normalcy. However reconstruction of the built environment need to be approached with caution, as there is no intention to expose prevalent communities to similar or more hazards that they are unable to cope with. Disaster response and recovery are not 'business as usual' hence normal routine processes are unlikely to be effective (Rotimi, 2011). Wilkinson, Rotimi and Mannakkara's (2014) five stages of reconstruction activities comprise chaos, realisation, mobilisation, struggle and new normal. These provide a picture of the dislocations and abnormalities that follow disasters.

Legislation and regulatory policies and programmes have to be put in place beforehand to assist with post-disaster reconstruction efforts. Where it is not possible to institute legislation before hand, quite often this has to be done during recovery programmes in the light of prevailing circumstances. Although Cousins (2004) explains that the opportunities for increasing community resiliency do not remain for too long after disasters. Rotimi (2010) rationalizes that the overall desire is for legislation to enhance recovery and reconstruction programmes so that the affected community recovers rapidly while also attempting to reduce their future disaster risks.

Wilkinson *et al.* (2014) explains that changes in legislation after disaster events usually take the form of legislation for compliance or for facilitation. Legislation for compliance enforce initiatives that could reduce future vulnerabilities. For example there may be requirements to comply with existing building design codes or other general guidelines. Legislation for facilitation refers to situations where legislation simplifies and assists recovery activities to hasten recovery processes. These changes can usually be in the form of revision or change to existing building and environmental legislation.

In this light, fast-tracked consenting procedures, collaborative arrangements between responding agencies, access to shared information, are some of the creative means by which legislation could be made to speed up reconstruction (Wilkinson *et al.,* 2014).

Legislation would need to be well thought out, articulated and implemented in a manner that the objectives for reconstruction are largely achievable. This suggests that legislation may become impediments. May (2004) provides three means by which legislation may constrain reconstruction programmes. Firstly legislation could constrain reconstruction by delaying compliance and approval processes for reconstruction programmes. Secondly, legislation may become overly rigid in implementation such that it becomes unsupportive of genuine reconstruction efforts. Perhaps the most serious disadvantage of too rigid implementation according to Listokin and Hattis (2004) is it forces implementers to want to "go by the book". Hence, preventing their discretionary or proactive implementation of recovery policies. Lastly, May (2004) suggest legislative provisions may involve too many administrative layers which could complicate implementation. For instance, commenting on the Resource Management Act in New Zealand, Rotimi (2014) had indicated that its administrative requirements (around wide scale consultation for example) may result in unfulfilled community expectations for early return to normalcy after a disaster event.

Rotimi’s (2010) study on the negative effect that legislative provisions could have on post-disaster reconstruction is useful in this context also. Rotimi contends that poor planning and implementation, restrictive legislation and regulatory provisions, and lack of government commitment in reconstruction programmes will result in loss of vital momentum of action. Consequentially post-disaster reconstruction activities become ineffective. Recovery agencies become non-commitant because legislation prevents them from using their discretions and to apply pragmatic solutions where needed. Oftentimes agencies are unable to accelerate procedural arrangements because legislation prevents them from doing so.

Yet speed is of essence in the reconstruction of the built environment, to prevent a secondary disaster from happening because an affected community does not feel that normality has been restored. In the case of the Northridge Earthquake, USA in 1994, rapidity of the reconstruction programmes contributed to the economic revitalization of the Southern California area. Marano and Fraser (2006) commenting on the reconstruction after the Northridge earthquake concluded that "identifying and easing regulations and statutes that inhibit reconstruction can mean a dramatically faster and less costly recovery." Similarly Comerio (2004) found that enabling emergency management legislation played a substantial role in the rebuilding works. Legislation was suspended, and emergency powers were used with the consequence of reducing reconstruction times for damaged highways (Wilkinson *et al.,* 2014).

Wilkinson *et al.* (2014) provide examples to demonstrate how policy changes and legislative reviews impact positively on recovery after Hurricane Katrina, New Orleans, USA in 2005. Three major changes that were noted in their study include; changes in building codes and standards, changes to emergency management regulations and guidelines and changes in land development regulations. Reconstruction works after the disaster event which were aimed at stimulating development and growth were largely achieved through the three key changes highlighted previously. Built asset reinstatements are a major input to holistic recovery (Rotimi, 2010).

Other world examples of reviews to legislation to allow reconstruction include: the review of requirements for planning and building permits for temporary accommodation after Australian bushfires in 2012. Planning permits were exempted for temporary structures so they could be put up quickly. Planning permits were exempted for permanent dwellings also, and only building permits were needed after the bushfire (DPCD 2013). These major moratoriums greatly sped the pace of rebuilding programmes after the bushfire.

Considering the above examples, it is safe to conclude that when building and environmental legislation and regulatory provisions are well-articulated and implemented, they would provide an effective means of reducing and containing vulnerabilities (Rotimi, 2010). Further, effective implementation of legislation could facilitate reconstruction programmes.

APPROACH

This study undertakes a review of legislative changes that took place during the Canterbury earthquakes (case study event) in New Zealand. The review of legislative studies requires an inductive methodology to be adopted as this is more open ended and exploratory in nature and would enable meaningful findings to emerge. The current study adopted a qualitative research method because this is ideal for understanding perceptions on the impact of legislative changes during the Canterbury earthquake in New Zealand. Two distinct lines of investigations were used. Firstly, content analysis method is employed to review recovery reports in order to determine changes to building legislation necessitated by the disaster event (earthquake). The second line of investigation involved semi structured personal interviews with two disaster management practitioners (DM1 and DM2) to explore and understand the rationale for the identified legislative changes in New Zealand. The questions developed for the personal interviews were both open-ended and more theoretically driven questions which helped to draw participants more effectively into the subject matter. The questions align with key issues associated with the reconstruction of the built environment. In presenting the result of the study findings, these key issues are expounded further.

FINDINGS

The findings from the two lines of investigations have been merged to provide coherent set of information on the legislative changes that have taken place since the earthquake in the Canterbury region. Legislative changes relate to those of compliance and facilitation. For convenience the findings are discussed under these two major groupings.

Legislation for Compliance

As was previously explained, legislation for compliance refers to situations where initiatives for reducing vulnerabilities are enforced through legislation. This usually relate to building and environmental legislation. In the context of this paper most of the content reviewed seem to focus on the amendments to the Building Act 2004 and the Resource Management Act 1991 in New Zealand.

The Building Act 2004

The Building Act provides for the regulation of building work and setting performance standards for New Zealand buildings. Considering the extent of damage to buildings and infrastructure after the Canterbury earthquakes, there was concern that the remaining existing built assets and any other proposed, require future proofing to reduce their vulnerability to disaster damage. Thus a Building (Earthquake-prone Buildings) Amendment Bill was put together for the New Zealand Parliament to consider. The main focus of the Bill was to cause a review of Government's policy on the management of earthquake-prone buildings.

Green, Monteith, Pickmere and Gilbert (2016) provide an overview of the significant amendments that were introduced into the Building Act 2004. They include:

inserting a new definition of 'earthquake-prone building';

creating new geographical zones of seismic risk;

providing for work on "priority buildings" to be prioritised;

providing for timeframes during which territorial authorities must undertake seismic capacity assessments and building owners must strengthen or demolish earthquake-prone buildings (including a possible extension for heritage buildings);

amending the provisions relating to alterations to existing buildings;

enabling territorial authorities to issue building consents for required seismic work on buildings that are earthquake-prone without requiring the owner to undertake other upgrades at the same time (for access and facilities for people with disabilities and for means of escape from fire);

enabling territorial authorities to apply to the District Court for an order authorising it to carry out or complete seismic work; and

creating offences for the failure to comply with seismic work notices and imposing fines of up to $200,000.

One of the interviewees (DM2) explains that so much concern was generated for earthquake prone buildings because of the significant fatality recorded in one building alone in Christchurch, Canterbury. Hence any building or parts of buildings that will have their ultimate capacity exceeded in a moderate earthquake are a source of concern. Particularly buildings that meet less than 34% of strength requirements contained in the National Building Standard.

The Building (Earthquake-prone Buildings) Amendment Bill received Royal assent (on 13 May 2016). However most of the proposed changes will not come into effect till 2018. The general implication of the Bill is that there will be more proactive assessment and identification of buildings that fall within the earthquake prone category, even in areas where there is a low risk of earthquakes occurring. Further, timeframes have been shortened significantly (and in accordance to seismic risk profiles) so that compliance is ensured in the nearest future. This approach is preventative and forward looking, thus vulnerability of New Zealand communities are designed to be significantly reduced.

The Resource Management Act RMA 1991

The RMA encapsulates environmental management legislation in New Zealand. It is the Act that provides for the avoidance, remedy or mitigation of the adverse effects of proposed activities on the environment; and also ensures that environmental principles are provided for in every resource management planning and decision-making activities (Rotimi, 2014). The RMA has been criticised variously for outlining cumbersome planning processes and for the enormous time and cost involved in consenting applications. Rotimi (2014) highlights some of the impediments to include: bureaucracy and procedural requirements that could become frustrating when there is a spike of consent applications after a disaster event, improper work prioritization routes that do not take into cogniscance the peculiarities of emergency works, and poor attention to nationally significant projects that do not take into cogniscance the peculiarities of emergency works.

There were reviews and amendments put in place for simplifying and streamlining stipulated procedures in 2009, and ensuring that the RMA is in tandem with community planning needs in 2013. More recent amendment proposed in 2015, desire to create a resource management system that achieves the sustainable management of natural and physical resources in an efficient and equitable way (MfE, 2015). Five key subject matters were covered in the new proposals contained in the Resource Legislation Amendment Bill 2015:

Improving national consistency and direction

Creating a responsive planning process

Simplifying the consenting system

Recognizing the importance of affordable housing

Better alignment with other Acts

In relation to natural hazards and probably as a consequence of the Christchurch earthquake the Bill includes the management of natural hazards like earthquakes as a matter of national importance. This means that separate procedural guidelines will be adopted in the event of wide scale destructions that will bypass normal bureaucracy. According to DM1, this "portends well reconstruction programmes". The pace desired for reconstruction works during the Canterbury earthquake was hampered by the wide scale consultation required by the RMA. Therefore DM1 is of the opinion that making reconstruction works nationally significant bodes well for overall recovery.

Legislation for Facilitation

Legislation for facilitation refers to situations where legislation simplifies and assists recovery activities to hasten recovery processes Wilkinson, (2013). One significant change that was made to legislation to allow for recovery activities to take place with minimal hindrance was the creation of the Canterbury Earthquake Recovery Act CERA 2011. The Act replaced the Canterbury Earthquake Response and Recovery Act which was enacted in the immediate aftermath of the earthquake in 2010. The 2011 was an overarching document that influences the way other legislation and Acts (incidental to recovery programmes) are implemented. According to Stewart (2011), CERA was created to streamline the management and planning of demolition and reconstruction works, ensure safety around damaged buildings and to facilitate faster and more effective recovery.

In the aftermath of the earthquakes and aftershocks in Christchurch, the rebuilding programme became stalled and the community became restive about the future of recovery. There was high risk of depopulation and capital flight in the Canterbury region (Clements, 2012). There was frustration experienced by homeowners because they could not rebuild, and they had difficulties in finding alternative (affordable) land. Clements (2012) explains that businesses, operated under cramped working conditions or unable to operate at all. Furthermore, insurance claims took long to be processed and paid. There was a need to clear all hindrances to reconstruction in the form of backlogs in consent processing, unnecessary bureaucracy and inaccessibility to land.

The creation of CERA was a necessity and saw to the establishment of the Canterbury Earthquake Recovery Authority. The authority was mandated to facilitate and direct the greater Christchurch and its communities to respond to, and recover from, the impacts of the Canterbury earthquakes. There are conflicting accounts of the authority's performance which was brought to a close (after 5 years) mid-2016 (Wright, 2016).

However irrespective of perceptions about CERA, considerable traction was recorded in the rebuilding programme because of the coordinated approach provided by the authority. The recovery of the Canterbury region provides a case study of reconstruction that was facilitated by Legislation.

CONCLUSIONS

The purpose of the paper is to review legislative changes that took place during the Canterbury earthquakes (case study event) in New Zealand. It is conclusive that central to recovery activities after disaster events is having in place appropriate building and environmental legislation. Legislation is better preplanned for different disaster scenarios but very often may need to be adjusted in the immediate aftermath to allow for reconstruction to take place unhindered. Disaster response and recovery are not 'business as usual' hence normal routine processes are unlikely to be effective, hence the need to for legislative and regulatory changes.

When building and environmental legislation and regulatory provisions are well-articulated and implemented, they could provide an effective means of reducing and containing vulnerabilities. Whether legislating for compliance or for facilitation, stipulated procedural guidelines would need to be adopted in a manner that bypasses normal bureaucracy. Further, legislation should permit recovery agencies to apply pragmatic solutions where needed as several studies have indicated that discretionary powers are limited during recovery.

To conclude, in line with the objective of the conference, achieving building resilience to address the unexpected, the current study takes the position that legislation is significant either to ensure compliance to cause changes to be made to facilitate reconstruction programmes. The study has provided evidence from the Canterbury earthquakes to justify this. Wider studies using information from more recent disasters will be useful in this regard.

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THE RELATIONSHIP BETWEEN RESILIENCE AND SUSTAINABILITY IN THE BUILT ENVIRONMENT

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ABSTRACT

This paper explores definitions of sustainability and resilience as applied to the built environment and suggests a different way of thinking about these two concepts. While there may be ways of rating sustainability there are as yet no agreed ways of measuring resilience. Moreover built environments that are rated highly for resilience, like Toronto, Canada score poorly when it comes to sustainability as measured by the ecological footprint. Does this mean a resilient built environment can never be sustainable?

The paper argues that the key aspect of both resilience and sustainability is that they deal with change, whereas all too often they are presented as goals. In these terms sustainability in the built environment is thinking clearly about the availability of resources and designing physical spaces that allow people to adapt to live within these. At present most sustainability thinking assumes most resources presently in use will continue to be available and looks only for a reduction in use. In other words it is about making the status quo more resilient in engineering terms without thinking about possible system change. We are still building cities in the image of the industrial revolution when resources seemed limitless, when globally human society is increasing the overreach of biocapacity.

This paper proposes using the theory of ecological resilience to think about built environments as complex systems. The paper concludes by discussing how this might be translated into envisioning such environments for both enhanced resilience and enhanced sustainability.

Key words: resilience, sustainability, built environment

INTRODUCTION

The Grosvenor Group is a private research organization that dates back to 17th century London and deals with issues related to property and the built environment, including sustainability and resilience (Grosvenor Group, 2014a). As part of recent research they have ranked cities in terms of their resilience, with Toronto, Canada topping the list of the 50 most resilient cities (Grosvenor Group, 2014b). However, another way of looking at the resilience of Toronto is to measure its environmental impact using the ecological footprint (EF). A city with a low ecological footprint will be living within its resource means, whereas a city with a high EF will be living beyond its resource means, and hence drawing in resources from elsewhere through trade, which makes it vulnerable should such sources be reduced or even cut off. In 1998 the average citizen of Toronto had an ecological footprint of 7.6 gha, (global hectares represent land of average productivity) which was just under the Canadian average of 7.7gha/person (Onisto et al, 1998). Although the Canadian average EF has dropped to 6.4gha/person, this is still more than twice the world average of 2.7gha/person (WWF, 2012). In contrast, the Grosvenor Group ranking of cities in terms of their resilience looks at their vulnerability and ability to adapt. Cities with fast growing populations tend to appear at the bottom of the rankings, but these are also the cities with low ecological footprints, like Dhaka, Pakistan (50^{th} in resilience) and Jakarta, Indonesia (49^{th}). Cities have good resilience if they have the governance and finances in place to deal with climate change issues, even if they are vulnerable to sea level rise, as is the case of Vancouver, Canada (2^{nd}).

What is missing here is the big issue of tackling climate change by reducing greenhouse gas emission by 80%, in line with the Paris CoP agreement, and acknowledgement that every year the date at which humanity overshoots the resources available to it on a sustainable basis moves ever further forward, falling in mid-August in 2015 (WWF, 2016). Since resilience, which is a property of complex adaptive systems (Gunderson, 2000) like cities, states that change happens all the time, it would seem that big changes to do with climate change mitigation and using many fewer resources, so that as a species we can live within the resources available to us on a sustainable basis, might be part of assessing the resilience of cities. Vancouver aims to be the greenest city in the world and as part of its plan has the goal of reducing the EF of the city's residents by a third (City of Vancouver, n.d. p.6). The EF is defined as the area of land and sea needed to supply all aspects of a life-style on a sustainable basis (Wackernagel and Rees, 1996). Looking at how this is to be achieved in Vancouver the emphasis is reducing greenhouse gas emissions through moving to a renewable energy city by 2050 and on education and sharing the experience of trying to reduce footprint (City of Vancouver, n.d. pp.63-67). The latter approach has been shown to reduce footprint in New Zealand (Vale and Vale, 2013b) but this will still not reach a fair share footprint of 1.7 gha/person, given that Vancouver EFs vary from 4-7 gha/person, which would require a 58-75% reduction (Rees and Moore, 2013, p.17). Less discussion is given to how the economic basis of the city, or even its diets, will have to change to reduce footprints. For the former the 2020 target is 33,400 green jobs (double that of 2010) in an economy that has recently been growing at 3% per annum (City of Vancouver, n.d. p.57), this is in a city with in 2016 a population of 2.2 million and a 62% employment rate (Statistics Canada, 2016), making green jobs 2.4% of all employment in the city. However, it is this very sound conventional economic basis that makes the city appear resilient because it has the money to deal with disturbances. The action plan is also concentrated on local food and urban food production but without discussion of the problem of meat eating and related greenhouse emissions.

Given the confusion, this paper sets out to define both sustainability and resilience as they might be applied to a built environment like a city, and then consider whether the terms are in conflict, as in the example of Canadian cities, or can be reconciled.

DEFINING SUSTAINABILITY

Of necessity sustainability is nested, so it is not possible to have a sustainable built environment, without having a sustainable economic basis on which it operates, or sustainable citizens to live in it (Vale and Vale, 2009). To understand what a sustainable built environment is it is necessary to understand sustainability, in terms of what one planet with its incoming solar energy can support on a long term basis. As a concept it has arisen precisely because it has become apparent through the climate change issue that the current situation is no longer sustainable long term (Cimate Action and UNEP, 2015). Understanding its history is, therefore, a vital part of understanding what it is.

Sustainability, like ecological resilience theory, has links with forests, which is not unsurprising given trees yielding large timbers normally take many decades between planting and harvesting. The concept of engineering resilience also began with considering the behaviour of wood, as the first use of the term in English is believed to be in Tredgold’s (1818) treatise *On the Transverse Strength of Timber* (MacAslan, 2010). Tredgold used the term for the property of a timber beam that allows it to deform but support heavy loads. Later Mallet (1856) developed the idea into the modulus of resilience, which is the energy needed to distort something, like a length of elastic, to the extent that it will no longer return to its original shape. However, sustainability grew out of a concern for managing forests so as to achieve a sustainable yield of timber, without damage to the soil, meaning the whole forest system had to be set up in so as to achieve the sustained use of timber. Von Carlowitz in his 1714 book of forestry *Sylvicultura oeconomica* went further than this, arguing that everything done by people depended on nature’s systems, and therefore people had to work with nature rather than seeing nature as a set of resources for human exploitation.

In 1804 another German, Hartig, lecturing on forestry, came up with a statement that echoes the familiar definition of sustainability in the 1987 Bruntland Report, “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987 p.43). Hartig said all forests had to be used to their maximum extent but that this meant the benefits extracted had to be the same for both present and future generations (Reynolds, 2007, p.185). This principle was known as Nachhaltigkeit, which has since been translated as sustainability. The logical extension of this definition of sustainability is that a society that builds its structure around a resource, like fossil fuels that cannot be consumed in a way that leaves equivalent resources for future generations, cannot be sustainable. Consequently society cannot be made sustainable without reorganising it around 100% renewable energy supplies, and this includes its economic basis. This is the problem with the Vancouver 2020 Action Plan as although it aims to be using 100% renewable energy for its buildings and transportation by 2020 it soon becomes clear that this is problematic as "The City has limited to no jurisdiction over many emission sources and looks to the federal and provincial governments to take action in the areas of electricity generation, vehicle fuels and efficiency, and the taxing of carbon" (City of Vancouver, n.d. p.10). In a globalised society the real problem of being sustainable is that in terms of Nachhaltigkeit it has to be all or nothing. A sustainable city or built environment has to be within a sustainable society.

DEFINING ECOLOGICAL RESILIENCE

Holling (1973) developed the ecological resilience hypothesis as a way of explaining the non-linear behaviour of ecosystems. His article makes reference to the spruce-fir forests of eastern Canada and outbreaks of spruce budworm. Populations of the latter fluctuated but Holling saw this not as something unstable but necessary so the budworms could persist in this environment, as by fluctuating "successive generations of forests are replaced, assuring a continued food supply for future generations of budworm and the persistence of the system." This is not the same as the idea of engineering resilience which is to do with being able to return to a previous state after a disturbance. In ecological resilience what persists are the relationships within the system, in the case of the budworm between it as a predator and the trees it eats. There is no ideal or stable state for the ecosystem but rather the system is ever changing in an attempt to preserve the relationships within it as it adapts to change. In some ways this has more to do with Tredgold's original definition of resilience where the timber adapted to the applied load by deforming but the relationship between the timber and the load stayed the same.

The concept of ecological resilience has since been further elaborated by Holling (1987, 1992, 2004) and others (Folke, Holling and Perrings, 1996; Carpenter et al, 2001; Folke et al, 2004; Walker and Meyers, 2004; Carpenter and Brock, 2006; Walker and Salt, 2006; Walker et al, 2012). The theory has also been applied to people through the concept of social-ecological systems, which would include built environments. Adger (2000) linked social and ecological systems by stating "Ecological and social resilience may be linked through the dependence on ecosystems of communities and their economic activities." In other words people should be interested in how ecosystems behave because ultimately human societies take from them what they need for their existence. This view is similar to the ecological footprint, which measures sustainability through how much productive land and sea it takes to supply on a sustainable basis the resources for a particular lifestyle.

RESILIENCE, SUSTAINABILITY AND BUILT ENVIRONMENTS

The built environment is important for a sustainable future because humanity will continue to become increasingly urbanised. Urbanisation raises issues related both to sustainability and to resilience theory as it has emerged from ecology. The first is that the environmental impact of living in cities is on average higher than living in rural areas (Guo, 2013; Vale and Vale, 2013a), so as urbanisation rises so does human impact. The second is that a resilient ecosystem has tight feedbacks between cause and effect (Walker and Salt, 2006), which is the opposite of most cities where people are divorced from the natural ecosystems on which they rely, and often fail to see the effect of their actions. Driving the children to school on a 2km round trip in a large SUV produces just over 900 grams of CO_2 (Rightcar, 2011). Assuming the school is open for 192 whole days (Ministry of Education, n.d.) gives an annual emission of 173kg CO_2 for a journey that could be walked. This is the same greenhouse gas emissions as running a laptop for 8 hours a day every day for a year (Sibelga, 2016). However, without bothering to look up these numbers few people will instinctively know that such everyday actions are part of the critical issue of climate change (after all, "the journey is really short" and "a laptop hardly uses any power"). Even when it comes to something as clearly defined as energy, feedback in the built environment is poor as most people only pay for what they used some time after they used it.

IS IT POSSIBLE TO HAVE RESILIENT AND SUSTAINABLE CITIES?

The big issue, however, is how to make cities both sustainable and resilient, and given the example of Vancouver, whether this is even possible. From the brief definitions above the first thing to note is that sustainability is not the same as resilience. The first is a goal that is linked to living within the resources of what the planet offers in such a way that those resources are available for everyone. Inherently, then sustainability raises ethical issues of how much should each person have and whether those in richer nations should have more than those in poorer societies. Even within rich, developed societies, environmental impact will differ between those that have the money to spend on resources and those that do not (Vale and Vale, 2009 pp.21-23). In New Zealand the Ministry of Social Development states ”there was a large and rapid rise in household income inequality from late 1980s to early 1990s” and although since then incomes of the top two-thirds of New Zealanders have risen those of the bottom third have remained flat. In contrast using Holling’s (1973) definition of resilience as the property of a system, it has no ethics, at least until the people start to intervene in a system to make it into something different. At that point the decisions that are made have ethical consequences. If the goal is to see resilience not as the property of a system but as a goal (Reghezza-Zitt et al, 2012), as in making a place resilient (Vale, 2014), this is a different situation. What seems to emerge is that the understanding of resilience as a system property questions the possibility of having resilient and sustainable cities.

RESILIENCE AS A PROPERTY OF COMPLEX SYSTEMS

The position taken in this paper is that in a built environment, as in an eco-system (Holling, 1973), resilience is the ability of a complex system like a city to absorb change while, at the same time, the relationships within the system persist. This is not the same as the engineering definition of resilience, which implies that after change the city will be the same as it was before. An example of engineering resilience would be the reconstruction of parts of Dresden after it was destroyed by bombing in WWII, since what is there after the event looks the same as before. In contrast the city of Napier was rebuilt after the 1938 earthquake with the same relationship of streets to buildings but the appearance of the city changed with the new buildings being in the latest art deco style. The resilience shown by Napier is thus different since the relationships within the system persisted but the visual identity of the city was altered. Rather than being recreated Napier could be considered to have displayed resilience as defined in ecological terms at the scale of streets and buildings.

The example of Napier raises the issue of what is resilient to what in the face of change. Change itself comes in two forms—the sudden unexpected disturbance, such as an earthquake, and the continual change that is part of living in built environments that daily have to respond to new needs, deterioration, and unprofitability. When it comes to measuring resilience in built environments it is therefore important to know what sort of change events are being discussed in assessing resilience. An event could be defined as “something shocking, out of joint, that appears to happen all of a sudden and interrupts the usual flow of things” (Zizek, 2010, p 2) Looking at these event types separately, the first type of event is often linked to sustainability by assessing how resilient the particular built environment is to the effects of climate change, such as flooding due to storm surges. This is why the city of Vancouver for all its wealth is not the most resilient city, as sitting on the coast it is increasingly vulnerable. However, this is not the same as assessing the general resilience of an urban area, which is to do with how it copes with change and keeps on functioning. What can be said with certainty is that moving to living within the resources of the planet will mean very big changes in how the built environment is organised, not least how urban areas relate to their hinterlands, as these are the areas that will provide the resources (food, energy, timber) that the city cannot provide.

FUNCTIONAL DIVERSITY: WHERE ECOLOGICAL RESILIENCE AND SUSTAINABILITY CONVERGE

Ecological resilience when applied to the built environment also suggests that looking at function (what happens in buildings) rather than just the physical form of buildings and associated infrastructure may be important. This is the point at which what might be desirable for sustainability and for general resilience start to converge. An Asian city in a developing country to western eyes can appear untidy, disorganised and impoverished but such an environment is far more able with a diversity of skills and a minimum of resources to produce goods and services. What in the developed world would take a factory and an office to produce can be made by hand from recycled parts on the street of a city like Jakarta, Indonesia or Bangkok, Thailand. The same streets also offer what is needed for daily living within walking distance, with home and work close together. It is this very mixture which makes the organisation of the urban fabric not just more sustainable, because less energy is needed to access everything required for daily living, but also potentially more resilient because there is more diversity and redundancy in the availability of services and skills and closer feedback between producer and consumer. The mix of what is available can absorb change because if one business selling reconditioned motorcycles fails, there is another one still working if not next door then in the next street. Away from the high rise centre of Bangkok the low rise city with green spaces between the buildings also offers a better chance of producing local food than a highly compact, high rise city like Hong Kong. The latter is predicated on the western model of work in one place and living in another, and in the name of sustainability this then becomes compacted to try to reduce the energy it takes to move from one place to another. The alternative way is to bring work and living to the same place, which will achieve the same sustainability goal and also increase general resilience. It is thus the untidy and poorer parts of developing world cities that provide the best model for what a more sustainable (because people are living on fewer resources) and more resilient built environment might be like. This is a long way from relating resilience to Bangkok as reported by 100 Resilient Cities (2016) where the concerns are to do with flooding, pollution and a poor transportation system. These are all real concerns but in dealing with these problems it is also necessary to understand the nature of resilience as a property of a complex system, such as a city. In addressing the problems the aim of 100 Resilient Cities is to make Bangkok more like a developed world city, and thus more like Vancouver, with its own problems when to comes to sustainability. Suggesting that urban poverty is potentially more sustainable and resilient than wealth is not going to be a popular idea but in any investigation of urban resilience it has to be faced. In terms of human settlement the very persistence of urban slums suggests they have something to teach about built environment resilience.

CONCLUSION

Trying to assess resilience should not become a displacement activity for avoiding the big issues involved with creating sustainable built environments (climate change, earth overshoot, inequality). Nor should resilience assessment be solely concentrated on the engineering definition of resilience that sees any response to change as returning the environment to its previous condition. Resilience acknowledges that change happens all the time and that some urban forms may accommodate this continual change more easily, and at the cost of using fewer resources, than others. This is the point where the goal of sustainability and the property of resilience meet. What the example of Vancouver with its high resilience and high ecological footprint teaches is that at present we have little idea of what a built environment that addresses both these issues will be like. The example of Bangkok above, with all its faults to developed world eyes, was offered as a starting point for thinking about this. The application of resilience to built environments is in its infancy. What resilience does teach is that unless these problems are addressed climate change and overuse of resources are going to impose very big changes on all human environments including urban ones.

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RESILIENCE BEYOND DISASTERS

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ABSTRACT

The potential impact of climate change on coastal regions has made research into resilience in the built environment a subject of prime interest in developed and developing countries. However, what resilience is and how to achieve it is still unclear. Moreover, the duality between the engineering and ecological dimensions of the definition of resilience has not contributed to making the use of the concept more accessible. While engineering approaches have been applied through disaster resilience, the use of ecological resilience has been restricted to environmental sciences. Designers of the built environment, like architects and landscapers, that have to deal with disturbances emerging from everyday life could benefit from ecological approaches. The theory behind ecological resilience offers designers the possibility of understanding the built environment as a complex adaptive system, whose change and persistence depends on its resilience. By implementing this point of view, designers could focus on analysing and developing strategies to enhance the resilience of the built environment to issues produced by the development of its own complexity. Nevertheless, this theme is often overlooked by the literature focused only on disasters. The present paper presents a short discussion drawn from the literature of the importance of understanding the differences between ecological and engineering resilience and their applications in the built environment. The objective is to highlight the benefits and potential of ecological resilience in the research, analysis and design of urban landscapes. The paper concludes by discussing how resilience can contribute to advancing existing systemic approaches to the city.

Key words: *ecological resilience, engineering resilience, built environment*

INTRODUCTION

Commonly the concept of resilience is associated with the mitigation of shocks produced by earthquakes, tsunamis, droughts, and floods in rural and urban landscapes. This understanding of resilience implies that the management of disasters and the process of recovery of the communities affected should be the main concerns if they are to be resilient. This approach has been consolidated at institutional level through frameworks like the United Nations International Strategy for Disaster Reduction and initiatives like the campaign entitled Making Cities Resilient (UNISDR, 2012). In this way, building disaster resilience has become the goal for governments and institutions dealing with the resilience of cities. However, the meaning of resilience is still not very clear. Evidence of this misunderstanding can be found in the lack of agreement between practitioners, institutions, and governments over the definitions of resilience. Moreover, using resilience to make built environments and communities more adaptable and less vulnerable is still to be proved, since ways of measuring resilience are hardly advanced. Given this, how is it possible to build resilience if the concept itself is neither one that is commonly shared nor understood? Furthermore, if disaster resilience is focused on mitigation and recovery, what is the role of the built environment being affected? This paper proposes that the first approach to answering some of these questions should be focused on looking at what resilience is and how it might be used in the built environment. To do this it draws on existing literature and an experiment in applying ecological resilience to a built environment, described in full elsewhere (Garcia, 2013).

WHAT IS DISASTER RESILIENCE?

The UNISDR (2005) defines disaster resilience as: "the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure." However, the definition of the concept of adaptation is not specified and nor are the ways in which it could be measured.

The concept of disaster resilience is constituted by two ideas: resilience and disaster. Paton and Johnston (2006) defined disasters as disruptions in the community functions of a society that produce a significant loss, and resilience in this context is the adaptive capacity of people to deal with the new reality created by the post-disaster scenario. The definition has a sociological background that relies on the potential resilience capacity of a community. From this point of view disaster resilience can be linked with community disaster resilience and household disaster resilience respectively (Arbon, Steenkamp, Cornell, Cusack, and Gebbie, 2016). Disaster Resilience has been linked with a variety of concepts like mitigation, recovery, bouncing back, preparedness (Paton and Johnston, 2001), urban risk, reconstruction, rehabilitation, building back better (Chang, Wilkinson, Seville, and Potangaroa, 2010) and hazard-reduction. These ways of approaching disaster resilience have been focused exclusively on the relationship between the disaster and the community affected without attending to the importance of the role played by the environment. In order to explore this gap, scholars clustered around the *International Journal of Disaster Resilience in the Built Environment* have been raising awareness about the role that the built environment might play in the disaster management process. However, this process has been defined as the "mobilisation of resources, rapid responses, and having a long-term strategy to prevent disasters and reduce the risks of vulnerable groups" (Amaratunga and Haigh, 2010), a definition that emphasizes the speed of responses but does not clarify or describe its link with resilience.

Definitions of resilience in the research field of disaster resilience tend to describe actions that should be taken before or after a disaster, like preparedness, awareness, mitigation, recovery and bouncing back, but the nature, meaning and role of resilience are not clearly explained. This is the first obstacle that scholars will have to face when applying resilience to the study of the built environment.

WHAT KIND OF RESILIENCE IS DISASTER RESILIENCE?

The concept of resilience was originally developed in engineering to describe the elasticity of materials and was further developed as the modulus of resilience, which was used to measure the quantity of energy that materials can stand without breaking or deforming permanently. However, the current use of resilience in a context of disaster has its roots in studies done in ecology and psychology in the seventies. In psychology the concept was developed using the studies of Garmezy (1973) who described the ability of children coming from hostile environments to cope with these problems without interrupting their learning processes.

In ecology, Holling (1973) proposed that the management of ecosystems should be focused on creating the appropriate environment for survival. The idea was to highlight the fact that keeping systems stable was of little use if they do not survive. Therefore, Holling proposed that variability and resilience were key to creating the conditions for the persistence of a species. Resilience was defined as "the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973). By establishing the dichotomy between stability and resilience Holling defined two ways of understanding resilience: ecological and engineering resilience (Gunderson 2000). Engineering resilience is conceptually related with the ideas developed in material mechanics, where resilience is defined as a function of the time it takes to a system to come back to its original state. The faster the system recovers, the more resilient it is (Pimm, 1984). Systems are assumed to work only around a single possible stability state. The main goal of engineering resilience is to view systems as predictable, efficient and stable (Holling, 1996). However, complex systems like the built environment are not always predictable, are hardly efficient, and are rarely in a stable situation for a long period (Folke et al, 2004).

Ecological resilience questions the possibility of coming back to a previous state since system are changing and their outcomes are not always predictable. Therefore, adapting to change becomes more important than resisting it. Ecological resilience proposes that complex systems, like ecosystems or cities, can work in a diversity of situations (for example earthquakes, and economic or environmental crises) by absorbing change while maintaining their main functions and structures without collapsing (Walker and Salt, 2012). In some ways, the ecological approach describes how systems adapt by changing and persisting at the same time. From this point of view, change and persistence are complementary terms that describe the core of resilience. However, the engineering approach focuses on persisting by resisting change. The basic assumption of ecological resilience is that risk and instability are not threats to the persistence of a system; moreover systems need to change if they want to persist (Walker and Salt, 2006).

An ecological approach describes resilience as a property of complex system, which means that resilience is not a goal or a state that can be reached permanently. As a property, resilience can be desirable or undesirable. The resilience of crime and domestic violence are not desirable while the enhancement of the resilience of rural landscapes to land use change caused by urban growth would be more than welcomed. While the engineering approach of disaster resilience is more focused on the threats than the system, the theory behind ecological resilience offers the possibility of understanding the built environment as a complex adaptive system, whose change and persistence depends on its resilience and therefore on its system state. The downside of ecological resilience is that it is difficult to use the available theory to predict specific outcomes in complex system like cities.

The definitions of resilience proposed in ecology (engineering and ecological) can be used as a theoretical framework to dig deeper into the definitions of disaster resilience. A basic analysis that looks at the background and origins of the definition cited, keywords used, goals, and measuring methods could provide a framework for describing the nature of the particular definition of resilience used (see Table 1).

Table 22. Difference between ecological and engineering resilience

	Engineering Resilience	Ecological Resilience
Background	Engineering and others	Social Sciences, Ecology, Psychology and others
Keywords	Mitigation, recovery, bouncing back, risk and hazard reduction, reconstruction, rehabilitation, resistance.	Adaptation, learning, crisis as opportunities, awareness, complexity, multiplicity, self-organization, thresholds, scales, Panarchy, adaptive cycle.
Ethics	Resilience is a goal and it is always desirable.	Resilience is a property. It can be desirable or undesirable.
Subject of analysis	System performance	System dynamics of change and self-organization processes.
Assumption	Single stability state	Multiple stability states
Assessment	Predictable. Always measureable.	Fairly predictable. Not always measureable
Measurement	Time it takes to come back to stability or to recover a capital. Use of indicators.	General resilience and specific resilience (resilience of what to what).

IMPLICATIONS OF ENGINEERING RESILIENCE APPROACHES

Understanding what kind of resilience is used in each definition of disaster resilience could provide more clarity about what could be expected when different approaches are taken. In the engineering approach, resilience is predictable and therefore measurable. This view might be very useful for designing the structure of a building to resist earthquakes because the variables involved in the calculations (characteristics and mechanics of different materials) are known, the size of the system is manageable, and the performance of anti-seismic structures, within a certain range, can be predictable. Therefore, to enhance the disaster resilience of buildings to earthquakes is an achievable and desirable goal and engineering resilience offers the appropriate tools to do this. The problem starts when an engineering approach is applied to defining the resilience of much more complex systems, like cities, where the variables are numerous and the outcome is much less predictable. An example of the use of an engineering approach to the study of disaster resilience in complex systems can be found in Earthquake Engineering to Extreme Events (MCEER) that describes resilience as "reduced probability of system failure, reduced consequences due to failure, and reduced time to system restoration". In this definition resilience is used as a synonym of mitigation and fast recovery. From this point of view, a resilient system is a system that recovers the loss of a capital in a short period of time. Therefore, the definition of the capital to be measured becomes essential for assessing resilience. This is a challenging task since communities, institutions and governments value capitals in different ways depending on the interest of the parties involved in the decision making process. Also, a fast recovery of a capital could be a subjective measurement of resilience, since deciding what to recover first is more important since not all capitals can necessarily be recovered simultaneously. These problems can be seen in Christchurch where the speed of recovery of the built environment in the Central Business District (CBD) has been prioritized over improvement of the housing of communities living at the periphery.

Applying the engineering perspective to disaster resilience implies that it is possible to build resilience and therefore to produce resilient cities. An example of this, as stated earlier, is the Making Cities Resilient campaign (UNISDR, 2012) that has a precedent in the United Nations International Strategy for Disaster Reduction. The campaign understands resilience in relationship with disaster and risk reduction. The assessment of resilience is blurred because it aims at tackling the whole complexity of a system by using ten criteria. Moreover, these criteria can easily be transformed into a series of indicators to measure subjective matters in an objective and quantitative way. What is clear in this framework is that if there is no money and no budget available then it is not possible to build resilience. This is the main issue behind all the engineering approaches; they rely on having a capital to fix the problem that a disaster will cause. The more important the budget, the faster the recovery and the more resilient a city will be. The only problem is that the majority of the cities affected by natural disasters are situated in poor countries, with insufficient financial resources. The engineering approach that can be reasonable for retrofitting a single building at a domestic scale is not feasible for retrofitting an entire built environment at a city scale. From this point of view, every time that a sub-system is strengthened some other parts are weakened. It is really hard or perhaps even impossible to build a resilient city.

DISASTERS AND RESILIENCE IN THE BUILT ENVIRONMENT

By definition, disaster resilience narrows down the use of the concept to buffering only one type of system disturbance: disasters. This approach might be limiting when it comes to analysis of the role of the built environment because complex systems are exposed to all kind of disturbances, not only disasters. Designers of the built environment, like architects, landscape architects and urban designers often deal with disturbances that emerge from the complexity of everyday life but that are not considered disasters even though they play an important role in the life and survival of cities. In the earthquake of 2011 in Christchurch 185 people died. The cost of the reconstruction has been estimated at more than 40 billion (OneNews, 2015). This was a disaster for New Zealand and still is. However, more frequent disturbances in the built environment, like car accidents for example, have already cost the life of 43 pedestrians and a social cost associated with fatal injuries and crashes that, in total has been estimated to be more than $3 billion in 2014 (Transport, 2015). From 2003 to 2014 crashes and accidents on the streets have cost New Zealand the same money as a major earthquake, with the only difference that the crashes on the streets have killed 453 people. Similar comparisons could also be made by analysing the impact of badly insulated and poor quality buildings on the health of people or by acknowledging the cost of air pollution from human activities (estimated in 2006 to be more than $4 billion per year). In the long run, frequent and ordinary disturbances produced by self-organization processes of change could have a much bigger impact on a community than extraordinary disasters. From this point of view, designers should be focused on analysing the resilience of the built environment to issues produced by the development of its own complexity.

The built environment is not a homogeneous grey stain on a map; it is continuously changing, as some buildings appear and others disappear. This phenomenon was explored by Conzen (1960) who found that different elements of the built environment like streets, plots, and building footprints change at different paces, therefore they exhibit different resistances to change. Conzen also discovered that the building footprints of plots followed a cyclical process of change, from incipient occupation to plot clearance, which he called the burgage cycle. These ways of describing change are important for the application of ecological resilience to built environments, since they are similar to metaphors used in ecology, like the “adaptive cycle” and “Panarchy” (Gunderson and Holling, 2002), that explain resilience as a cyclical and scale dependent process. The objective of all these analyses is to know how systems adapt by changing and persisting at the same time.

However, little advance has been made in the application of ecological resilience to built environments. Qualitative observations using an ecological approach have been made by Allan and Bryant (2011) after the earthquake in Concepcion, Chile. They found that open private and public spaces provided by streets and the front-yards of suburban houses increased redundancy in the system and offered opportunities for better adaptation in neighbourhoods. A different approach has been used by Garcia (2013) who analysed the relative resilience (Allen, Gunderson and Johnson, 2005) of the urban landscape of Auckland by measuring changes in the diversity of its built environment. Garcia found that the diversity of open spaces plays a key role to buffering changes produced by the built environment.

There is currently no disaster resilience framework that demands such a minimum understanding of how built environments work. The scorecard of the UNISDR is totally focused on analysing built environments through building codes, which is good for regulating change but highly unsuited to understanding why and how persistence and change happen. The latter are important qualities to identify what kind of elements in a built environment will be able to absorb more or less change.

Architects, urban designers and landscape architects should be working in close relationship with planners and local governments because they have a knowledge that ranges from the domestic scale to the city and region scales. Unfortunately institutions, government units and editorial boards interested in developing and understanding resilience in built environments do not have designers involved in their processes. This is still a big gap but also an opportunity to start researching about resilience in an alternative and more inclusive way.

CONCLUSION

There has to be more than disasters in future research about resilience, particularly if the concept is to be applied to the study of the built environment. It is still not clear how actions oriented to the mitigation of hazards might impact on the enhancement of the resilience of a system. Disaster resilience limits the study of resilience to buffering only extraordinary cases while undermining the power of frequent disturbances at small scales in the built environment. After reviewing the different approaches to defining resilience and realizing that the understanding of the concept is fragmented, it is clear that before developing scorecards and checklists to assess resilience the definition of resilience has to be both understood and shared.

In order to study resilience in the built environment, the former has to be analyzed as a complex adaptive system, which means that it has different scales with discrete issues affecting the pace and magnitude of change in each scale in an uneven way. A disaster can affect one scale but others may remain functional. Resilience in the built environment is about understanding these dynamics of change before trying to build resilience. Whether it is possible to enhance or build the resilience of a city is something that still has be proved but humble steps can be done by consolidating the theory of resilience and producing a better understanding of the dynamics of change of the built environment.

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INTEGRATING ADAPTATION STRATEGIES INTO POST-DISASTER RECOVERY: LESSONS FROM ASIA-PACIFIC COUNTRIES

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To date, most academic studies and development interventions have considered climate change adaptation and post-disaster recovery processes as two separate issues. Yet there is growing recognition that post-disaster recovery can only be successful and sustainable when it is combined with rural communities' long-term efforts to enhance their adaptive capacities to cope with future hazards and environmental risks. In addition, climate change is just one among various risk factors that may adversely affect local communities. Such factors may be of higher priority for local communities and have a more immediate impact on livelihood opportunities and human security than climate-related risks. Drawing on comparative field studies in Prek Prasob District, Kratie Province, Northeast Cambodia and in the Ba Watershed, Viti Levu, Fiji, we show how individual households and rural communities employ a combination of strategies to adapt to the increasing frequency of climate-induced risks in multi-risk contexts. By applying and expanding Agrawal and Perrin's climate change adaptation framework (2008) – which identifies five major sets of strategies, i.e. mobility, storage, diversification, communal pooling and market exchange – we elicit both synergies and trade-offs and demonstrate how some combinations of strategies are effectively reducing vulnerabilities, while others may inadvertently exacerbate other livelihood risks. We further argue that 'livelihood security' needs to be understood in a more holistic manner by including less tangible elements, such as cultural identity and sense of place. We conclude that adaptation strategies in post-disaster recovery processes need to be situated within a broader context of risks, vulnerabilities and community resilience.

KEY WORDS: Climate change adaptation, post-disaster recovery, livelihoods, Southeast Asia, Pacific

MAPPING BUILT ENVIRONMENT PROFESSIONAL SKILLS AND NEEDS TO SENDAI FRAMEWORK

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ABSTRACT

Further to the adoption of Sendai framework for disaster risk reduction in March 2015, there is urgent need to leverage the understanding of disaster management in all its dimensions among the stakeholders working towards enhancing disaster resilience of the built environment through the capacity development and scientific research in the relation to core priority areas of the Sendai framework. Thus, this study aims to identify the skills and needs expected of the built environment professionals by the communities affected by natural disasters with a view to map the identified skills and needs with core priority areas of Sendai framework. In achieving this, a literature synthesis including the CADRE (Collaborative Action towards Disaster Resilience Education) outcomes and Sendai framework were reviewed and a comprehensive desk review to map the identified skills and needs with core priority areas of Sendai framework were conducted. The study findings would be beneficial to the built environment professionals in enhancing their capacity and capability development in all the priority areas of Sendai framework. The study would further be useful for non-governmental organisations (NGOs), governments including national, regional and local government, and the private sector in drawing policy recommendations, monitoring and assessing the capacity required of the built environment professionals in the implementation of Sendai framework.

Keywords: Built environment, capacity development, communities, disaster resilience, Sendai framework

INTRODUCTION

Since the adoption of the Hyogo Framework for Action (HFA) in 2005, progress has been achieved in reducing disaster risk at local, national, regional and global levels by countries and other relevant stakeholders, leading to a decrease in mortality in the case of some hazards (UNISDR, 2015a). Over the same 10-year time frame, however, disasters have continued to exact a heavy toll and, as a result, the well-being and safety of persons, communities and countries as a whole have been affected. For instance, the earthquake in Haiti in January 2010 and New Zealand in September 2010 and February 2011, the floods in Pakistan in July 2010 and in Australia in December 2010 to mention a few (UNISDR, 2011). This is affirmed by Emergency Events Database (EM-DAT) (2016) that in 2015, there are 346 reported disasters, 22,773 people dead, 98.6 million people affected, and US$66.5 billion economic damage. Thus, it obvious that 10 years after the adoption of the HFA, disasters continue to undermine efforts to achieve sustainable development. Notwithstanding, the HFA has provided a critical guidance in efforts to reduce disaster risk and has contributed to the progress towards the achievement of the Millennium Development Goals (UNISDR, 2015a).

The implementation of HFA has, however, highlighted a number of gaps in addressing the underlying disaster risk factors, in the formulation of goals and priorities for action, in the need to foster disaster resilience at all levels, and in ensuring adequate means of implementation. These gaps indicate a need to develop an action-oriented framework that governments and relevant stakeholders can implement in a supportive and complementary manner, and which helps to identify disaster risks to be managed and guides investment to improve resilience (UNISDR, 2015a). In pursuance of filling these gaps, led to the development of Sendai framework, which was endorsed by the UN General Assembly following the Third UN World Conference on Disaster Risk Reduction held in Sendai City, Miyagi Prefecture, Japan in March 2015. A particular emphasis was given to the Sendai framework for disaster risk reduction 2015-2030, as it is the first major agreement with the post-2015 development agenda. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors. By adopting the Sendai Framework, it is expected to substantially reduce the disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries (UNISDR, 2015)

The Sendai framework has re-emphasised the importance of educational measures in reducing the disaster risk. Education and training on disaster resilience can be provided in numerous ways and Sendai framework highlighted the importance of promoting the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery, and rehabilitation, in formal and non-formal education, as well as in civic education at all levels, as well as in professional education and training (UN-ISDR, 2015a). Thus, there is urgent need to leverage the understanding of disaster management in all its dimensions among the stakeholders working towards enhancing disaster resilience of the built environment. Against this backdrop, the research community including professional bodies and international organisations were triggered to identify the key roles and responsibilities of the built environment professionals in disaster management (see Max Lock Centre 2009; Amaratunga, 2014; Witt et al., 2014). Earlier researchers have also identified the skills that built environment professionals could contribute to disaster resilience (see Thayaparan et al., 2010; Siriwardena et al., 2013; Perera *et al*., 2015; Thayaparan et al., 2015). However, there is a dearth of efforts at identifying and mapping the skills and needs of the built environment professionals with the core priority areas of the Sendai framework to aid its implementation. In this respect, this study was guided by the following objectives: Identify the skills and needs expected of the built environment professionals by the communities affected by natural disasters; Map the identified skills and needs with core priority areas of Sendai framework.

It is believed that the study findings will be beneficial to the built environment professionals in enhancing their capacity and capability development in all the priority areas of Sendai framework. Similarly, these study findings will be useful for non-governmental organisations (NGOs), governments including national, regional and local government, and the private sector in drawing policy recommendations, monitoring and assessing the capacity required of the built environment professionals in the implementation of Sendai framework.

INTERNATIONAL POLICY FRAMEWORKS FOR DISASTER RISK REDUCTION

Disaster resilience and management is prominent in international policy agenda and the year 2015 brought together three international policy frameworks; the sustainable development goals; the Sendai Framework for Disaster Risk Reduction and new Climate change agreements (COP21). Therefore, it becomes imperative to understand the current policies related to disaster resilience and management. It is on this premise that Hyogo framework for action and Sendai framework are briefly discussed as follows:

Hyogo Framework for Action (HFA) 2005–2015

In January 2005, the 168 countries at the World Conference on Disaster Reduction in Kobe, Japan, Member States of the United Nations adopted the Hyogo Framework for Action (HFA) 2005–2015, as an ambitious programme of action to significantly reduce disaster losses, in lives, and in the social, economic, and environmental assets of communities and countries (UNISDR, 2007). Thus, the HFA's expected outcomes, strategic goals, and priorities served as a guiding framework for disaster reduction for the decade that followed (UNISDR, 2009). It is worth emphasising that the HFA has been a determinant in strengthening and guiding international cooperation efforts (UNISDR, 2011). It has helped in generating the political momentum necessary to ensure that disaster risk reduction and served as foundation for sound national and international development agendas (UNISDR, 2011). It has given a common language and a framework of critical actions to follow, which governments have clearly responded (UNISDR, 2011). Therefore, since 2005, substantial progress has been made in raising the profile of disaster risk reduction across the globe.

Moreover, it was indicated in HFA that its implementation "will be appropriately reviewed" and requests the UN International Strategy for Disaster Reduction (UNISDR) to "prepare periodic reviews on progress towards achieving its objectives and priorities" (UNISDR, 2011). As a result, efforts have been taken on the HFA monitor, particularly by the World Bank and the UNISDR Secretariat through a participatory approach involving stakeholders at international, regional, and national levels. Progress is being monitored and challenges remaining in the implementation of the HFA are identified. For instance, the disaster risk reduction goals anticipated in the HFA that were not achieved in the time period, identify what was missing in the HFA to provide a more robust framework for disaster risk reduction, highlight the areas for improvement in the HFA instrument and present conclusions that were fed into the Post-2015 framework for disaster risk reduction, which is Sendai framework.

The Sendai Framework 2015-2030

The Sendai framework for disaster risk reduction 2015-2030 was the first major agreement of the post-2015 development, endorsed by the UN General Assembly following the Third UN World Conference on Disaster Risk Reduction held in Sendai City, Miyagi Prefecture, Japan in March 2015. The Sendai framework was developed to build on and ensure continuity with the work carried out by countries and other stakeholders under the aegis of the Hyogo Framework for Action and previous instruments such as the International Strategy for Disaster Reduction of 1999, the Yokohama Strategy for a Safer World of 1994, and the International Framework of Action for the International Decade for Natural Disaster Reduction of 1989 (UNISDR, 2015b). Thus, the Sendai framework provides the basis for a risk-informed and resilient future (COP21, 2015). The Sendai framework specifically address climate change and climate action, providing measures, guiding principles, and means of implementation. Therefore, Sendai framework establishes the significance of ensuring credible links between the sustainable development goals, financing for development, climate change, and disaster risk reduction and the calls for enhanced coherence across policies, institutions, indicators, reporting and measurement systems for implementation (COP21, 2015). In overall, the Sendai framework aims to achieve the following outcome over the next 15 years:

"The substantial reduction of disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities, and countries" (UNISDR, 2015a).

RESEARCH METHODOLOGY

This study adopted the 29 disaster resilience needs and skills expected of the built environment professionals identified through an EU-funded research project (CADRE) for stakeholder groups – communities, the private sector, government, NGOs, academia and others (see Perera et al., 2015). The needs and skills were derived from literature review/desk review and interviews. The literature review and interviews were conducted to identify the needs and skills expected of the built environment professionals towards enhancing disaster resilience of communities affected by natural disaster (see Perera et al., 2015). Thereafter, a comprehensive desk review comprised four researchers and academia in the built environment was carried out to review the Sendai framework in terms of the priorities for action, guiding principles, among others. Finally, the adopted 29 disaster resilience needs and skills and outcome of the desk review of Sendai framework were mapped.

RESULTS AND DISCUSSION

Table 2 revealed the identified 29 skills and needs with their respective components expected of the built environment professionals towards enhancing disaster resilience of communities affected by natural disaster. This study finding affirmed the existing literature, particularly Jo da Silva, Lubkowski, Batchelor, and Kabir (2010) that described post-disaster reconstruction or recovery as a complex process that requires multi-sectoral involvement, the range of skills, and consumes very significant resources. This is evident in the number of times that issues relating to community participation and mobilization, use of local skills and local knowledge, empowering and engaging communities, multi-stakeholder management, among others were mentioned and emphasized (see Table 2 for details). In addition, multi-stakeholder management practically implies the deployment of a range of skills and consequentially the consumption of huge resources. Thus, this study has presented knowledge areas and skill sets that built environment professionals could bring to leverage the disaster management process.

Table 2: Descriptions of the identified needs and skills with sample portion of their components

1. Budgeting & financial planning - Fund sourcing and financial management skills -Funding or financing to address disaster resilience -Financing flood adaptation strategies	**10. Quality leadership & people management** -Objective consideration of issues-Flexibility -Understanding the community needs -Leadership skills	**19. Communication & negotiation/Information systems** - Language (familiarity with local language) and communication skills - Effective communication links - Negotiation skills
2. Quantification & costing of construction works -Budgeting and estimating construction costs -Pricing and estimating-Construction works	**11. Team working** -Effective use of community groups & individuals -Engaging community - Relationship with other agencies and communities	**20. Project audit & reporting** - Knowledge of loss assessment and loss adjustment - Auditing skills
3. Supply chain management -Alternative utility supplies after disaster	**12. Governance** -Transparency and accountability in adopted processes - Minimising political interferences	**21. Management & dispute resolution procedures** - Knowledge of dispute resolution
4. Consultancy services -Assistance from external parties (i.e. government; NGOs; Private	**13. Multi-stakeholder management** - Clarity on roles and	**22. Cross-cultural awareness in global resilience** - Familiarity with local language

sector, etc.) -Providing property advice to community	responsibilities of different parties - Multi-stakeholder engagement	- Use of local skills and local knowledge
5. Procurement & contract administration/practice -Advice to community on selection of contractors and consultants -Selection of consultants and contractors - pre-qualifications	**14. Business planning** - Temporary business area - Business continuity strategies/plans - Business protection - Needs assessment and prioritisation of resources	**23. Project management** - Project management skills **24. Asset/Resource management** -Use of local skills and resources - Prioritisation of resources
6. Building regulation & planning -Resilience planning, designing and construction -Knowledge on land-use planning	**15. Environmental assessment** - Weather changes monitoring - Awareness of potential disaster threats - Forecasting and warnings	**25. Disaster management** - Management of disaster relief **26. Risk management** - Disaster risk assessments
7. Legal/Regulatory compliance -Knowledge of prevailing laws needs for the flexibility of laws and policies	**16. Management of the built environment** - Development of preventive structures and methods	**27. Continuing professional development** -Awareness & education on disaster resilience
8. Health & safety -Temporary housing provision -Availability and identification of suitable alternative place to relocate	**17. Insurance** - Financial compensation for damages - Knowledge and awareness of insurance - Property insurance - Adequacy of insurance cover	**28. Emergency management** - Rapid recovery after an onset of a disaster - Management of emergency shelters
9. Work progress & quality management -Rapid restoration of damaged infrastructure -Better infrastructure needs	**18. Time management** - Time management	**29. Construction technology & environmental services** - Knowledge on resilient construction practices

Table 3 indicated the mapping of the identified 29 skills and needs expected of the built environment professionals towards the effective implementation of the core priorities area of Sendai framework. Thus, the cross-cutting areas of the Sendai framework have been analysed to identify the skill and knowledge requirements of the built environment professionals. Therefore, Table 3 contained the identified skills and needs with core priority areas of Sendai framework priorities for action (PA) and guiding principles (GP). It is evident from Table 3 that Building regulation & planning, Legal/Regulatory compliance, Team working, Multi-stakeholder management, and Construction technology & environmental services were linked to PA1-PA4 (see Table 3 for details). Table 3 further indicated that expect for 3(out of 29) identified skills and needs, all the identified skills and needs were directly mapped to Sendai framework priorities for action (PA). This implies that the entire identified skills and needs are significant for the built environment professionals towards enhancing disaster resilience of the built environment, and the effective implementation of the core priorities area of Sendai framework.

Table 3: Mapping of the identified needs and skills with Sendai framework

No.	**Identified needs and skills**	**Sendai framework**		
		Priorities for action (PA) (With details)	**Priorities for action (PA)**	**Guiding principles (GP)**
1	Budgeting & financial planning	PA1NLk, PA2NLc, PA3NLm	PA1, PA2, PA3	GPj, GPm
2	Quantification & costing	PA3NLc	PA3	GPj

No.	Identified needs and skills	Sendai framework		
		Priorities for action (PA) (With details)	**Priorities for action (PA)**	**Guiding principles (GP)**
	of construction works			
3	Supply chain management	PA4NLe	PA4	
4	Consultancy services	PA4GRg	PA4	GPj, GPm
5	Procurement & contract administration/practice	PA3NLc	PA3	
6	Building regulation & planning	PA2NLd, PA3NLf, PA3NLh, PA4NLj, PA4NLk, PA4NLl	PA1, PA2, PA3, PA4	
7	Legal/Regulatory compliance	PA1NLn, PA2NLa, PA2NLb, PA2NLd, PA2NLf , PA2NLk, PA3NLj, PA4NLa, PA4NLb, PA4NLp	PA1, PA2, PA3, PA4	GPa, GPh
8	Health & safety	PA4NLj, PA4NLo	PA4	
9	Work progress & quality management	PA3NLc,	PA3	GPk
10	Quality leadership & people management	PA2NLc, PA4NLo	PA2, PA4	GPb, GPd
11	Team working	PA1NLh, PA1NLo, PA1GRe, PA2NLf, PA2NLh, PA2GRa, PA2GRb, PA2GRc, PA2GRd, PA2GRe, PA2GRf, PA3GRc, PA3GRf, PA4GRa, PA4GRf,	PA1, PA2, PA3, PA4	GPa, GPd, GPe, GPf
12	Governance	PA2NLa , PA3GRg	PA2, PA3	GPa, GPb
13	Multi-stakeholder management	PA1GRa , PA1GRg, PA2NLg , PA2NLi, PA2GRa, PA2GRb, PA2GRc, PA2GRd, PA2GRe, PA3GRd, PA4NLi, PA4NLl, PA4GRa, PA4GRf	PA1, PA2, PA3, PA4	GPa, GPe, GPl
14	Business planning	PA3NLo, PA3GRi, PA4NLg,	PA3, PA4	
15	Environmental assessment	PA3NLg, PA4NLb	PA3, PA4	
16	Management of the built environment	PA3NLn, PA3GRa	PA3	GPc
17	Insurance	PA3NLb, PA3GRb	PA3	
18	Time management			GPm
19	Communication & negotiation/Information systems	PA1NLa, PA1NLc, PA1NLe, PA1NLf, PA1GRa, PA1GRc, PA1GRg, PA1GRh, PA1GRi, PA2GRf, PA4NLb, PA4GRb, PA4GRd	PA1, PA2, PA4	GPg, GPm
20	Project audit & reporting	PA2NLe	PA2	
21	Management & dispute resolution procedures			
22	Cross cultural awareness in global resilience	PA1NLc, PA1NLi, PA1NLo, PA3NLd	PA1, PA3	GPa, GPi, GPm
23	Project management			
24	Asset/Resource management	PA3NLa, PA3NLn, PA3NLp, PA3NLq, PA3GRf,	P3	GPc, GPm
25	Disaster management	PA4NLh	PA4	
26	Risk management	PA1NLb, PA1NLaj, PA1GRb, PA1GRg, PA2GRf	PA1, PA2	GPa, GPc, GPl
27	Continuing professional development	PA1NLg, PA1NLl, PA1NLm, PA1GRe, PA1GRf, PA1GRg, PA1GRi, PA2NLj, PA4NLm, PA4GRf	PA1, PA2, PA4	GPk, GPm
28	Emergency management	PA4NLd, PA4NLm	PA4	
29	Construction technology & environmental	PA1NLj, PA2NLc, PA3NLc, PA3NLe, PA3GRc, PA4NLc,	PA1, PA2, PA3, PA4	GPk, GPm

No.	Identified needs and skills	Sendai framework		
		Priorities for action (PA) (With details)	Priorities for action (PA)	Guiding principles (GP)
	services	PA4NLk,		

Legend

GPa - GPm: Sendai framework guiding principle a to m
PA1NLa – PA1NLo: Sendai framework priority for action 1 – National & local levels
PA1NLa – PA1NLo: Priority for Action 1 at National & local levels (sub actions a to o)

PA1GRa – PA1GRi: Sendai framework priority for action 1 – Global and regional levels
PA2NLa – PA2NLk: Sendai framework priority for action 2 – National & local levels
PA2GRa – PA2GRf: Sendai framework priority for action 2 – Global and regional levels
PA3NLa – PA3NLq: Sendai framework priority for action 3 – National & local levels
PA3GRa – PA3GRi: Sendai framework priority for action 3 – Global and regional levels
PA4NLa – PA4NLp: Sendai framework priority for action 4 – National & local levels
PA4GRa – PA4GRh: Sendai framework priority for action 4 – Global and regional levels

CONCLUSION

The Sendai framework has re-emphasised the importance of educational measures to include formal and non-formal education, civic education at all levels, as well as professional education and training in reducing the disaster risk. Thus, the need to clearly understand the required needs and skills for the implementation of Sendai framework cannot be overemphasised. Against this backdrop, this study identified the skills and needs expected of the built environment professionals by the communities affected by natural disasters and mapped the identified skills and needs with core priority areas of Sendai framework. The study revealed the identified 29 skills and needs with their respective components expected of the built environment professionals towards enhancing disaster resilience of communities affected by natural disaster. These study findings affirmed the existing literature that described post-disaster reconstruction or recovery as a complex process that requires multi-sectoral involvement, the range of skills, and consumes very significant resources.

It is evident from these study findings that team working, budgeting & financial planning, quality leadership & people management, communication & negotiation/information systems, insurance, project audit & reporting, business planning, multi-stakeholder management, among others were identified as knowledge areas and skill sets that built environment professionals could bring to leverage the disaster management process. Similarly, the study showed that expect for 3(out of 29) identified skills and needs, all the identified skills and needs were directly mapped to Sendai framework priorities for action (PA). This implies that the entire identified skills and needs are significant for the built environment professionals towards enhancing disaster resilience of the built environment, and the effective implementation of the core priorities area of Sendai framework. In the same vein, this study has presented the skills and needs that are significant towards effective implementation of the four core priorities of Sendai framework on the respective areas of priorities for actions with the relevant Global & Regional level and National & Local level actions. It is believed that these study findings would be beneficial to the built environment professionals in enhancing their capacity and capability development in all the priority areas of Sendai framework.

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PRIORITIZATION OF CRITICAL FACTORS FOR RESILIENCE OF TRANSPORT INFRASTRUCTURE: THE SENDAI FRAMEWORK

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ABSTRACT

Flood is the most costly natural disaster faced by Australia. It has devastating impact on Australian society, economy and infrastructure. Despite the importance of understanding flood risk management, few empirical studies have been conducted over the last decade in terms of analyzing the factors that determine the resilience of transport infrastructure in flooding. Hence, the aim of this paper is to analyze and rank disaster risk reduction approaches and critical factors across New South Wales, Australia by the resilience of their transport infrastructure to flood disasters by using an ELECTRE I as a multi-attribute group decision-making technique. This research seeks to measure local councils' approaches and synergies with the Sendai Framework for Disaster Risk Reduction 2015–2030. Results indicate that engineering design, building regulations and land use controls are significant factors contributing to the resilient transport infrastructure, even when they have located far from coastal areas. On the other hand, areas with more non-urban unsealed networks encounters huge amount of post-flood road reconstruction cost and they are less resilient. The paper concludes the anticipated benefits of analysis of resilient transport infrastructure as (i) direct comparison of different flood risk reduction approaches for resilient transport infrastructure and (ii) high-level flood resilience decisions.

Key words: Flood, resilience, transport infrastructure

INTRODUCTION

The global weather climate is becoming more extreme and will continue to change in ways that have adverse impact on the operations of transport infrastructure. The manifestations of climate change include higher temperatures, altered rainfall patterns and more frequent or intense extreme events (AGO, 2006). Flood is widely regarded as the most destructive and expensive natural disasters (Alexander, 1997). Australia is one of the most susceptible countries to flood damage, with around $13 billion of direct economic impact from floods over the past three decades (CRED, 2012). Almost $250 billion worth of buildings and transport infrastructure is potentially exposed to flooding by 2050 (Emergency

Management Australia, 1999), making flooding the most costly potential cause of natural disaster in Australia (Blong, 2004). Transport infrastructure such as roads, bridges, airports and tunnels can be at particular risk of direct damage from flooding events. Meyer (2008) pointed out that transport infrastructure is vulnerable to extremes in temperature, precipitation/river floods, and storm surges, which can lead to damage to road, rail, airports, and ports. Although transport infrastructure is considered vulnerable to flooding, the level of exposure and impact will vary by region, location, elevation and condition of infrastructure, etc. (IPCC, 2012; Meyer, 2008).

Investing in disaster risk reduction for resilience is one of priorities in the Sendai Framework for Disaster Risk Reduction 2015–2030 (United Nations Office for Disaster Risk Reduction 2015). The Sendai Framework for Disaster Risk Reduction 2015–2030 is the first global policy framework developed by the United Nations to substantially reduce disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. Investing in disaster risk reduction for resilience in a changing environment is one of priorities of Australian governments and the Sendai Framework emphasizes the strong international consensus to act by identifying the full potential of effective building regulations in reducing disaster risk for resilience. Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment.

Relevant research to date has tended to focus on economic impact that floods have on transport infrastructure. Little has been done to determine the factors that determine the resilient of transport infrastructure against flooding. Indeed, there is little agreement even on how resilient approaches might be prioritized and measured in this context. Several studies have investigated flood risk management in the context of seismic risks (Lindell & Prater, 2003), but no empirical studies have developed the decision-making models to prioritize the critical factors that determine the resilient transport infrastructure. The aim of this paper is to analyze and rank disaster risk reduction approaches and critical factors across New South Wales, Australia by the resilience of their transport infrastructure to flood disasters by using a multi-attribute group decision-making technique.

In Australia, local councils are responsible for approving most development projects and building plans (Huq et al., 2007; UNISDR, 2004; UNISDR, 2011). They are important in reducing risk in planning and building; they must pass bylaws on building regulations and prepare land use plans and emergency response plans. This research seeks to measure local councils' approaches and synergies with the Sendai Framework for Disaster Risk Reduction 2015–2030. Local councils have emphasized the need to focus on urban resilience, however, there have been insufficient tools and techniques to measure their urban resilience efforts with clear quantitative decision-making tools (Chang et al. 2014, IPCC 2012). The development of a mathematical multi-attribute group decision-making tool will help local decision-makers prioritize resilience activities and understand the value of their investments in these areas.

CONCEPTUAL FRAMEWORK

Disaster risk reduction approaches refer to the social processes used for designing, implementing and evaluating strategies, policies and measures that promote and improve the preparedness, response and recovery activities at different organizational and societal levels (IPCC, 2012). Figure 1 represents the conceptual framework for proposing a set of critical factors that best represent the most effective resilient transport infrastructure. These factors then combine to provide an overall score or measure of the effectiveness of each factor in local councils' resilient transport infrastructure.

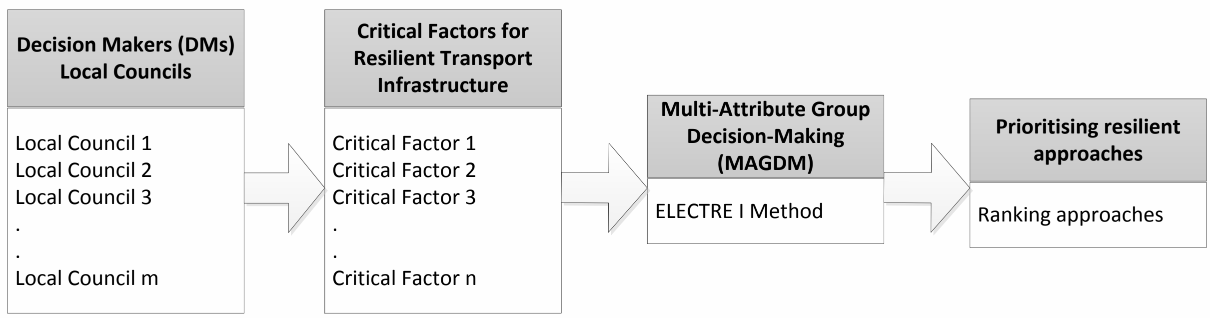

Figure 1: Conceptual framework of prioritizing flood risk reduction approaches for resilient transport infrastructure

RESEARCH METHOD

Step 1: Identify factors

A systematic investigation will identify most of relevant critical factors in the literature based on the developed conceptual framework that local councils need to implement for flood risk reduction and resilient transport infrastructure. The list of factors identified is presented in Table 1. This study draws critical factors from previous studies (e.g., Altay and Green, 2006; Covington and Simpson, 2006; Haigh et al., 2006; Moe and Pathranarakul, 2006) as potential critical factors for the resilient of transport infrastructure against floods.

Step 2: Collect data and evaluate councils

Data was collected from local councils to apply to the model developed in Step 1. Local councils in New South Wales are the sampling frame in this research for several reasons. Local councils are responsible for approving most development applications for renovation, demolition, construction and development under each council's Local Environmental Plan and relevant state planning policies. In addition, local councils are responsible for investing, constructing, maintaining and restoring a major portion of regional and local roads and bridges.

Since not all local councils are susceptible to flood disaster, the sampling frame will be filtered by focusing on local councils who are members of Floodplain Management Australia, which promotes appropriate development in floodplain areas and helps to reduce the risk of flooding to life, property and infrastructure. A survey designed by the researcher was distributed by Floodplain Management Australia to its 74 local council members in New South Wales, Australia to collect the required data for the model. Responses were sought from floodplain engineers, planning and infrastructure engineers, emergency management officers and others with direct experience in floodplain management. The survey had a response rate of 48% (36 out of 74 members). Therefore, 36 decision makers evaluated flood risk reduction approaches relevant to flood resilience in transport infrastructure. Local councils were asked to rate individual question on a seven point Likert scale pertinent to their flood risk reduction approaches developed in Table 1.

Step 3: Develop a decision-making model and data analysis

A mathematical optimization model based on multi-attribute group decision-making was developed to combine the factors identified in Step 1 and collected in Step 2 into a composite decision-making matrix that best represents the range of approaches used in flood risk reduction by local councils in New South Wales. Multi-attribute group decision-making is an optimization technique which can address the problem of conflicting conditions. The aim of multi-attribute decision-making is to select the most desirable risk reduction approaches that have the highest degree of satisfaction for all of the relevant local councils. In multi-attribute decision-making, decision-makers need to select or rank the alternatives that are associated with commensurate or conflicting attributes. In order to index the various factors a multi-attribute decision making technique is required.

In this paper, a non-compensatory approach is introduced for the ranking of local councils' transport infrastructure in terms of their resilience to flood disasters, using the original ELECTRE, known as the elimination and choice translating reality method, is a widely used multi-attribute group decision-making method. It is first introduced by Roy (1968). This approach provides solutions to resilience activities selection problems of transport infrastructure involving multiple conflicting objectives, particularly when the compensation among the criteria is not allowed. By producing a decision matrix and a criteria sensitivity analysis, the ELECTRE can be applied to perform a reasonable strategy selection for a particular application, including a logical ranking of considered local councils

ELECTRE is an effective method for analyzing and ranking alternatives that uses the Net Concordance (NC) value from the best solution and Net Discordance (ND) value from the worst solution. ELECTRE I concurrently takes into account both NC and ND distances to calculate a Net Concordance Dominance (NCD) value (Chen, 2000). The NCV notion is derived from prospect theory which is used to identify the ideal point from which a compromised solution would have the shortest distance. In this paper, ELECTRE I and the notion of NCV is used to develop score values for each resilience activity.

Table 1 presents the respective Net Concordance Dominance (NCD) value obtained from the ELECTRE procedure. The table shows that R8-developing engineering design standards for resilient roads and bridges (NDC = 0.73), R6-Zoning and land use controls to prevent building of roads in flood prone areas (NDC = 0.68) and R2-Road type (sealed/unsealed) (NDC = 0.67) have greater focus than other critical factors for flood resilience.

Table 1: Ranking critical factors in flood resilience approaches in transport infrastructure by local councils

ID	Resilience Activities	NC	ND	NCD	Rank
R1	Road location (urban/rural)	0.52	0.5	0.51	7
R2	Road type (sealed/unsealed)	0.59	0.29	0.67	3
R3	Culverts length on local roads	0.21	0.32	0.40	14
R4	Roads and bridges at risk from flood	0.24	0.22	0.52	6
R5	Response time for reconstruction	0.76	0.54	0.58	4
R6	Zoning and land use controls to prevent building of roads in flood prone areas	0.7	0.33	0.68	2
R7	Insuring roads and bridges to reduce the financial impacts of floods	0.81	0.74	0.52	5
R8	Developing engineering design standards for resilient roads and bridges	0.4	0.15	0.73	1
R9	Constructing flood retarding basins, barriers, culverts, levees and drainage	0.34	0.55	0.38	15
R10	Locating emergency operation centers in roads	0.29	0.39	0.43	13
R11	Evacuating threatened populations and vehicles from flooded roads	0.37	0.45	0.45	11
R12	Cleaning flood disaster debris	0.5	0.55	0.48	9
R13	Shortening reconstruction time by applying quick mobilization	0.75	0.82	0.48	8
R14	Constructing temporary roads and bridges	0.46	0.52	0.47	10
R15	Realigning and upgrading roads and relocating bridges to lower flood hazard locations	0.35	0.45	0.44	12

DISCUSSIONS AND CONCLUSIONS

This paper reports on a recent study that specifically aims to prioritize local councils' approaches for resilient transport infrastructure in a broader flood risk reduction context. The most substantive outcome of this research is clear confirmation that local councils believe that developing engineering design standards is the main critical factor for successful resilient roads and bridges. All participant local councils in this study also believe that appropriate zoning and land use controls should be taken to prevent building of roads in flood prone areas. Building and land use regulation has proven to be an effective tool for risk reduction in the developed world. To date, such regulatory measures have proven ineffective in transport infrastructure and this is a main concern for engineers, city planners and other stakeholders. The future research should seek to improve the effectiveness and efficiency of building regulation, and so guide urban development to less hazardous locations and less vulnerable structures.

A further benefit of the results of this paper is that the critical factors for resilient infrastructure of different local councils can be directly compared in floodplain risk reduction terms. Individual local councils can benchmark their floodplain risk reduction activities against other, comparable local councils. Funding agencies can utilize the values of ELECTRE technique in prioritizing the allocation of resources to local councils. The results from this research will inform city managers, planners, engineers, architects and economists as they develop more quantitative indicators and standards for resilient buildings, set targets and make improvements over time. This research integrates disaster risk reduction attributes and reflects the need to promote standards of resilience that can guide sustainable urban development and planning.

The research presented in this paper establishes a novel approach to build a resilient transport infrastructure. The ELECTRE technique provides a more realistic form of modelling for multi-attribute group decision making because it allows for trade-offs between attributes. The resulting values are relatively straight-forward to compute, are replicable and readily modified to reflect changes in the values of any factors. With the methodology established, future studies can examine more critical factors for resilient built environment by focusing on the Sendai Framework for Disaster Risk Reduction 2015–2030.

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BUILDING RESILIENCE IN A POST-DISASTER SITUATION: LESSONS FROM CYCLONE IAN IN TONGA

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The Kingdom of Tonga is the second most vulnerable country in the world according to the 2012 World Risk Report. In January 2014, Tropical Cyclone Ian (TCI) - a Category 5 cyclone with sustained winds of 200 km/h - passed through the Ha'apai island group and caused losses of 11% of the GDP, affecting approximately 5,500 persons, and damaging 1,130 buildings. Due to repeated climate hazards, Tongan institutional capacity, local expertise, and resources are often overstretched, and limited in their ability to cope with the long term negative impacts on the communities.

To help the country mitigate the effects of TCI, the Tongan Government together with the World Bank (WB) undertook a large housing reconstruction effort in the affected outer islands with the objective of improving long-term resilience of the communities. The US$13.8 million WB project was designed with a strong resilient recovery focus, and was aimed to address the critical needs for housing, water and sanitation in the community, while targeting the most vulnerable households.

This paper focuses on key challenges - and how they were addressed - during project implementation, particularly related to: (i) low-cost structurally sound resilient house designs, (ii) compliance with design specifications, and (iii) enforcement of good construction practices. In the Tongan context, having project designs that comply with the latest structural codes applicable in the country, qualified building inspectors, and experienced constructors, proved to be critical factors in being able to advance the project and achieve its objectives.

In addition, given the importance the project placed on enabling quick mobilization of local authorities in the case of future hazards, the paper discusses two of the solutions proposed for an efficient and long term resilient recovery: (i) the role of pre-approved housing designs, and (ii) the support for improving local technical expertise.

KEY WORDS: design, disaster, housing, resilience, vulnerable.

A PROCEDURE FOR SELECTING WATER SUPPLY SYSTEM RESILIENCE INDICATORS

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ABSTRACT

The resilience of communities to earthquakes is a function of the performance of infrastructures and, specifically, water supply systems in the aftermath of the disaster and their functionality during recovery time. Determination of a framework for measuring resilience of water systems remains a challenge. This paper proposes a procedure to select appropriate indicators to estimate water supply system resilience before a disaster happens. Applying this procedure will enable urban planners and disaster managers to figure out what technical, organisational, social, economic, and environmental factors can affect water system resilience.

Keywords: resilience, earthquake, water supply system, indicators

INTRODUCTION

The functionality of infrastructures is subject to disruption when earthquakes happen. Due to numerous pull factors, urban areas are absorbing people and growing in size and population around the world. The coincidence of earthquakes and densely populated cities creates the potential for increased direct and indirect consequences of seismic events such as loss of life, economic losses, etc. (Burby, Deyle, Godschalk, & Olshansky, 2000).

The resilience of communities to disasters is a function of the performance of infrastructures and, specifically, water supply systems in the aftermath of the disaster and their functionality during recovery time. Water supply systems provide crucial services to enable, preserve and improve living conditions (Fulmer, 2009) and any disruption in these systems will cause inconvenience and difficulties for the community. Loss, or contamination, of water in previous earthquakes have led to epidemics like cholera (Piarroux et al., 2011) or conflagrations and significant losses (Chung et al., 1996; Scawthorn, 1996; Scawthorn, Eidinger, & Schiff, 2005) and changed the societies' priorities from recovery activities to response to the epidemics and conflagrations.

Identifying existing resilience of water supply systems to earthquake is becoming more important for society (Frazier, Walker, Kumari, & Thompson, 2013). The most significant goals and functions of measuring resilience are understanding resilience and its underlying factors. In other words, measuring resilience of water systems can provide decision makers with appropriate information about the most vulnerable components of the system and the community as well as their recovery duration if a disaster happens. In addition, perceiving the concept of resilience will demonstrate the interdependencies between technical perspectives and other attributes of the community.

Like any other phenomena, resilience requires indicators to be measured. The resilience indicators enable different levels of administration to integrate resilience fostering strategies into mitigation and preparedness planning (Queste, Lauwe, & Birkmann, 2006). Due to the unavailability of comprehensive quantifying indicators, it is difficult to estimate the resilience of water supply systems to disasters. In addition, the qualitative nature of indicators, if any, makes it arduous to assess the impact of different factors on water systems resilience. However, to be able to evaluate water systems resilience, the concept of resilience should be clearly defined and made quantifiable.

This paper proposes a procedure to select appropriate indicators to estimate water supply system resilience before a disaster happens. Applying this procedure will enable urban planners and disaster managers to figure out what technical, organisational, social, economic, and environmental factors can affect water system resilience.

WHY WE NEED INDICATORS TO MEASURE RESILIENCE?

Despite measuring resilience to earthquakes having been pointed out in recent literature (Béné, 2013; Chang & Shinozuka, 2004; Francis & Bekera, 2014; Winderl, 2015), a comprehensive and unanimously accepted methodology for measuring resilience of communities is missing. In the case of infrastructure resilience, physical vulnerability of these systems was the dominant view in estimating post-earthquake status for decades (Hashimoto, Stedinger, & Loucks, 1982; Hwang, Lin, & Shinozuka, 1998; Little, 2002). Most of these studies focused on estimating lifelines' damage when an earthquake happens, rather than focusing on either system performance as a whole or recovery phase in which the system would be bounced back to an acceptable level of service. In addition, they take the physical dimension of infrastructures into account to measure outages after earthquakes.

in engineering discipline, Bruneau et al. (2003) have been pioneers in replacing the concept of vulnerability of components with the definition of resilience on the basis of system functionality. They defined resilience as the ability of the system to reduce the chances of a shock, to absorb a shock if it occurs (abrupt reduction of performance) and to recover quickly after a shock (establish a new normal performance). By using the term of functionality as a tool to measure system's well-being, these researchers redirected the disaster management approach from damage-based to performance-based and replaced single-component viewpoint with systemic perspective.

The definition of engineering systems' resilience expressed by Brunau et al. (2003) and their followers, however, is further conceptual and can be used best, at the moment, based on post-disaster data on system functionality because it is not clear which factors may affect system's functionality when a disaster happens. To estimate the system resilience prior to a disaster, we need to understand how and based on what factors does the system functionality improves and system gets recovered to an acceptable functionality. One can claim that restoration curves can be utilized to estimate post-disaster restoration process. Although empirical restoration curves are helpful in having a rough estimation of post-disaster restoration process, they are region-based and cannot be utilized in different areas. Moreover, restoration curves do not take into account the factors which form the curves. Understanding these technical, social, organisational, economic, and environmental factors or variables are somehow more important that just estimating the recovery time. Figuring out these variables will enable the decision makers and governors to find the weak points which need to be paid attention.

SELECTING RESILIENCE INDICATORS

Literature on developing composite indicators shows various methodological approaches, most having a process of indicators construction in common (Birkmann, 2006; Cutter, Burton, & Emrich, 2010). The current study proposes a procedure to select appropriate indicators to measure the resilience of water supply systems, precisely and in a straightforward manner (figure 1). This procedure consists of two fundamental sub-procedures: (1) indicator selection, (2) data check.

The analysis of indicator selection process must be integrated within the framework of water supply system resilience estimation. The procedure of indicators selection is a significant part of resilience estimation as can be seen in figure 1, containing two major sub-procedures: selecting appropriate indicators and data check in which indicators are refined based on data availability. Each sub-procedure contains a number of activities as follows:

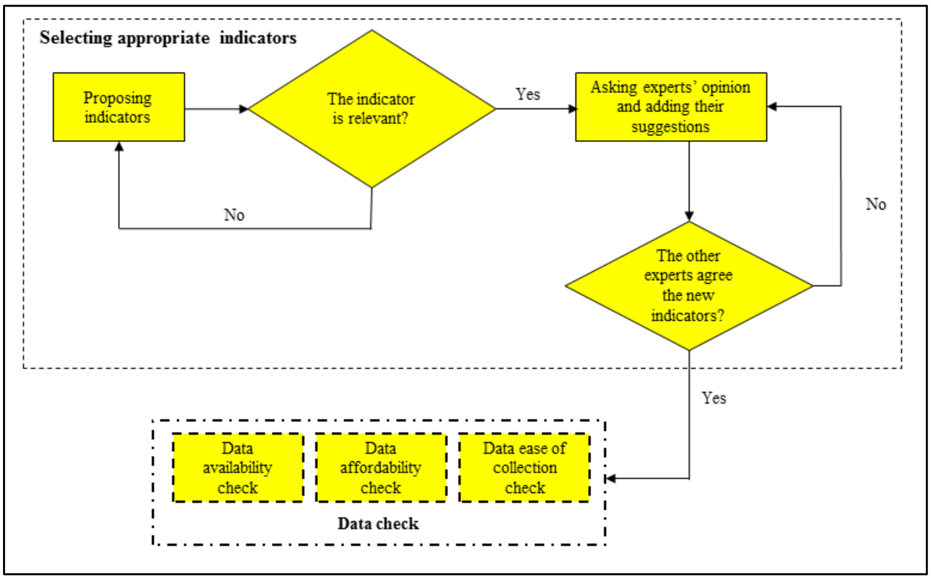

Figure 17. Water supply system resilience composite indicator selection procedure

1. SELECTING APPROPRIATE INDICATORS

Measuring the complicated concept of resilience of water supply systems to earthquake requires a reduction of all the potentially collectable data to a set of significant indicators from regional to national level to enable decision makers to assess the impact on the affected society. Due to the difficulty in quantifying resilience in absolute terms without utilizing external references to validate the calculations, most existing resilience measurement techniques use indicators or variable agents to assess relative levels of resilience. The relative levels of resilience, therefore, are mostly being used to compare systems (e.g. water supply systems) in various places (spatial), or to analyse resilience trends of systems (e.g. water supply systems) in a certain place over time (Cutter et al., 2008; Schneiderbauer & Ehrlich, 2006).

Different researchers define indicators in different ways, as ambiguities and contradictions emerge when considering the general concept of indicators. Gallopin (1997), as a comprehensive definition, defined an indicator as a pointer that gives an outline of information relevant to a particular case. More precisely, indicators are variables –either nominal, ordinal, or a quantitative variable- which represent an attribute –such as quality, quantity or a characteristic- of a system or phenomenon (Birkmann, 2006; Gallopin, 1997).

According to the definition of indicators, resilience indicators are defined in this paper as follows:

Resilience indicators are variables which are operational representations of functionality, quality or a characteristic of a system, either in technical, organisational, social, economic, or environmental aspects, which can potentially affect its resilience to natural disasters such as earthquakes.

The ability of the indicators to show the characteristics of a system based on predefined goals shows the quality of indicators. The most important criteria for selecting indicators, and which are taken into account in this paper, include the following (RW.ERROR - Unable to find reference:229; Briguglio, 2003; Hahn, 2003):

Validity, that determines if the indicator is proxy of the targeted resilience dimension,
Sensitivity, that shows whether or not the indicator is sensitive to changes in outcome,
Objectivity, that demonstrates if the indicator can be utilized over time based on updated and reproduced data, and
Simplicity, that represents ease of comprehension by decision makers and other users.

Although other criteria are mentioned for selecting indicators by other researchers, they are either data-relevant criteria, or have overlap with the abovementioned principle criteria. Data-relevant criteria (e.g. data availability, affordability, etc.) have not been considered here because this paper focuses on gathering the most effective indicators for water supply systems regardless of concerns for data. However, the indicators can be localized and prioritized based on data availability and affordability over the spatial scale. The time scale resilience is measured in is another significant consideration. Resilience indicators might vary over time due to data and information availability (Cutter et al., 2008).

DATA CHECK

Data collection is one of the most challenging parts of constructing indicators. The most significant difficulties are due to:

Lack, or deficiency, of data,
Data collection/generation costs,
Data collection hardness,
Lack of unity on definitions among different countries,

Lack, or deficiency, of data arises when data is not gathered during a certain event or has a limited spatial and temporal scope. Data availability is a very significant concern in measuring phenomena because it can change the measuring method. In such cases the researcher should either gather/complete the required data or change the indicators to avoid massive errors in outcomes. In some cases proxy variables might be appropriate if they do not impose huge uncertainties.

Although the availability of data is very important in developing indicators, data affordability can be of a major concern in any country, depending on its economic state. Sometimes, gathering data is a very expensive procedure, for instance measuring actual water leakage ex- and ante-earthquakes. In some other instances, data is being gathered by several agencies and companies, but it may cost a lot to purchase whole data from them. The solutions to data unavailability can also be applied for data cost problems.

Data collection hardness may not lead to permanent change of the indicators; however, it can result in temporary variable changes and postpone the finalization of measuring indicators. For example, when a water catchment is located in a hilly, wild, sylvan area, aerial photography is an impossible way of data collection and it is difficult to gather the data manually. In these cases alternative variables can be quite helpful.

Generally, data gathering methods and data units vary in different countries. In social sciences, such as economics and sociology, various agencies gather the data and represent them across countries and regions. In these cases, every component of the final index should be accompanied by a detailed explanation of the intended measuring purpose to ensure that the indicators are defined in an integrated way across the countries.

CONCLUSION

Measuring resilience of water supply system calls for a multifaceted conceptual framework. A resilience measuring framework should address all the factors including technical, organisational, social, economic, and environmental elements that affect the resilience of water systems. A key challenge is how to measure resilience as precisely as possible based on information available from previous earthquakes.

This paper has presented a procedure of selecting indicators to estimate water supply system resilience to disasters. Although this procedure is proposed for water supply systems, it also can be adopted and utilized for other infrastructures. Two fundamental sub-procedures proposed to choose and refine resilience indicators in water systems. The first sub-procedure, selecting appropriate indicators, enables planners to find relevant variables by means of literature review, qualitative surveys, and interviews with experts. The final indicators coming out of this section will go to the data check sub-procedure to make sure that they can be utilized in specific regions. In the data check sub-procedure, data availability, affordability, and ease of collection should be checked specifically in the area the indicators are going to be applied.

Despite all the strengths of using indicators to measure resilience, this approach might share a number of weaknesses. One issue that should be avoided is the subjective selection of indicators that is not a particular problem of a resilience index but is with most empirical works, especially multivariate analysis. Subjective selection of indicators might result in using redundant indicators. Clear understanding of the objective of the indicators can minimise this problem.

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VULNERABLE AND RESILIENT? IMMIGRANTS AND REFUGEES IN DISASTERS

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ABSTRACT

This sociological study explores how immigrants and refugees, many of whom are linguistic minorities, experienced the 2010-2011 disasters in Canterbury (New Zealand) and Tohoku (Japan). The focus is on their perceived social vulnerabilities and resilience to disasters. Previous research has found that linguistic minority immigrants and refugees are socially vulnerable as they occupy a position of relative deprivation compared to majority groups. However, findings drawn from in-depth interviews demonstrate the fluid, complex and contextual nature of social vulnerabilities in disasters, suggesting that people may be simultaneously vulnerable *and* resilient. The current disaster resilience paradigm can be misleading as it suggests that some of the socially vulnerable may be *naturally* disaster resilient. This study, utilizing key-informant interviews drawn from snowball sampling, suggests that they can be resilient partly because of the everyday inequalities that already confront them, and because of their previous experiences of disasters. Wars, conflicts, displacement and everyday hardships have given them "earned strength" and made them disaster *resilient*. Employing Bourdieu's theoretical notions of capital, this study demonstrates how these victims were active social agents in these disasters, using a variety of resources (capitals) to cope with them. In-depth analysis of their individual and collective experiences can help disaster researchers to re-conceptualize the social vulnerability approach and disaster resilience thinking. Further, examples of the ways in which they individually and collectively coped with disasters can provide practical knowledge to help researchers, practitioners and policymakers develop more effective disaster risk reduction (DRR) strategies.

KEY WORDS: Capital, Earned Strength, Resilience, Social Vulnerability, Sociology of Disasters

RE-THINKNG RESILIENCE

There has been a noticeable shift in disaster research from the vulnerability approach to resilience thinking. The emphasis is on disaster prevention and risk reduction, instead of disaster response (Tierney, 2014). This thinking became particularly prevalent in disaster research after the Hyogo Framework for Action in 2005. The term "resilience" now outnumbers "vulnerability" in the Sendai Framework for Disaster Risk Reduction 2015. Resilience has become the most important concept for promoting more effective and efficient disaster risk reduction (DRR) strategies (Dodman, 2016).

Resilience thinking emerged from ecology (Holling, 1973) and has now spread across disciplines, although its premises have been frequently challenged (Alexander, 2013; Manyena, O'Brien, O'Keefe & Rose, 2011; Masterson, Peackock, Van Zandt, Grover, Schwarz & Cooper 2014; Payton & Johnston 2006). Prominent criticisms of resilience include: 1) it is resource-dependent in some cases, possibly meaning that the more resources people possess, the more resilient they can be, 2) resilience approaches individualises social vulnerability and obscures structural inequalities, 3) it lacks clarity: "what kind of resilience for whom?" (Neocleous, 2013; Pike, Dawley & Tomaney, 2010), and 4) resilience connotes "bouncing back" rather than bouncing forward, which may be undesirable to victims if it entails a return to vulnerability (Manyena et al., 2011).

The rapid shift in disaster discourse saw policymakers, practitioners and researchers emphasize resilience without properly understanding social vulnerability in disasters, particularly pre-existing social structural inequalities which often create uneven disaster impacts. The social vulnerability approach helps us identify more vulnerable groups and individuals in disasters, yet the current disaster resilience paradigm misleads. It suggests that vulnerability can be reduced by promoting resilience because vulnerability and resilience are binary opposites, or that they exist in an inverse relationship to each other (Rodin & Garris, 2012). The simple logic at work here is that if you are resilient in disasters, you will not be vulnerable. While vulnerability and resilience are closely related, this relationship is more complex. It is also misleading (and politically troubling) to suggest that some of the socially vulnerable may be *naturally* disaster resilient and that *anyone* can be resilient without addressing the types of deprivation that the socially vulnerable confront.

Consequently, we argue that resilience thinking needs to be re-conceptualized to reflect the actual experiences of the socially vulnerable. This will create a more effective DRR strategy. To emphasize the point, this sociological study explores how immigrants and refugees, many of whom are linguistic minorities, experienced the 2010-2011 disasters in Canterbury and Tohoku. These groups have been understudied in disaster research, although it is acknowledged that other groups such as the poor, racial/ethnic minorities, women, and those with disabilities, are also socially vulnerable in disasters. The research that has been done on linguistic minority immigrants and refugees shows that they occupy a position of relative deprivation compared to majority groups (Santos-Hernández &

Morrow, 2013). Moreover, there is a lack of sociological research on these vulnerable groups from their perspectives. Thus the focus is on their perceived social vulnerabilities and resilience to disasters and its complex relationship. However, findings drawn from in-depth interviews demonstrate the fluid, complex and contextual nature of social vulnerabilities in disasters, suggesting that people may be simultaneously vulnerable *and* resilient.

METHODOLOGY AND DATA COLLECTION

The data used for our qualitative analysis was primarily drawn from the 28 in-depth interviews with immigrants and refugees conducted in Canterbury and Tohoku in 2015 and 2016 (14 in Canterbury and 14 in Tohoku). Interviewees were first contacted through the researchers' personal networks, colleagues and supporting organizations such as Tohoku Help! and the Christchurch Refugee Council (CRC). Further interviewees were then selected through referrals from the first sets of interviewees (snowball sampling). Interviewees include both males and females and various age groups and nationalities with different cultural backgrounds in order to capture diverse experiences of these disasters. All interviews were informal and open-ended. They were conducted at locations comfortable for the interviewees. A set of open-ended interview questions was created prior to the interviews based on our pilot study and literature review. All interviews were audio-recorded and later transcribed (and translated to English if necessary) by the researchers for qualitative analysis. Further, some publicly available secondary data such as "Women's Voices" (Christchurch Branch of National Council of Women of NZ, 2014) and *Experiencing Disasters in Foreign Land: 3/11 for Koreans Living in Tohoku* (The Great East Japan Disasters Korean Immigrants Interview Project, 2015) was also used to include more voices of immigrants and refugees in these disaster-affected areas.

EARNED STRENGTH: VULNERABILITY GIVES RESILIENCE

Interviewees noted a variety of strategies and resources/capital that they used to cope with the disasters and their aftermath. One of the many significant themes to emerge from our primary and which is present in the secondary data can be analyzed with reference to McIntosh's (2007) concept of "earned strength". Some socially vulnerable can be resilient partly because of coping with the everyday inequalities which already confront them (Marlowe, 2013), and because of their previous experiences of disasters. Those who face social inequality on an everyday basis might have earned "strength" to get by in disasters because their everyday experiences of social marginalization contribute to their disaster resiliency (Davidson & Davidson, 2009).

Some of our Canterbury interviewees, such as Somali and Afghani refugees, explained that because they had gone through civil war, displacement and then resettlement in a foreign country, the series of 2010-2011 earthquakes was, while scary, still easily manageable. Because many of these refugees restarted life in the new host country without much capital, they have collected and created capital such as developing durable social networks to depend each other to collectively get by life's everyday hardships and systemic inequalities. They had the cultural and social capital to be disaster resilient: prior experiences, practical knowledge, cultural values and attitudes of how to support each other – in order to survive in chaotic situations, to survive without basic necessities such as water and power and to *restart* their life without major government assistance. In this sense, earned strength acted as cultural capital, which was an important yet unintended outcome of ongoing social inequality. Another Canterbury interviewee, a former Iraqi soldier and refugee to New Zealand, lived through multiple wars and had first-hand battlefield experience. In comparison to this, the earthquakes were minor traumas. Indeed, he felt compelled to help his neighbors who panicked and who could not react quickly to protect themselves from the earthquakes' direct and indirect threats. His prior wartime experience made it easier for him to deal with shaking ground, collapsing houses, distraught neighbors and the post-quake chaos.

Similarly, some Korean immigrant women's stories from our interviews and the book, *Experiencing Disasters in a Foreign Land: 3/11 for Koreans Living in Tohoku,* by The Great East Japan Disasters Korean Immigrants Interview Project (2015) helps us understand how their earned strength as cultural capital helped to deal with the disasters that impacted upon them. Most of these immigrant women decided to move to Japan to get away from the everyday hardships and "bad luck" they had in their home countries. After being recruited, moving to Japan and getting married to Japanese husbands (most of whom are farmers and fishermen), they now faced the oppression and discrimination mainly due to patriarchy and the traditional Japanese family system, the language barrier, and different cultural norms and expectations. We can assume that their experiences of being oppressed both pre- and post-migration to Japan might have made them somewhat disaster resilient. It is worth noting that they were facing the actual disasters (3.11) and "everyday disasters" for being non-Japanese immigrant "mail order" wives. However, some of the Korean and Filipino immigrant women respondents in Tohoku repeatedly reported that they had been happy with the fact that the disasters actually made them *visible* to the wider Japanese public. This has been empowering for them. Prior to the disasters, they were socially invisible, isolated in small rural communities. Thus, while the negative impacts of disaster cannot be denied, these women obtained social and symbolic capital in being both recognized by, and connected to, the people outside of their closed communities. Ironically, without the disasters, it is likely that they would have remained oppressed and unnoticed because, as they pointed out, they would not have received as much public attention and support.

Similar examples are found in the existing disaster literature. The Vietnamese community in the Eastern New Orleans during Hurricane Katrina in 2001 is arguably the paradigmatic example here. Community members' previous experiences of the Vietnam War, displacement, resettlement and racial discrimination in the host country gave them earned strength. This enabled them to make what many regard as an exemplary recovery (Leong, Airriess, Chen, Keith, Li, Wang & Adams, 2007). Consequently, "Katrina was a minor inconvenience" (Father Vien, quoted in Shenker, 2006, para.32). This community's resilience is often treated as an exception to the social vulnerability framework; however, all of these stories show us why some socially vulnerable are disaster resilient. Against the typical assumption of some individuals being naturally resilient, it is their previous experiences of everyday structural inequalities and hardships which give disaster resilience. This does not apply to all socially marginalized groups: compare the Vietnamese community's experiences in New Orleans with those of the African American communities, who remained vulnerable.

BOURDIEU'S CAPITALS

Bourdieu (1986, p.243) uses capital to refer to resources in the broadest sense. This capital may be economic (financial assets), cultural (skills and education), social (networks and group membership) or symbolic (rewards accruing from status). Capital possession determines one's place in the social order. One can see why Bourdieu's work is normally used to explain inequality and its perpetuation. But some of these non-economic forms of capital, particularly social capital, can also make groups resilient to disasters. Indeed, in some disasters, poor groups may cope better than others (Klinenberg, 2003). This suggests that there can be important resources beyond the merely financial. For example, Klinenberg's (2003) study stresses the value of what we might term "social infrastructure", the development of neighborhood ecologies of support. Bourdieu would understand this as "social capital". Aldrich (2011) also found in his study of Kobe's disaster recovery from the Great Hanshin-Awaji Earthquake that social capital conclusively proved to be a more significant and important recovery factor than other factors that are more typically employed to explain recovery (like physical damage and economic conditions). We give additional examples below.

VULNERABLE OR RESILIENT, OR VULNERABLE AND RESILIENT?

The paradox of resilience – that some groups and individuals are simultaneously vulnerable and resilient – is not only observed in immigrant and refugee communities. We also see it amongst other minority groups such as the Māori community in Canterbury during the 2010-2011 earthquakes. Tangata whenua in Christchurch showed remarkable disaster response and recovery (Kenney & Phibbs, 2015; Lambert, 2014), yet, according to New Zealand government reports, Māori are socially marginalized and disadvantaged in comparison to other ethnic groups (Statistics New Zealand, 2013). Using Bourdieu's conceptual schema, we can say that their economic and symbolic capital was low compared to Pākehā, but their cultural and social capital was high. We can also say that Māori resilience does not eradicate social vulnerability. This resilience comes from facing everyday hardships and inequities.

We can also bring McIntosh back into the analysis: earned strength can be considered a form of cultural capital for these socially vulnerable, but it implies that socially vulnerable groups often inherit and create a set of capital/resources such as durable social networks in order to survive and deal with their "everyday disasters". In other words, they have developed and obtained unexpected disaster coping abilities, as an unintended consequence of the structural social inequalities they experience. Social vulnerability gives resilience, so some groups and individuals in disasters may be vulnerable and resilient simultaneously, rather than – as academic discussions suggest – vulnerable or resilient.

CONCLUSION

This study suggests that immigrants and refugees can be resilient partly because of the everyday inequalities that already confront them, and because of their previous experiences of disasters. Wars, conflicts, displacement and everyday hardships have given them earned strength. This has made them disaster *resilient.* Further, by employing Bourdieu's theoretical notions of capitals this study demonstrated how these victims were active social agents in these disasters, using a variety of resources to cope with them. In-depth analysis of their individual and collective experiences can help disaster researchers re-conceptualize the social vulnerability approach and also disaster resilience thinking. Examples of the ways in which they individually and collectively coped with disasters can provide practical knowledge to help researchers, practitioners and policymakers develop more effective DRR strategies. The great policy challenge going forward is how to build capitals and earned strength without subjecting marginalised populations to enduring hardship.

DISCUSSION: THE PARADOX OF RESILIENCE

As emphasized here, some socially vulnerable groups and individuals are resilient simply because they possess earned strength arising from their position of social vulnerability. Vulnerability gives resilience in some cases. This paradox of resilience remains unexamined. As such, a critical yet complicated question remains: How do we make policymakers, practitioners and other researchers aware of this? How do we achieve the vitally important dual task of promoting resilience and reducing vulnerability within marginalized groups?

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SIMILATION OF POST-DISASTER RECOVERY FOR BUILDING A RESILIENT TOKYO

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ABSTRACT

An urban sociotechnical system is a large and complex system that consists of lifeline infrastructure as well as various human activities such as industrial, service, and daily life activities. Therefore, to build a more resilient urban sociotechnical system, it is necessary to understand the mechanism and characteristics of such complex systems, especially how lifeline infrastructures and human systems are interdependent and how the multiple interdependency affects the resilience of the urban city. First, this paper introduces a modelling framework for urban sociotechnical systems with such multiple interdependencies. Second, this paper describes how a real urban city is modelled and implemented based on the framework using open data for 23 Tokyo wards, including the network topology of lifelines, location of facilities, and population distributions. Finally, the results of the simulation of the recovery process from disaster damage using the model of 23 Tokyo wards as well as the result of the sensitivity analysis of the recovery to various model parameters for the model verification are presented.

Key words: multiple interdependency, recovery simulation, genetic algorithm, urban sociotechnical systems, building resilience

INTRODUCTION

An urban sociotechnical system is a large and complex system that consists of lifeline infrastructure as well as various human activities such as industrial, service, and daily life activities. Therefore, to build a more resilient urban sociotechnical system, it is necessary to understand the mechanism and characteristics of such complex systems, especially how lifeline infrastructures and human systems are interdependent and how multiple interdependency affects the resilience of the entire urban sociotechnical system. First, this paper introduces our modeling framework for urban sociotechnical systems in the form of a system of systems consisting of lifeline systems, industrial and service systems, and civil life systems (Kanno & Furuta, 2012, Kanno et al., 2015). Second, this paper describes how a computational model of a real urban sociotechnical system is constructed based on the aforementioned framework using open data of 23 Tokyo wards, including the network topology of lifelines, location of lifeline facilities, and population distributions. Finally, a computer simulation of the recovery process from disaster damage using the model of 23 Tokyo wards and the result of sensitivity analysis of the recovery to various model parameters to find insights for building more resilient buildings in Tokyo are presented.

MODELING FRAMEWORK

The urban sociotechnical system comprises not only physical infrastructure systems such as roads and power supply but also various human activities and the daily activities of citizens. To consider various such aspects in society, our study has adopted a modeling framework that consists of three subsystems, namely, the physical lifeline infrastructure, various industrial organizations and their activities, and citizens and their daily lives. Figure 1 shows a schematic of the model, which illustrates that there are multiple interdependencies within and among these three subsystems. In the implementation for the simulation, an agent-based model is adopted to represent various organizations, teams, and people, and a network model is used for representing the topology of lifeline infrastructure systems. The details are explained in the following subsections.

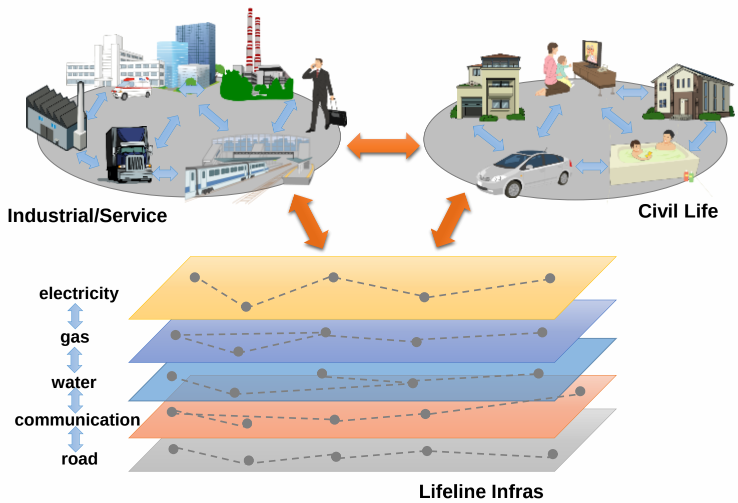

Figure 1: Modeling framework

Agent-based Model

Various types of organizations and citizens are represented by the agent-based model. Three major types of agents are implemented for the following simulations: citizens, companies, and restoration teams. Each agent has an inner status and response/usual tasks. These task processes are described by an input-process-output framework. In the simulation model, a lifeline company such an electronic power company, gas company, or water company is also implemented as an agent. The details of each agent are explained next. The PCANS (Krackhardt & Carley, 1998) model is adopted to describe the interrelationship among different agents and the structure of a group such as a company and family. A set of five PCANS relationships slightly modified for this study is explained as follows:

Precedence (P): This is a temporal ordering of the tasks of a company agent. This becomes the execution condition for the completion of the entire task to produce products and services.

Commitment (C): This represents the relationship between a task and required resources, which is described by the matrix C, where $C_{ij} = n$ iff n amount of resources j are required for task i to be accomplished. This becomes one of the prerequisites for the task execution.

Assignment (A): This represents task assignment to a company agent, which is described by the matrix A, where $A_{ij} = 1$ iff agent i is assigned to task j, else $A_{ij} = 0$.

Network (N): This represents various types of interrelationships among different agents, such as affiliation and transactional relationships.

Skill (S): While this element in the original PCANS represents the accessibility of an agent to some resources, this represents the ability of an agent to perform some task that affects the time required to complete the task.

Citizen Agent

Citizen agents try to perform daily life activities. Twenty-five primitive daily activities, such as cooking, laundry, air-conditioning, bathing, and communing, are defined, and the quality of life will deteriorate if some or all of these activities are unavailable owing to the damage to lifeline systems or service companies.

Company Agent

Company agents produce products or services for citizens and other companies. The structure of a company, such as task sequences, resources required for a task, and task assignment to individual agents, is described in terms of the relationships among the model elements of PCANS — individuals, tasks, resources, and skills. Inter-organizational relationships such as the demand-supply network are also described by the PCANS model.

Restoration Agent

Restoration teams try to repair disaster damage. There are different types of teams for different types of lifelines. Because there are interdependencies between different infrastructures, the restoration schedule is subjected to such interdependencies. For example, damage to the water line cannot be repaired if the damage location is unreachable; it may be necessary to repair the road before restoring the water line.

Grid Network Model

While PCANS relations can describe almost all inter- and intra-organizational relationships, they cannot capture the physical connections or geographical aspects of the interdependency behind sociotechnical systems. The network model is thus adopted to describe these aspects in the modeling. In this study, the physical topology of each lifeline infrastructure is described by a simple grid network. In the simulation, this network also provides a geographical coordinate system for the deployment of agents; in other words, each agent is placed on a network node. The reachability of a node in the graph from any source node is one of the requirements for the availability of the lifeline at that node.

MODELING 23 TOKYO WARDS

Twenty-three Tokyo wards are modeled based on our modeling framework using the open data of lifeline infrastructures and the population distribution. In this study, a 15 × 15 grid network was used as a background map for 23 Tokyo wards. The unit of this grid is double the size of the third-order grid unit, in which one mesh corresponds to 30 seconds (~1 km) in latitude and 45 seconds in longitude. Figure 2 shows the 15 × 15 grid mapped on 23 Tokyo wards.

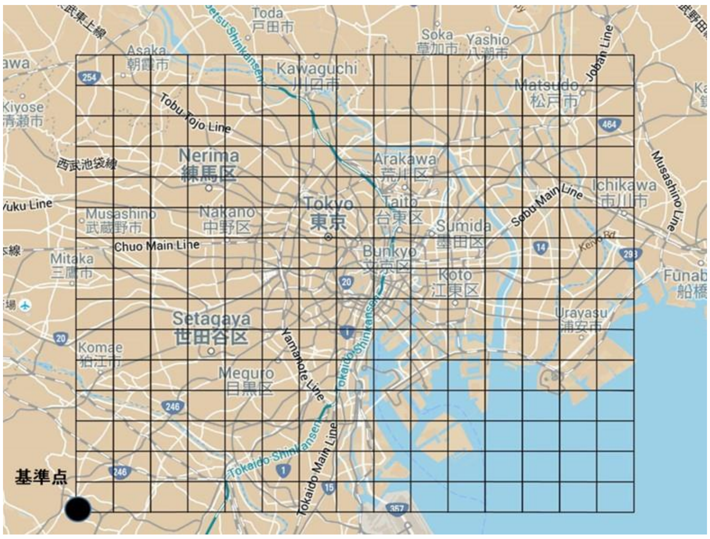

Figure 2: A 15 × 15 grid map

Location of Agents

The location of agents such as lifeline facilities, companies, and citizens is determined based on open data. Lifeline facility agents such as power substations, switching centers, water stations, and sewage plants are placed at the nearest node of the 15 × 15 grid network to the original locations. Citizen agents and company agents are deployed according to the distribution of the night and day time populations, respectively. Figure 3 shows the water supply network of 23 Tokyo wards, and the black dots in the figure represent the location of the water stations.

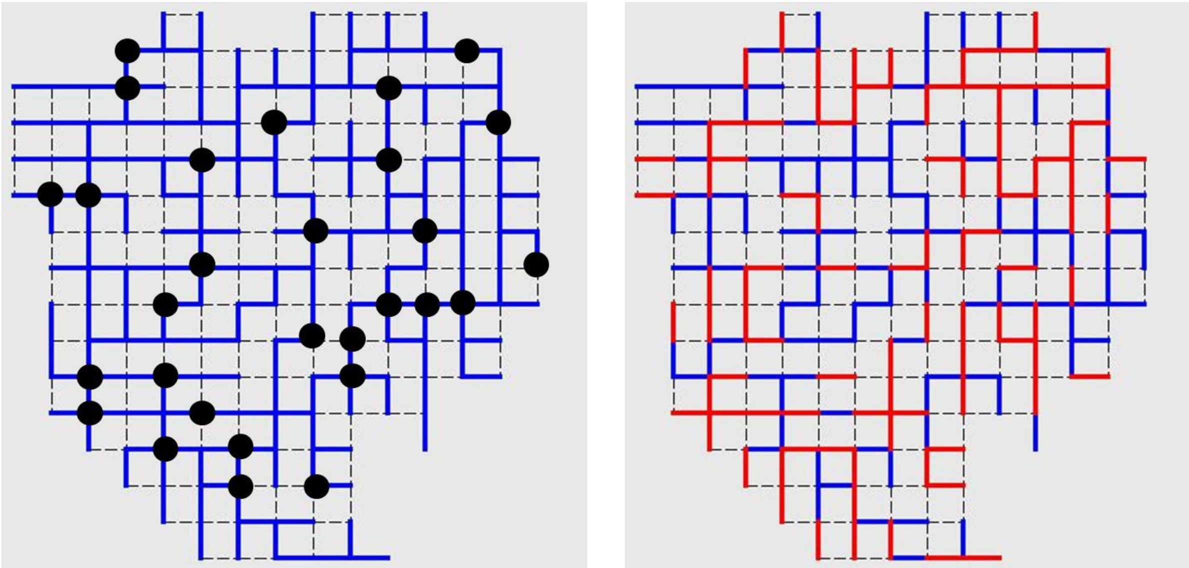

Figure 3: Water supply network (left) and its initial damage (right)

Network Topology

The network topology of the lifeline infrastructure is approximated as follows.

Road and City Gas

It is easy to obtain precise open data for a road network such as Open Street Map; however, under the geographical resolution of 15 × 15 grids, we assumed that the road network is a complete grid network in this study. On the other hand, almost no data/information is available for the gas supply network; thus, we tentatively assumed that the topology of the gas supply network is also a complete 15 × 15 grid.

Railway, Water Supply, and Sewage

We approximated the network topology by using open data for these networks. Figure 4 shows an example of how to convert an actual network to a grid-based network. If an actual lifeline network is a blue dashed-line, the network is approximated to the red grid line.

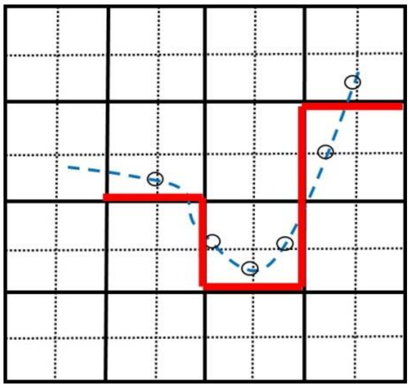

Figure 4: How to construct a grid network from actual data

Power Supply

The power system diagram for voltages of 66 kV and higher in the Tokyo area is open to the public; however, that for lower voltages is not available. Therefore, we first approximated the 66 kV power grid by the same method as that used for the railway and water supply, and then we drew lower-voltage links based on the assumption that the network has a tree structure.

Telecom

While the location of switching centers is open to the public, the details of the network are not. However, it is known that the base topology is a ring. Therefore, we assumed that the network consists of several rings and that it is installed beneath main roads such as national and prefectural roads. We drew the telecom network by connecting switching centers based on these assumptions.

Initial Damage on Lifelines

We consider an expected earthquake occurring directly beneath the Tokyo Metropolitan area as a case example for the simulation and assume the initial damage on lifeline infrastructures based on the predictions of the seismic intensity around Tokyo as provided by the Central Disaster Prevention Council, Japan. The damage is determined using the following equation. This equation means that, for example, if the seismic intensity of an area is 5 and 6.5, then 20% and 50% of lifeline links in the area are randomly broken, respectively. The red links in the right-hand-side figure of Figure 3 represent the damaged links obtained using by the equation.

$$damage = \begin{cases} x, x \geq 100 \\ 0, x < 100 \end{cases}$$
$$x = seismic\_intensity \times 40 - random\_between(60,260)$$

SIMULATION

This section explains the simulation of the post disaster recovery process for assessing the resilience of the urban sociotechnical system. We employ a genetic algorithm (GA) to obtain the optimized restoration plan for each restoration agent by conducing recovery simulation repeatedly. The outline of the simulation process is summarized as follows: (1) the urban sociotechnical system and initial damage to the lifeline infrastructure are configured using the model, and (2) an initial individual set for the GA is randomly generated. Here, each chromosome represents a set of restoration plans with which to restore all damaged lifeline infrastructure, and (3) during recovery simulation, restoration teams restore the damaged lifeline links according to their plan while company and citizen agents try to continue their own activities. (4) The resilience of the urban sociotechnical system is assessed by the area of the resilience triangle obtained from the recovery simulation with the optimized set of restoration plans.

RESULTS AND DISCUSSIONS

This section shows the result of the sensitivity analysis to the parameters corresponding to the R4 framework of disaster resilience (Tierney & Bruneau, 2007) to verify the model implementation as well as the result of the recovery simulation using the model of 23 Tokyo wards.

Sensitivity Analysis to 4Rs

The 4Rs represents the attributes and determinants of disaster resilience, that is, Robustness, Redundancy, Resourcefulness, and Rapidity. To verify the model implementation, we conducted sensitivity analysis for the model parameters corresponding to 4Rs. We selected the inverse of the initial amount of damage, initial amount of stockpiles of lifeline resources (water, gas, electricity, etc.), number of generations in GA, and ability of restoration teams for 4Rs. The simulation settings for this analysis are shown in Table 1. We conducted 10 simulations under the same conditions and plotted the average area of the resilience triangle with standard deviation (Figure 5).

The graphs, except for those of the resource stockpile, show that as each 4R parameter increases, the area of the resilience triangle decreases, indicating that the system becomes more resilient. These results are consistent with the prediction from the R4 framework. On the other hand, the sensitivity to the initial amount of resource stockpiles was not as sensitive as expected. One possible reason for this is that while the stockpile can delay and moderate the initial drop off of the system’s function for a while, it does not contribute to shortening the time required for recovery under the tested conditions. It is of course necessary to verify the model further; however, the simulation results obtained so far are generally consistent with the R4 framework of disaster resilience, which suggests that the model was properly implemented.

Table 1: Simulation settings

Parameters	Initial settings
Size of network	5 × 5 complete grid
Number of lifelines	11
Number of citizen agents	300 in 70 families with 25 daily activities
Number of companies	40 companies with 70 sections, 300 workers
Number of restoration agents	180
Number of simulation steps	60 (assuming 60 days)

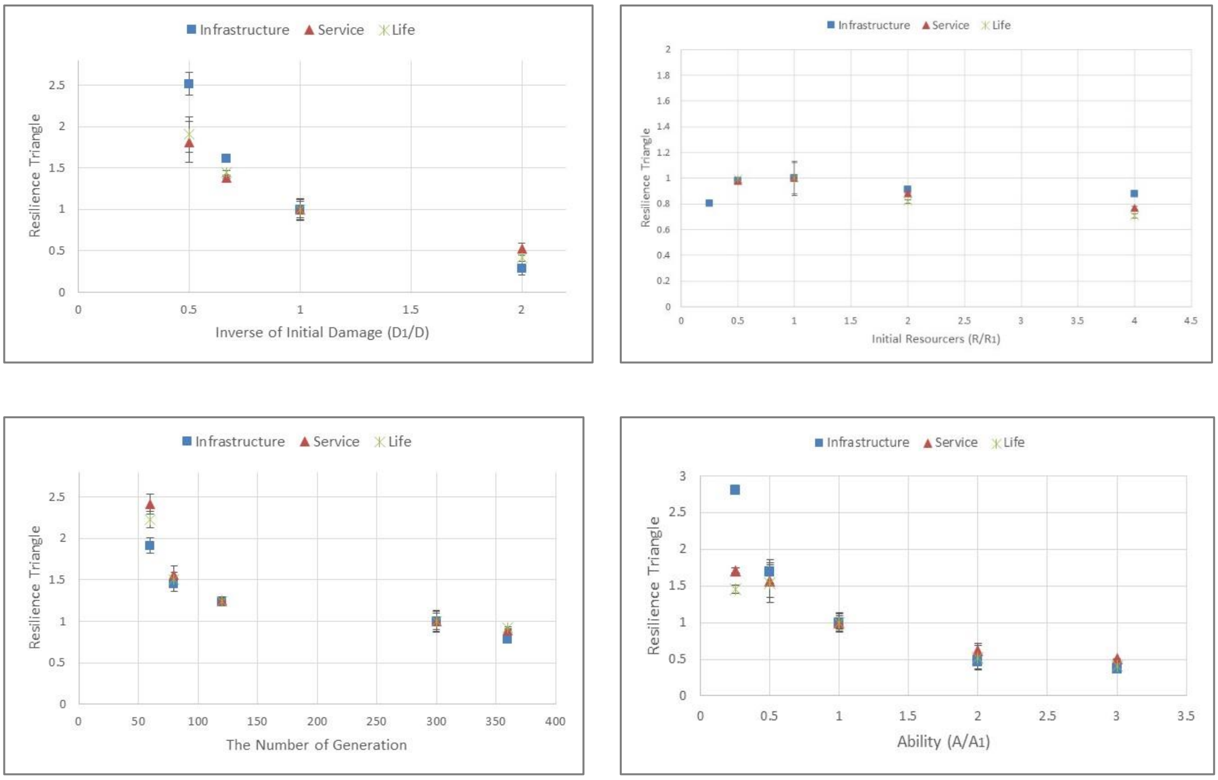

Figure 5: Result of sensitivity analysis (upper left: Robustness, upper right: Redundancy, lower left: Resourcefulness, lower right: Rapidity)

Simulation with Model of 23 Tokyo Wards

The final goal of the simulation is to assess the resilience of urban sociotechnical systems such as that of Tokyo under various disaster assumptions. In this study, a simulation using the model of 23 Tokyo wards is conducted for the first step to test the modeling and simulation. The simulation settings are shown in Table 2. Figure 5 shows the recovery process of six major lifeline infrastructures (road, power supply, water supply, city gas supply, telecom service, and sewage). The horizontal axis represents simulation steps (days) from the occurrence of the disaster, and the vertical axis represents the restoration ratio of the lifeline infrastructures, where 100% means full recovery. The graph shows that the lifeline infrastructures are gradually recovered and finally reach their original levels seemingly without strange and unexpected behaviors, indicating that the model works as expected and is verified at a minimum level.

Table 2: Simulation settings

Parameters	Initial settings
Size of network	Base size is 15 × 15 grid
Number of lifelines	11
Number of citizen agents	1000 in 200 families with 25 daily activities
Number of companies	100 companies with 200 sections, 1000 workers
Transactional relationship	Randomly configured
Number of restoration agents	180
Number of simulation steps	60 (assuming 60 days)

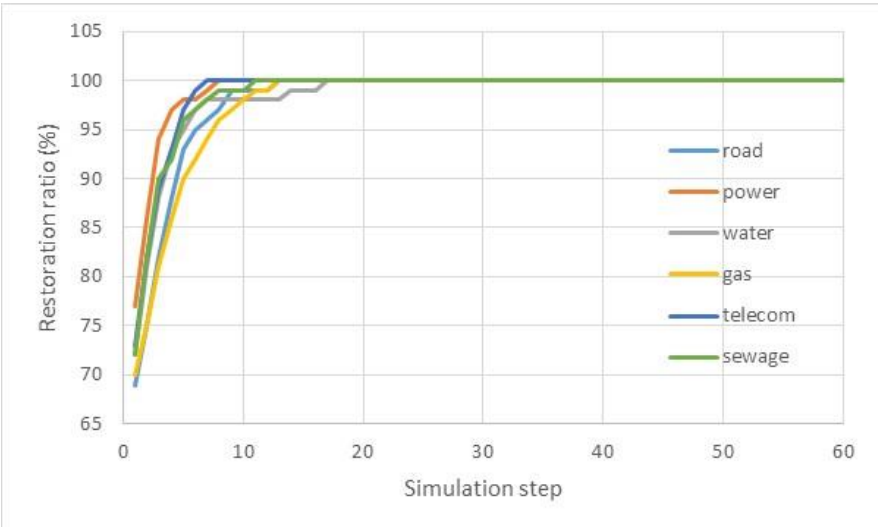

Figure 5: Recovery curve of lifeline infrastructures

CONCLUSIONS

This paper explains how to model a real urban sociotechnical system using an example of 23 Tokyo wards based on the modeling framework for capturing the structure and process of lifeline infrastructures, industrial systems, civil life, and multiple interdependencies within and among them.

In the modeling of 23 Tokyo wards, we used open data for the lifeline infrastructure and population distribution and considered the topology of lifeline networks and the location of various agents such as lifeline facilities, companies, and citizens. We conducted simulations of the recovery process of an urban sociotechnical system from disaster damage for several assessments. First, we conducted sensitivity analysis to the 4Rs of disaster resilience and partly confirmed that the model was properly implemented. Second, we conducted simulations of the recovery process using the model of 23 Tokyo wards and by observations of the resilience triangle, and we confirmed that the simulation ran properly. We are currently modeling 23 Tokyo wards with a 30 × 30 grid that corresponds to a third-order grid, and we plan to conduct simulations under various conditions to explore how to build the resilience of urban sociotechnical systems.

ACKNOWLEDGEMENTS

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LiDAR-BASED FLOOD MAPPING FOR AGRICULTURAL RESILIENCE AND FOOD SECURITY

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ABSTRACT

Lowland rice cultivation is the main source of staple food in the Philippines. It is mainly found in floodplains where prolonged and deep floods are commonly experienced. This study demonstrates the use of Light Detection and Ranging (LiDAR) technology for producing detailed flood inundation maps for optimal rice varietal cultivation to assist farmers' livelihood resilience and strengthen food security. Four zones were proposed. The flood-tolerant varieties and those that are tolerant to stagnant flooding are highly recommended in Zone 1 where both depth and duration exceed the threshold values set in this study, meaning flood conditions are least favourable for any existing traditional lowland irrigation varieties. A decline in yield will be possible as cultivation areas for traditional irrigated lowland varieties may decrease over time due to increasing flood extents and longer submergence periods. More than one of the flooding conditions can ensue in any particular flood-prone environment, which makes it is desirable to develop rice varieties that possess a combination of tolerance traits for flood-prone areas. The method introduced in this study can inform rice cultivation decision-making in flood-prone areas towards better agricultural resilience.

BACKGROUND

Flooding pose threats to food security in the Philippines. In the Philippines, rice growth and yield is adversely affected by complete submergence due to frequent flooding. A few days of complete submergence can destroy rice crops. This has led to the development of high yielding local flood tolerant varieties that can survive up to 14 days of submergence. However, the increasing frequency of rainfall events in the Philippines will exert more pressure on the cultivation and development of these newly developed varieties.

The exposure of the Philippines to extreme weather events is highly influenced by its geographical location in the western Pacific Ocean. In a year, around 20 typhoons visit the Philippine Area of Responsibility (PAR)

(PAGASA, 2009). Areas found within the major river systems experience flooding regularly (Zoleta-Nantes, 2000). Despite flooding susceptibilities, many dense settlements are concentrated along the banks of river systems, including those located within the Pampanga river basin. This condition is due to the natural source of irrigation that river systems provide to support agricultural activities (The World Bank, 2012). Climate change impacts have increased the intensity and frequency of flood events and are expected to adversely affect crop production (IPCC, 2007), resulting in 23.76 million US dollars of damages between 2007 and 2010 (Israel, 2012). This condition can potentially harm the viability of crop cultivation as a source of livelihood of farmers in the long run (Gwimbi, 2009). The need to develop strategies to support farms and their crops to adapt to changing climate conditions is crucial (Mitin, 2009) with 12 million farmers and their households dependent on rice cultivation as source of livelihood (Altoveros & Borromea, 2007).

Prolonged submergence can cause serious damage to crops (Ram, et al., 2002), but also inhibits desirable bio-chemical processes of the plant like photosynthesis (Jackson & Ram, 2003; Ram, et al., 2002; & Setter, et al., 1997). Multiple approaches have been done to address this. One of these is the development of flood-tolerant varieties (Septiningsih, et al., 2009). Flood tolerant varieties exhibit specific physiological traits that help them survive (Setter, et al., 1997) and are embodied in the sub1-a gene (Bailey-Serres, et al., 2010). The sub1 gene has been isolated and bred into rice varieties (Khanh et al., 2007) including varieties available in the Philippines such as the IR64 sub1 and NSIC Rc 194. Submergence-tolerant varieties can survive up to two weeks completely submerged without any adverse effects on production (IRRI, 2009).

Flooding can be viewed as a threat to certain agricultural crops, but certain measures have been taken to prevent flood further losses. Flood modelling is one approach that can help identify rice cultivation areas vulnerable to floods. By identifying flood extent and duration, potential damages to property and/or crops can be estimated and other countermeasures can be developed (Chau et al, 2013; Wang, Colby, & Mulcahy, 2002; & Thieken, Merz, Kreibach, & Apel, 2006). LiDAR is a relatively new remote sensing tool capable of gathering high resolution elevation data for flood hazard mapping. The study of Brandt and Lim (2012) emphasises the importance of high quality digital elevation models (DEMs) in flood modelling to achieve better accuracy. Sole et al. (2008) also stressed that the LiDAR-derived DEMs have very high accuracy. Because of the +/- 25 cm vertical accuracy of most LiDAR altimetry data, behaviour of floods can be captured in relatively flat terrain, which can be difficult with other data formats (Sole et al., 2008). When used in flood modelling LiDAR data can easily capture flood behaviour that most other formats cannot (Sole et al., 2008).

This study demonstrates the use LiDAR technology for producing detailed flood inundation maps for optimal rice varietal cultivation and how these maps can assist farmers' livelihood resilience and strengthen food security. The study provides a tool in mapping appropriate areas suitable for certain types of varieties based on flood depth, extent, and duration.

STUDY AREA

The study area is the municipality of Apalit, a rice producing municipality in the province of Pampanga. An estimated 71% of its total land area is devoted to agriculture. Because of the flat topography of the municipality as well as the location of the Pampanga river in its mid-western section, flooding events are frequent. Of its 6,147 hectares of land, an estimated 107.10 hectares have been unproductive due to annual floodwater inundation and salinity intrusion. Flooding is considered a serious problem for the municipality since a large portion of its land is devoted to agriculture, specifically rice production.

METHODS

Available hydrologic data such as discharge data were gathered from the Sto. Nino water level sensors and rain gauges of the Advanced Science and Technology Institute (ASTI). A summary of discharge and rainfall values can be seen in Table 1. A Thiessen Polygon approach was used for the selection of PAGASA rain gauges as source of rainfall data. Port Area rain gauge was selected. Rice extent/area data were obtained from the International Rice and Research Institute (IRRI) knowledge bank acquired through Synthetic Aperture Radar (SAR) satellite at a resolution of 500 meters. These were supplemented with 1-meter orthophotos obtained by the UP-DREAM program, supplemented with Google Earth images. Land cover was digitized from the orthophotos and Google Earth images using ArcGIS 10.2 at a scale of 1:1250. The Digital Elevation Models (DEM) used in the flood models were derived from LiDAR point cloud data collected by the University of the Philippines Disaster Risk and Exposure Assessment for Mititgation (UP-DREAM) Program. The DEM had a spatial resolution of 1-meter and was processed using Terrascan and Capture 1 software. The original 1-meter resolution LiDAR DEM was resampled to 5-meter to fit the model parameters.

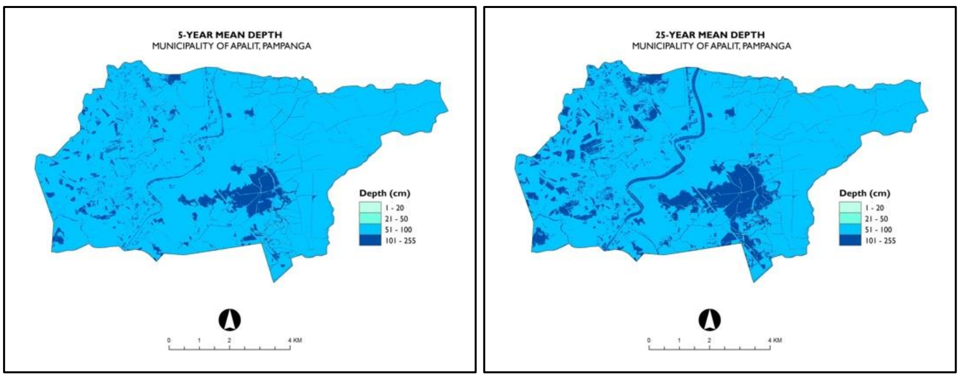
There are a total of seven rice cultivars used throughout the year. The IR64 is submergence-tolerant. However, IR64, introduced in 1990's, is no longer being planted due to its low tolerance to pest. Currently, NSIC Rc 150 had a particular resistance to submergence. It has been noted that another submergence-tolerant variety introduced by IRRI, the IR 64, was used by a majority of the municipality during the 1990's. IR 64 had a particularly high yield and good eating quality apart from its tolerance to submergence. However, it fell out of usage due to age (Manzanilla, 2014) and was thus discontinued and replaced with other varieties by the local farmers.

The hydrologic modelling was done through the use of LISFLOOD version 5.8.6 and HEC-HMS to generate flood inundation models, identifying depth, extent and duration for an extreme rainfall event and different rain return periods. The primary inputs used for the model include rainfall, discharge data, and DEM. The LISFLOOD model outputs used include time series images (.wd) showing the inundation sequence for the municipality, hazard maps (.maxhaz), total inundation time maps (.totaltm), and velocity values (.vx) for the whole municipality. The hazard classifications used by LISFLOOD for the hazard maps were a function of velocity and depth, $Haz = H * (Vc + 1.5)$, where H is water depth and V_c is the cell velocity. These files are in ARC ASCII grid formats. The .wd files along with the .totaltm outputs were further used in the creation of the rice cultivation maps.

The rice cultivation maps were generated using the .wd images and .totaltm outputs from LISFLOOD-FP. The .wd images were used to derive the mean depth and extent of inundation in the municipality over time. This was done by stacking the images one on top of the other using a stacksim program. The mean depth raster along with the .totaltm output were then placed in a Python program. The depth values used in the zone classification were derived from Mackill, et al., (2010) where 20 cm is the depth threshold at which rice plants can survive while the duration values were derived from Salam, Biswas, & Rahman (2004) where 7 days is the duration at which rice plants can survive without any severe negative effects.

RESULTS AND DISCUSSION

Figure 1 demonstrates the mean depth and extent of flood inundation over a period of 250 hours per rain return scenario. In all rain-return scenarios the highest sustained depth over the 250 hour simulation is 255 cm. Areas with these depths are concentrated in the south eastern portion of the municipality in all return periods and increases in extent per rain return scenario. The western area on the other hand has inundated areas that increase in both depth and extent as rain return scenarios increase.



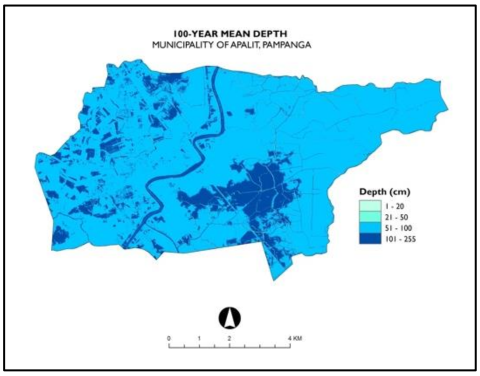


Figure 1 5-, 25-, and 100-year Mean Depth Maps

Figure 2 shows the total inundation time in the municipality per rain return scenario. The maximum inundation time for the 5-year rain return scenario is approximately 7 days while the maximum inundation time is constant for the 25-year and 100 year rain return scenario at around 10 days. Long inundation times are found mainly in the western portion of the municipality and the south eastern portion for all rain-return scenarios. The duration map shows the inundation time based on the simulation time. Since the simulation time run for all the rain return scenarios is approximately 10 days, inundation time displayed here may exceed 10 days.

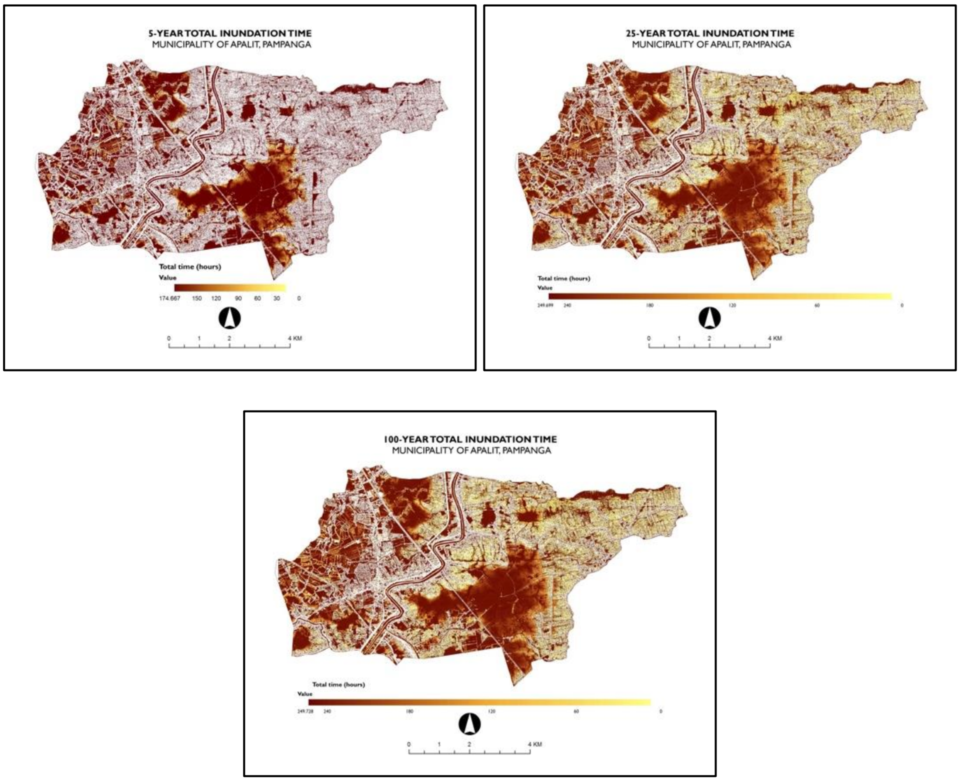


Figure 2 5-, 25-, and 100-year Total Inundation Time Maps

The rice cultivation maps (figure 3) are classified into 4 zones. Zone 3 is where mean depths are below 20 cm and thus are shallow and have flood durations not exceeding 7 days. These conditions are favourable for rice cultivation, thus areas found in Zone 3 can use all varieties (figure 4). Those found in Zone 2 and Zone 4 are considered conditional zones because of their mixed conditions. Areas found in Zone 2 have flood durations that are less than 7 days, making them favourable for the cultivation of regular varieties (figure 4). The flood depths in these areas exceed the survivable 20 cm. Areas found in Zone 2 are suggested to use either traditional varieties or flood tolerant varieties (figure 4). Areas found in Zone 4 on the other hand have inundation depths not exceeding 20 cm, but can last for more than 7 days. Areas found in this Zone are suggested to use varieties that are tolerant to stagnant flooding (figure 13). Areas found in Zone 3 have conditions that are not favourable for regular varieties (figure 13). The depth and duration exceed that of the surviving threshold of rice plants and thus submergence-tolerant varieties for both flash flooding and stagnant flooding are suggested.

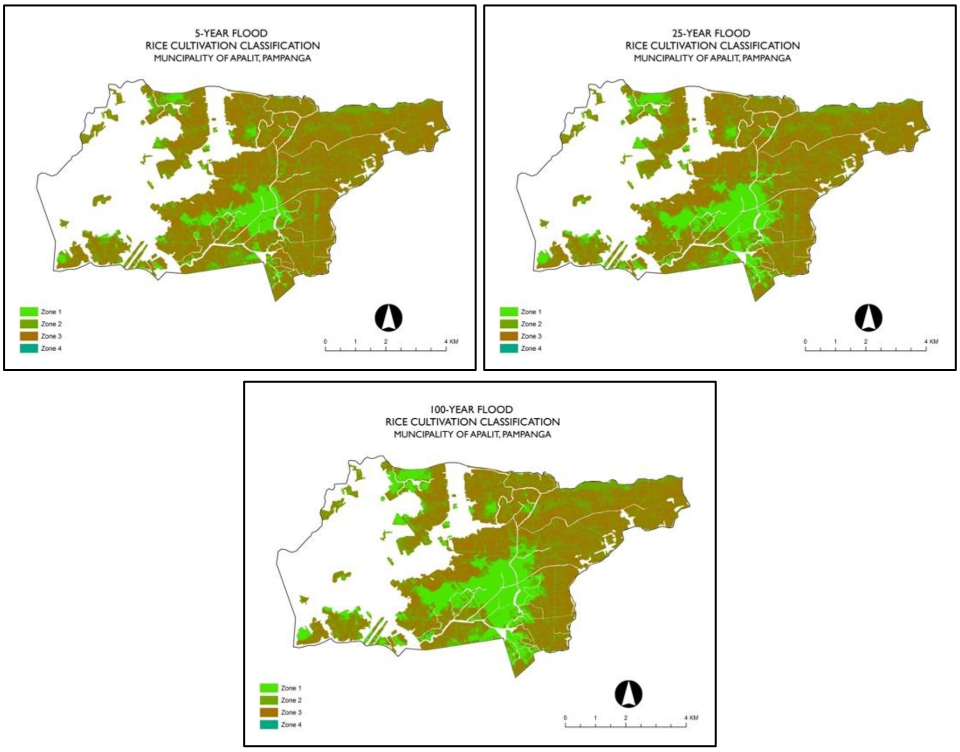


Figure 3 5-, 25-, 100-year Rice Cultivation Classification Maps

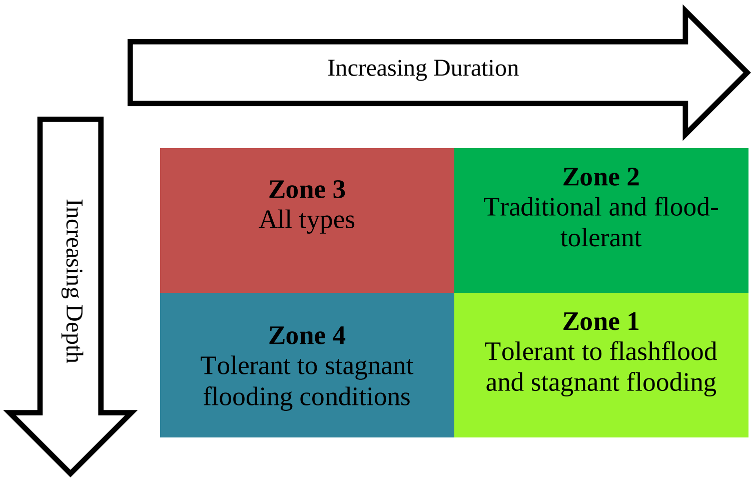


Figure 4 Recommended varietal types and characteristics per cultivation zone

CONCLUSION

Flooding is a threat that rice cultivation faces in the Philippines. There are several ways to mitigate the adverse effects of flooding. The rice cultivation maps were created in order to aid farmers to increase their livelihoods' resilience to floods. In particular, flood depth and duration were mapped using tools and techniques such as LiDAR, flood modelling and GIS. The resulting maps demonstrate higher accuracy than what is currently accessible due to LiDAR's inherent higher resolution. The rice cultivation maps demonstrate that increasing rainfall intensities would require a larger portion of the municipality to employ the use of rice varieties that are tolerant to prolonged submergence. Apalit is naturally lowland but the need for medium to deepwater rice varieties might potentially thrive for any flood scenario as some parts of the municipality already suffer stagnant inundation of at least a month during rainy season. This is the renewed challenge due to the observed reliance of the municipality on traditional varieties. The need to re-introduce submergence tolerant varieties such as IR 64 sub 1 must be put into consideration. However, based on the FGD, this can be momentarily remedied by suggesting the use of rice variety NSIC Rc 150 which possessed an unintended resistance to flooding. Consequently, it can be observed that it is important that farmers' experiences are taken into consideration. Their participation should also be actively sought out when suggesting adaptation and mitigation measures.

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MAPPING VULNERABILITY FOR KELUD VOLCANO, INDONESIA – APPROACH TOWARDS DISASTER RESILIENCE

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ABSTRACT

Kelud Volcano is a basaltic andesitic stratovolcano type, situated 27 km to the east of Kediri, Indonesia. It had been recorded to erupt with recurrent period of 9-75 years, put nearly 160.000 lives whom resided at Tulungagung, Blitar dan Kediri Districts at high risk area (Thouret et al., 1998). The research aims to map vulnerability towards lahar flow in Kediri and Malang. The vulnerability in this research defined as the degree of potential of losses and damage towards certain degree of hazard severity and it involves adverse reaction of social and natural system (Hizbaron, et al., 2012). The vulnerability analysis is an important analysis within risk management, since hazard and vulnerability conforms risk. Herewith, the research targeted people as vulnerable elements, and assess their vulnerability from four main variables, i.e. demographic, assets, hazard, and land use variables using Spatial Multi Criteria Evaluation or SMCE (Hizbaron, 2011, 2012; Hizbaron et al., 2015). The data is obtained from ground check and some of them are withdrawn from high-resolution satellite imageries. To ensure its model robustness, the research generates five scenarios indicating vulnerable element and its index. The research result indicated that the downstream area of Konto River poses higher vulnerability index. Densely populated area, accumulation of elderly, children and disabled. Also, more intrusion towards watershed area via mining activities at the downstream area positively correlated with increasing indices of vulnerability. The output of vulnerability is a valuable input for local stakeholder to increase local preparedness at vulnerable areas towards better disaster resilience.

Key words: lahar, resilience, social, vulnerability, volcano

RESEARCH CONTEXT

Endowed with "ring of fire" Indonesia poses several active Volcanoes, which one of them is Kelud Volcano. This research highlights Kelud Volcano due to several arguments, such as frequency, magnitude and likelihood of occurrence, also distribution of element at risk in the area. Kelud Volcano is a basaltic andesitic stratovolcano type, with a history of explosive eruption; pyroclastic density currents; volcanic ashes, and lahar flow (Bourdier et al., 1997; Thouret et al., 1998; Lavigne and Yanni, 2006). Situated 27 km to the east of Kediri, Indonesia, it had been recorded to erupt with recurrent period of 9-75 years, put nearly 160.000 lives whom resided at Tulungagung, Blitar dan Kediri at high risk (Thouret et al., 1998;; De Belizel, et al., 2012). Posits within three administrative boundaries, City of Malang, Kediri District and Blitar District, East Java Province, it was reported that during the last eruption in 2014 caused 87.629 lives affected and 8.452 settlement unit were destructed (BNPB, 2013; Sulaksana et al., 2014).

Based upon historical data, lahar flow at the aftermath of volcanic eruption in Kelud Volcano went to the southwest side of its slope to the Badak River. An anomaly was recorded at the aftermath of 2014 eruption, whereas the lahar went to the northern slope to the Konto River. Hence, the research aims to analyze the spatial characteristics of the social-economic vulnerability towards lahar flow in Kediri area, especially those along Konto River (Fig. 1).

Why vulnerability analysis? Scientifically, in order to produce risk information there is two important steps. First, is defining hazard and second is identifying vulnerability towards the specified hazard. The risk information is a formula of hazard and vulnerability information. Cited from several natural science documents, specific hazard, vulnerability and risk are translated into mathematic formulation respectively (Kubat et al., 2008; Sarris et al., 2009; Schmidtlein et al., 2010). Risk, is a formula of hazard and vulnerability, which can be presented into indices and curves. Hazard implies to any environmental problem that has possibility to impinge human existence. As hazard perceived in particular, an immediate action is to quantify the vulnerability or potential loss and damage within spatial unit for certain period and certain type of hazard (Cutter, 1996; Cutter, 2003). Furthermore, risk is slightly differs from vulnerability since it is defined as a formula between hazard and vulnerability to quantify the expected damage and loss from all level hazard severities (Kates, 1971; Cardona, 2003; Sarris et al., 2009). To add, in applied science, spatial approach and temporal approach are the most common approach to define hazard, vulnerability and risk. Using such approach, the risk information will be presented using spatial unit through times. The hazard and vulnerability distribution are somewhat dynamic and unique in each geographic unit, therefore spatial pattern of hazard, vulnerability and risk at best to be described in a map.

The risk information is an essential guideline within pre-disaster phase. It indicates which area are most prone and entitled for further capacity development in order to strengthen its resilience towards disaster. Additionally, this hazard, vulnerability and risk information are somewhat essential for any development planning. The main idea to assess vulnerability is due to minimum literature review working in such theme, especially related to Kelud Volcano. Most of the cited works are closely related to hazard assessment and disaster management in general. Herewith, the vulnerability analysis acts as precautionary assessment to predetermine damage, loss and adverse response due to particular hazard. In essences, this article denotes vulnerability as degree of potential of losses and damage towards certain degree of hazard severity and it involves adverse reaction of social and natural system (Hizbaron, et al., 2012).

The research area covered two administrative boundaries, in this case City of Malang and Kediri District (Fig. 1a). Derived from national statistics, these areas are clustered as high risks area with total score of 219 for Malang and 178 for Kediri (BNPB, 2013).

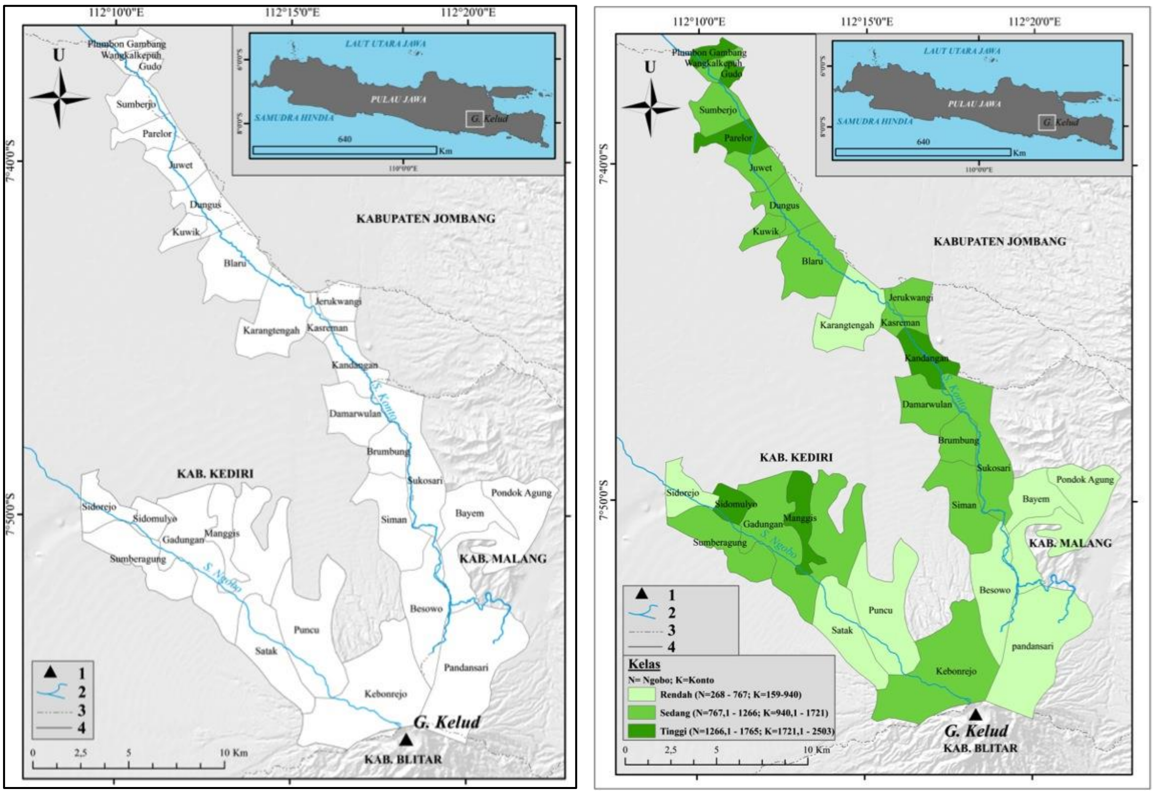


Fig. 1 (a) Map of research area and (b) demographic distribution

The research area covers nearly 23 hamlets along Konto River. Demographically, the most populated areas are located sporadically along the watershed area (Fig 1.b). Kandangan Hamlets located at the upperstream area, while Parelor, Gudo and Plumbon Gambang Hamlets are located at the downstream area. The map exhibits as “Tinggi” or “High” Population Density, marked by dark green color. While most of the hamlet classified as “sedang” or medium population density marked by light green color, as the rest of the area are “rendah” or low population density marked by very light green color.

The aggregate of people indicated accumulation of element at risk. Cited from Law No. 24/2007 on Disaster Management, such high risks area should be equipped with risk information, which needs to be updated annually. The risk information will be a valuable input and integrated into the long term and medium term development planning documents also within its spatial plan (Law No.26/2007 on Spatial Plan). This national mandate has been the main concern to local government, since most of the analysis were conducted at hazard map at very general scale, and it is important to draw detailed portray of local risk and its vulnerability. Therefore, most of the scholars are urged to conduct local scale assessment to assist local government in producing risk information.

RESEARCH METHOD

The research employs spatial and temporal approach, using ILWIS Software (Integrated Land and Water Information), which is based on SMCE technique (Spatial Multi Criteria Evaluation). The ILWIS Software is open source software, which enabled us to work with large GIS based data either in raster or vector formats. The SMCE is a spatial statistic tools that allows diverse criteria to be spatially analyzed using problem tree analysis, standardization, and weight assignment, lastly map generation (Hizbaron et al., 2012; Looijen, 2010, Marulanda, et al., 2009). The following Table 1 indicates the advantage of ILWIS – SMCE tools.

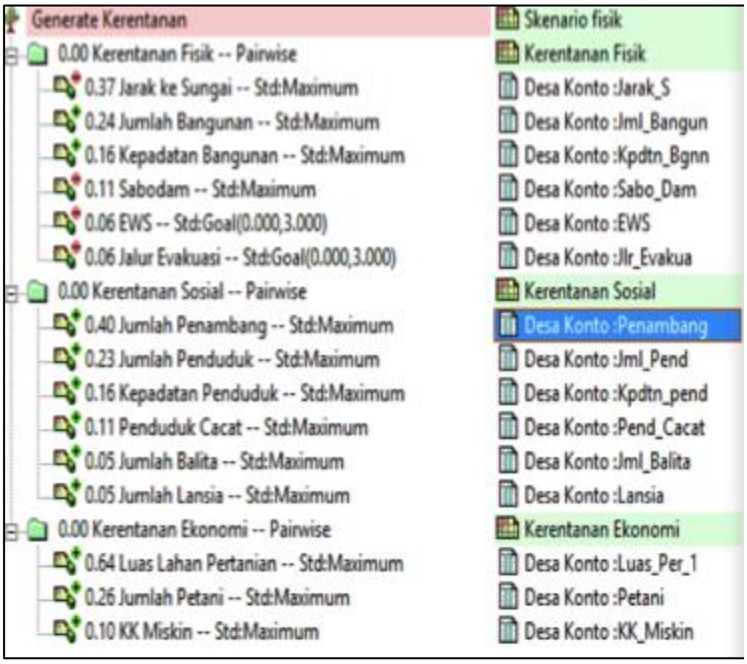
Table 23 Advantage of SMCE tools

Method of analysis	SMCE
Creating hazard map as an input for vulnerability assessment	√
Creating vulnerability map as an input for risk assessment	√
Enable combination of tabular and spatial data	√
Analysis of observed damage using high resolution image	√
Open indicator	√
Using expert opinion to define state of vulnerability	√
Weight assignment for each input factor	√
Deterministic scenario (Predefined scenarios)	√
Define best scenario	√
Software availability	√

Source: Hizbaron, et al., 2012

As argued by previous research, there were numerous methods and tools to serve vulnerability assessment, however, it gets vulnerability into ill-structured concept, which was difficult to translate (Rashed & Weeks, 2003). Based upon that argument, this research tries to define vulnerability using several predefine variables as follow (Fig. 2).

The SMCE is established by setting problem tree analysis. It is a process to define research goals that is to analyze vulnerability and to define factors to support it. The research employs three variables, which is defined by several factors as noted above. The selection of the variable was mainly considered availability of data and possibility of data getting verification from field observation and satellite imagery observation. Second steps, all factors are in standardization phase, whereas it gets subjective correlation value between factors to research goals. The correlation between factors and goals are distinguished either linier or inverted correlation (Fig. 3).



Step 1. Problem Tree Criteria
Develop variables and factors to define vulnerability.

1. Physical Variable
   a. Distance to river
   b. Build up area
   c. Building density
   d. Sabo Dam
   e. Early Warning System
   f. Evacuation Route
2. Social Variable
   a. Demography
   b. Mining community
   c. Difable group
   d. Children and Elderly
3. Economic Variable
   a. Agriculture land
   b. Farmer community
   c. Poverty group

Fig. 2 Step 1 SMCE Problem Tree Analysis

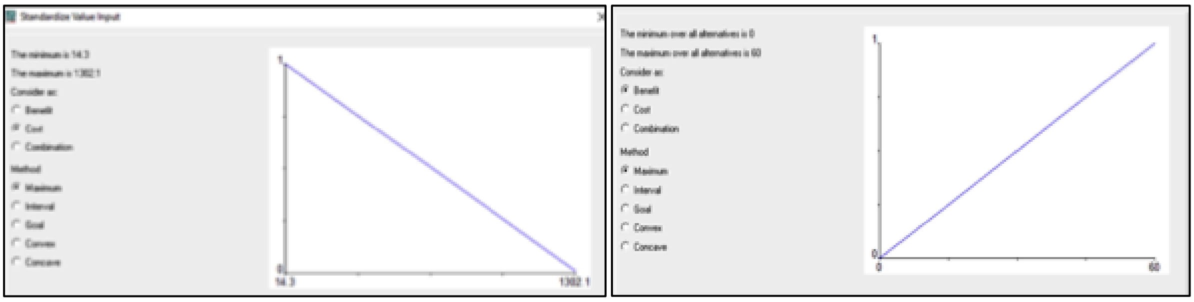


Fig. 3 Standardization for inverted correlation (left) and linier correlation (right).

Linier correlation assigns factors as benefit for the goals, while inverted correlation assigns as cost for the goals. Since the input data compiles maps and tables, there are several mathematical model operations, i.e. Boolean and Fuzzy logic. The Boolean logic applies binary value (true or false) to set factor standardization. While, Fuzzy logic applies flexible continues range between 0 (in such case full non membership) to 1 (full membership) to set factor standardization. Third, SMCE assigns weight to all the criteria and factors. In most cases, it utilizes linier weighting and pair-wise technique (Fig. 4).

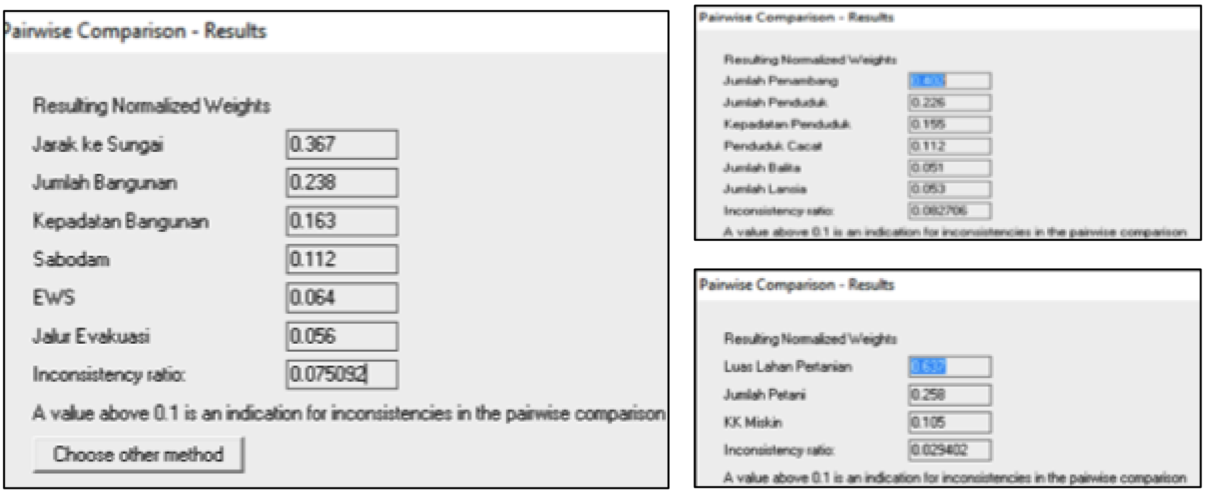


Fig. 4 Pairwise comparison for Physical Variables with inconsistency ratio 0.075 (left) and other two variable, Social and Economic Variables with inconsistency ratio of 0.082 and 0.029 (right).

Table 24. Weighting scenarios for the variables of vulnerability

No	Scenarios	Variables		
		Physical	Social	Economic
1	Physical	0.6	02	0.2
2	Social	0.2	0.6	0.2
3	Economic	0.2	0.2	0.6
4	Equal	0.33	0.33	0.33

The linier weighting refers to the more the weight of a factor the more it influences the goal and the final composite map. As for the pair wise comparison aims at comparison of factors using rating scale, i.e. extremely important to not important for each factors. At the operation model, all value computes in an operational spatial statistical model as an input to generate composite map and index of vulnerability. The weighting scenarios for the variables set in a different norm to the factor. To minimize subjectivity, the research generates several scenarios, entitled as Physical Scenario, Social Scenario and Economic Scenario and lastly Equal Scenario. The main objective to generate several scenarios is also to ensure the robustness of the generated outcome (Table 2). Once the steps are completed, hence the SMCE generates all composite map.

RESEARCH RESULT & DISCUSSION

There are four scenarios generated from the SMCE. The vulnerability indices range from 0 (not vulnerable) to 1 (vulnerable or lethal). The more vulnerable of the element at risk, thus the higher the indices. The scenarios is comprehend as follow:

The physical scenarios indicate that, "if the area dynamically challenged by physical characteristics, thus the most possible element at risk or vulnerable area are depicted within the physical scenarios". (Fig.5 left)

The social scenarios indicate that, “if the area dynamically challenged by social characteristics, thus the most possible element at risk or vulnerable area are depicted within the social scenarios”. (Fig. 5 right)
The economic scenarios indicate that, “if the area dynamically challenged by economic characteristics, thus the most possible element at risk or vulnerable area are depicted within the economic scenarios”. (Fig. 6 left)
The social scenarios indicate that, “if the area equally challenged by physical, social and economic characteristics, thus the most possible element at risk or vulnerable area are depicted within the equal scenarios”. (Fig. 6 right)
The research has generated four scenarios as noted above. Derived from the result the vulnerability is distinguished into three indices classes, i.e. “*rendah*” or low (0-0.33, indicated with green color), “*sedang*” or medium (0.34-0.66, indicated with yellow color), and “*tinggi*” or high (0.67 – 1.00, indicated with red color).

Based on the generated scenarios (Fig. 5 and 6), there are robust results of the vulnerability scenarios. Only several hamlets indicated as highly vulnerable area either from social, or physical characteristics, such as Kandangan Hamlet. The Jerukwangi and Pandansari Hamlet are the least vulnerable area according to Physical Scenario.

As Social Scenarios indicates more hamlets considers as the least vulnerable, such as Jerukwangi, Kasreman, Karangtengah, Wangkalkepuh, Sumberejo, Bayem and Pandansari. While the rest of the hamlets classified as medium vulnerable areas.

The Economic Scenarios presents more hamlets which are not vulnerable, while this scenario exhibit Sukosari Hamlet as the most vulnerable area. Slightly similar to two other scenarios, Equal Scenario indicates that Jerukwangi and Kasreman, Bumbung, Bayem and Pandansari are the least vulnerable area. This scenario have indicated only medium to low vulnerability classes.

Derived from the result we might take a recommendation towards Kandangan Hamlet. In terms of its social and physical aspects, this area is slightly vulnerable compare to its neighboring hamlets. Herewith, more attention needs to be taken into account to increase community capacity in Kandangan Hamlet. Meanwhile Sukosari Hamlets considerably more vulnerable in terms of its economic aspects. Thus to reduce vulnerability, there is a need to protect the local economic assets in particular. Additionally, the more productive land they owned, the more vulnerable they are towards lahar flow. As the predominant livelihoods in the areas are agriculture, hence, most of the population should find an exit strategy at the aftermath of the eruption.

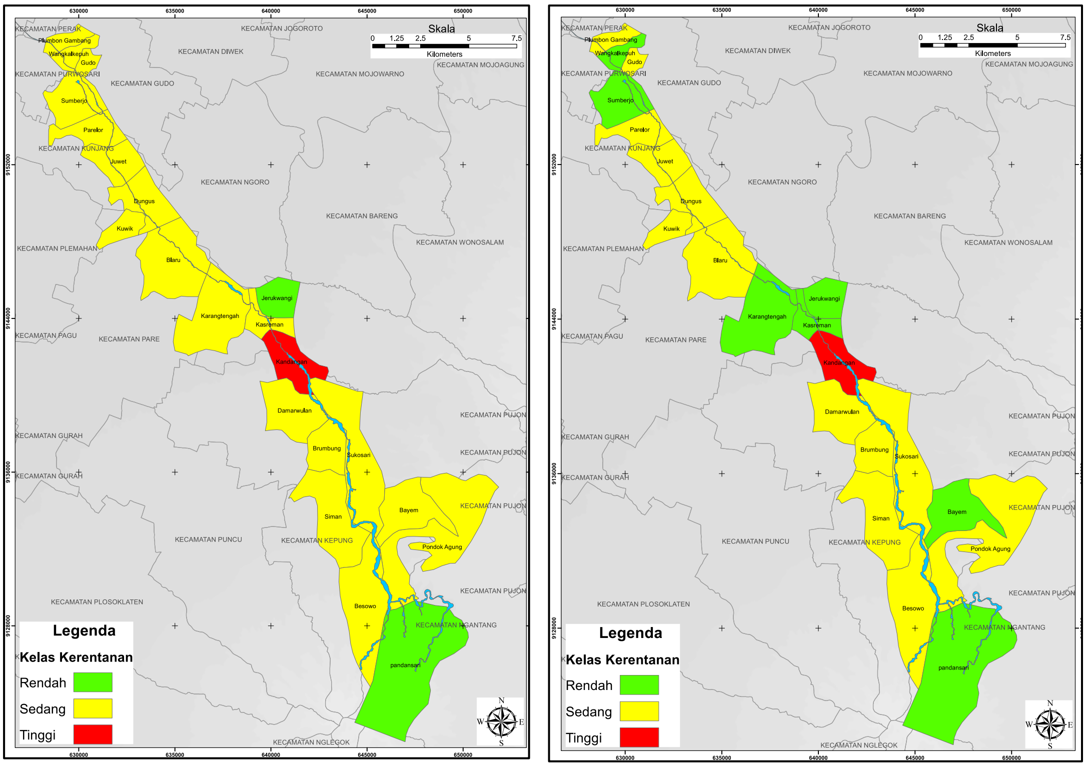


Fig. 5 Physical vulnerability scenarios (left) and Social vulnerability scenarios (right).

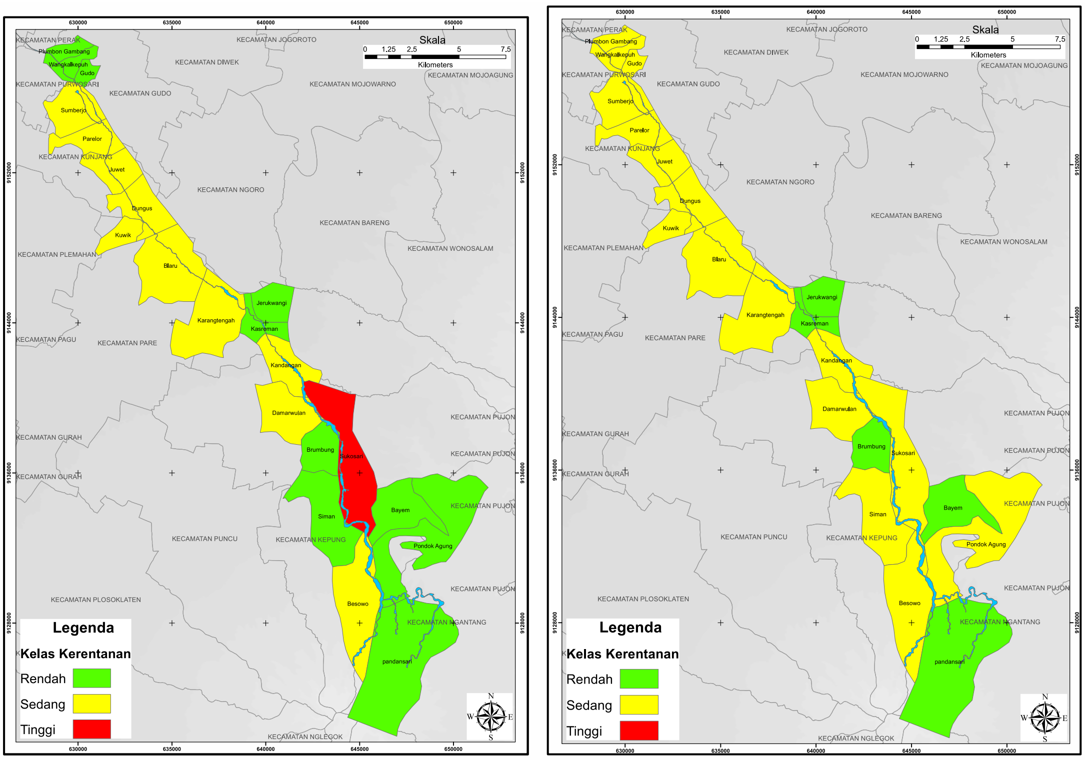


Fig. 6 Economic vulnerability scenarios (left) and Equal vulnerabilility scenarios (right)

Currently the area exposed to active mining activities, which also occurs in some of the other hamlets. This activity also need to be monitored to minimize further impact towards environmental degradation and increased vulnerability level.

To conclude, the mapping of vulnerability is an essential tool to define in which aspects a particular area lack of. The identification of this minimum aspect hinders them to survive from disaster occurrence. The scenarios explained that physical, social, and economic aspects poses by particular area at the same time conforms their vulnerability towards lahar flow. This research argues that the distribution of vulnerable area does not mainly focus on hazard existence but mostly on the distribution of element at risk and the potential aspects exist in the area. The SMCE has been very efficient to conduct vulnerability analysis for future need on integration of the hazard, vulnerability and risk into development planning to pursue stronger community based disaster resilience of Indonesia.

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URBANIZATION AND DISASTER RISK: TOWARDS RESILIENT URBAN COMMUNITIES IN AUCKLAND

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ABSTRACT

The concern for the rate of urbanization in Auckland is based on the hazard profile of the city and the impact climate change will have on communities and existing hazard mitigation strategies. As a result, there have been reconsiderations on how communities can surmount ecological challenges with their resources. Community resilience is often assessed during post disaster recovery rather than the period preceding hazard event. Post disaster assessment misinterprets recovery as resilience. It does not account for the empirical conditions of community resources before hazard event and initiate policies to enhanced resources with low resilience. Contrary to post disaster assessment, this paper reflects on existing knowledge in community resilience and posits that communities' ability to respond, adapt and recover from hazard event will be better enhanced if their resources are prepared and improved upon in anticipation of hazard eventualities. We expect that policies that may be implemented along this paradigm will offer great potential in the application of resilience thinking and serves as a starting point for investigating the resilience of communities in Auckland.

Keywords: Community resilience; Urbanization, Natural hazards, Preparedness; Disaster risk.

INTRODUCTION

During the past decade, disasters from natural hazards have resulted in colossal loss of lives and economic assets in urban communities. In New Zealand, the impact of Canterbury Earthquake was estimated to have affected '460,000 people in the cities of Christchurch, Selwyn and Waimakiriri and reconstruction cost was put at around NZD20 billion (Reserve Bank of New Zealand, 2012:14). Efforts to reduce the impact of natural hazards have focused on physical mitigation. However it has been undermined by climate change, increasing urbanization and lack of consideration for disaster resiliency of the affected communities. Consequently, urban communities have become more vulnerable to natural hazards.

Against this background, the paper from the conceptual framework of socio-ecological resilience argues that urban community resilience to natural hazards is best achieved through pre-assessment of household resources rather than post-disaster assessment. This is because the demographic structure of urban community has implication for vulnerability and resilience of embedded communities and households to natural hazards. By understanding the empirical resources available to communities and households, policies can be initiated to enhance resources with low resilience. The paper is structured as follows: Section 2 deals with the theoretical background of the paper, section 3 focuses on the conceptual framework of the paper, section 4 addresses resilience as an approach for disaster preparedness and lastly, section 5 concludes the paper.

THEORETICAL FRAMEWORK OF THE PAPER

Urbanization and disaster risk

The vulnerability of urban communities to natural hazards has been attributed to urbanization process (Jones and Kandel, 1992). Statistics from the Department of Economic and Social Affairs of the United Nations ESA/UN (2015:12) projects that 2.5 billion people will be added to the existing 3.9 urban population by the year 2050. Consequently, there has been a growing concern for the rate of urbanization and its implication for disaster risk. This is because considerable number of disaster impact in terms of human and economic losses are concentrated in urban area (Hewitt, 2014).

The implication of urbanization for disaster risk arises firstly from the transformative processes of ecological landscapes and secondly, the risk emanating from urban settlements (Friend *et al*. 2015). Geographically, the location of urban community plays a major role in the transformative process. It contributes to the overall exposure, sensitivity and vulnerability of urban community to disaster risk (UN, 2004). Urban risk is further increased by the expansion of communities into hazard prone areas to make space for increasing urbanization. In the process, new patterns of risk emerge as a result of the conjoining of risk from urban settlement with natural hazard risk. In the absence of proper mitigation strategies, urbanization constitute a major variable in urban vulnerability to the risk of both man-made and natural hazards.

Urban vulnerability and disaster risk

The naturalist confines urban disasters to the inevitability of natural forces. Contrarily, the alternative or vulnerability theorist attributes disaster to mainly socio-economic deprivation without jettison the contributions of natural hazards. Despite the divergence between the hazard and vulnerability views on the level of preponderance of socio-economic system and natural hazards in disaster causation, there is a consensus that disaster is an amalgam of geo-physical forces and socio-economic systems. As a result, explanations for urban community vulnerability have polarised along the hazard and political ecology orientations despite scholarly efforts by Blaikie *et al.* (2014) and Cutter *et al.* (2003) to integrate both perspectives to explain disaster.

The hazard perspective of urban vulnerability examines the potential source of disaster risk and associated impact of natural hazards. It posits that natural hazards are inherent part of the natural environment and that the vulnerability of urban communities to natural hazards result from the development of hazardous areas. In order to reduce urban vulnerability, multi hazard mapping to delineate population from potential source of risk is often recommended (Weichselgartner, 2001). However, the perspective did not account for the role of political economy in shaping community exposure and vulnerability to natural hazards (Kasperson *et al.* 1988; Blaikie *et al*., 2014).

Dissatisfied with the hazard perspective on urban vulnerability, the political ecology group posit that the vulnerability of urban community results from lack of coping capacity to respond to natural hazard challenges. Understanding urban vulnerability to natural hazards demand that we investigate and address the socio-economic reasons that impinge on community resilience to hazard event (Blaikie *et al*., 2014).

In addition to different explanations for urban community vulnerability, Cutter *et al*. (2003) explain that what determines urban community vulnerability is specific to its location. Thus urban vulnerability results from the synergy of exposure to the risk of natural hazards and lack of socio-economic capacity with respect to geographical location (Cutter *et al.* 2003).

Although vulnerability studies provide salient explanations for disaster, the concept often portrays disaster affected communities as helpless without external interventions (Neef and Shaw, 2013). Such portrayal has hindered the enthusiasm to investigate the resources that are available to urban communities to enhance resilience to hazard event. However, current thinking suggests that community resources and engagement as important steps in enhancing resilience to natural hazards.

CONCEPTUAL FRAMEWORK OF THE PAPER

Community resilience to local hazards

Since the inception of the concept of resilience in ecology by Holling in 1973 and subsequent application in hazard management, numerous literatures on community resilience have emerged. Despite extant literatures on resilience, it is beset with multiple conceptualizations as a result of limited theoretical understanding of the concept in terms of measurement, enhancement and how it is operationalised (Mayunga, 2007; Klein *et al.* 2004).

Holling, 1973:14 defines resilience as a "measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables". This conceptualization as applied to socio-ecological system has been a source of debate among scholars. One of the criticisms often levied against it is the allusion to 'bounce back', a condition critics regard as a dysfunctional state of vulnerability. Following this development, resilience was expounded upon to include social attributes and behavioural responses of communities and institutions to environmental perturbations (Klein *et al.,* 2003; Adger, 2000). Subsequently, theoretical explanations of resilience have encompassed interactions between human and environmental systems and the need for human system to adapt to environmental system. The interaction led to the consideration of resilience in terms of adaptive capacity, coping, learning from environmental perturbations and absorption of environmental shocks (Carpenter *et al.* 2001).

Aside from the adaptive component of resilience, Manyena (2007); Cutter *et al.* (2008) and Yonn *et al.* (2015) have expressed resilience in association with vulnerability. Manyena (2006) sees resilience as a concept that is embedded within the vulnerability structure. Cutter *et al.* (2008) believe that both vulnerability and resilience are separate concepts but conceptually link to each other. Engel (2011) shares Cutter and others' view but of the opinion that the concepts are linked by community adaptive capacity. Yoon *et al.* (2015) view resilience as more encompassing than vulnerability, and adaptive capacity as a separate concept but related to resilience.

Research in community resilience has also been distinguished either as an outcome or a process (Cutter *et al*., 2008; Dijalente and Thomalla 2010. Resilience is considered as outcome in terms of post disaster ability to recovery; and as a process is in terms of community adaptive capacity to natural hazards. The notion of resilience in terms of adaptive capacity is similar to Handmer and Dovers (1996) typology of proactive community resilience in which they likened a proactive resilience to reorientation of mitigation strategies in light of ecological dynamism.

Urban-community resilience

Community resilience is often used as synonymous with "bounce back" after ecological disturbances. Following this conceptualization, resilience has been assessed from the 'outcome' perspective. Paton *et al.* (2001); Smith *et al.* (2011); Wilson (2013); Thornley *et al.* (2015); Kenney *et al.* (2015) have assessed community resilience from post disaster recovery. Frankenberger *et al.* (2013) query that such assessment misplaces recovery as resilience because it does not address the dynamic nature of community resources and capacities.

Addressing the resilience of urban communities from the perspective of recovery raises fundamental questions. Firstly how do we account for the roles of ethnicity and race in urban resilience? Secondly, how do we account for the changing demographic structure in urban communities and the problem of preparedness which arises from ethno-cultural understanding of local risk and its interpretation? And lastly, how do we assess differences in the level of vulnerability and resilience that exist among communities and households within the urban community? These issues underscore the view that urban community resilience is intertwined with race, ethnicity and resource capacity of households. Thus, a community may absorb disruption but does not translate to the resilience of various units in the community and resilience of certain households does not constitute the resilience of a community (Bene *et al.* 2012). Achieving the goal of disaster risk reduction in urban community requires an investigation into the resource capacity of the various households and communities embedded in urban community.

TOWARDS A RESILIENT URBAN COMMUNITY TO NATURAL HAZARDS

Extant studies on resilience of urban communities have focussed on post disaster recovery rather than preparedness context. This approach misplaces community recovery as resilience which is an outcome of the process of resilience (Frankenberger *et al.* 2013). The implication of this approach for community resilience is that firstly, it does not give credence to the changing nature of community resources. Secondly, it does not address the influence of resource distribution on the resilience ability of communities and households. Thirdly, it does not stimulate evidence based policy for enhancing resilience and lastly, there is an assumption that the resilience of urban community encompasses the resilience of the embedded communities and households.

Addressing the above issues require both qualitative and quantitative investigations into the empirical level of preparedness of social, economic, human and physical resources of urban communities and households. The current status of the resources determine the state of preparedness and ability of urban communities to absorb ecological challenges. In situations where low resilience capacities are identified, socio-economic policies and planning to enhance better preparedness for hazard event will be implemented. Conceptualising resilience in this manner positioned the concept as nested within the scheme of disaster preparedness.

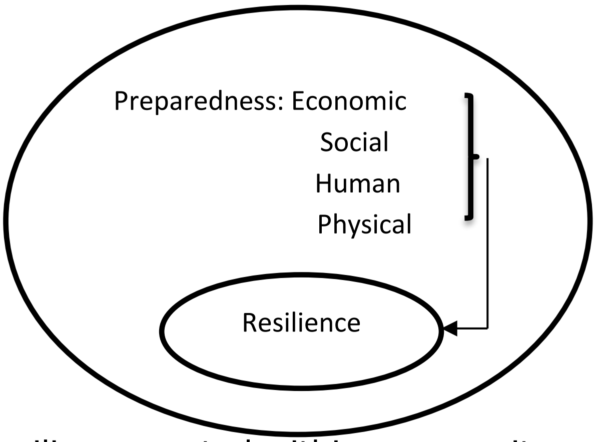

Figure 1. Resilience nested within community preparedness

In the above figure, preparedness is an umbrella for resilience. The level of preparedness of community resources determines the resilience of communities to natural hazards.

Community resilience as a strategy for disaster preparedness can be assessed by a combination of different resources and corresponding indicators that best predict the capacity to withstand local hazards. Assessment based on indicators reveal the positions as well as the pathways of resource attributes. The resilience of the resource component reflects the preparedness and quality of indicators variables chosen as proxies for resilience (Cutter *et al.* 2010). The indicator variables are regarded as community capacities that could be improved through interventions and policies to prepare communities for the risk of natural hazards. Some of the resources and variable indicators that facilitate preparedness of urban community are briefly highlighted below:

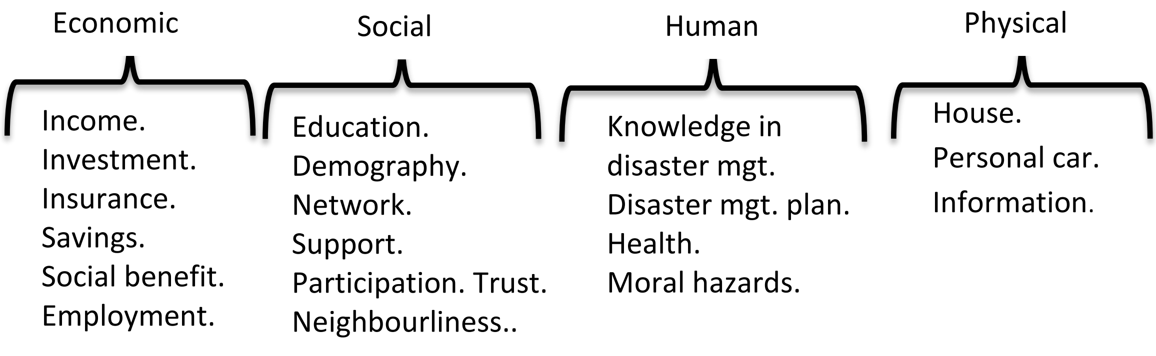

Figure 2 Resilience resources and attributes

Sources: Cutter *et al.* 2010; Cutter et al. 2008; Ainuddin and Routray (2012); Mayunga (2007); Norris *et al.* (2008); Peacock *et al.* (2010).

CONCLUSION

This paper situates resilience within the realm of preparedness. We argue that community's ability to recover from hazard event is a function of the preparedness of community resources. Assessing community's ability to recover therefore should take place at the preparedness phase rather than post disaster phase. The key strength of this paradigm is that it gives communities the opportunity to identify weak resilience indicators or component before the advent of a disaster. Although our model excludes government and technological resources and focuses on household resources, we recommend that future endeavours should encapsulate the preparedness of government and technological resources for a holistic assessment of resilience beyond household level.

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CANTERBURY QUAKE 2011: STRUCTURAL DESIGN LESSONS PAUP 2013

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ABSTRACT

This paper discusses the structural design lessons from earthquakes and their relevance to the land use planning process in mitigating future urban disasters. The paper examines the relevance of the key structural design lessons from the Canterbury 2011 quake to the Proposed Auckland Unitary Plan 2013 (PAUP 2013). Using logical argumentation (Groat and Wang 2002), a review of the building heights and soil structure of Auckland city in relation to earthquakes is done with a focus on the building types and soil behaviour during the earthquake followed by a summary of the key structural lessons learnt. These are then juxtaposed with the Proposed Auckland Unitary Plan's natural hazard response strategy to determine the extent to which lessons from the quake have been addressed. It is pointed out that PAUP 2013 plan making process has not specifically considered lessons learnt from the Canterbury earthquake, citing lack of detailed information, the timing and location of the occurrence of earthquakes and other natural disasters to enable effective address through land use planning. This paper concludes that the promise to effectively mitigate against natural disasters, lies less in the urban form but more in the pragmatic response to, and adoption in plan making of the lessons learnt from previous experiences, and in the case of Auckland, lessons from the Canterbury earthquake.

Keywords: Canterbury earthquake, land use planning, PAUP 2013

INTRODUCTION

Earthquakes, building height and soils

Charleson (2008) points out that building height has the greatest influence on the natural period of vibration of a building during an earthquake due to the 'whiplash' accelerations near the roof especially in tall buildings. This localised and intense horizontal accelerations are responsible for increased damage to non-structural elements in upper storeys.

Soil influences the frequency of ground shaking as measured in cycles per second while increasing its duration and severity. The Canterbury Earthquake Royal Commission (2012) in quoting Cubrinovski & McCahon (2011) states that soils are deformed by the seismic waves, both temporary displacements and permanent movements, and deformations. The soils are considered to have failed when ground deformation seriously affects the performance of land or structures.

When subjected to strong ground shaking, soil behaves like a liquid such that the hydrostatic pressure on the liquefied material causes it to flow towards an area of lower pressure, which is generally upwards to the surface. The process of liquefaction and, in particular the ejection of the excess water between the grains of sediment (pore water) results in a complete loss of shear strength, which in turn can result in heavy structures sinking into the ground and light structures floating to the surface. This often leads to localised collapse zones, sinkholes and vents (Canterbury Earthquake Royal Commission,2012; Charleson 2008).

Auckland soils

Auckland region is recognized as having zones with expansive clay soils (Brown et al 2003). Most of urban Auckland soils comprise the Waitemata Group-East Coast Bays formation with alternating mudstone and lithic sandstone of Miocene. This group of soils are the most dominant in Auckland region forming alternating visible beds in cliffs and on intertidal platforms around the Waitemata harbour (Brown et al 2003).

The East Coast bays are predominantly graded turbidite sandstones alternating with poorly sorted interturbidite mudstones. Quoting Harvey, Riley& Pickens (1982) these formations produce the greyish white to orange-browns clays which comprise a mixture of kaolinite, illite and montmorillonite with kaolinite being more dominant at the ground surface and montmorillonites being dominant at depth (Cubrinovski& McCahon 2011)

Harvey, Riley& Pickens (1982) states that the presence of clay minerals such as montmorillonites cause the expansion in clay soils which is in turn is influenced by the period and amount of precipitation and evapotranspiration. This expansion results in volume changes that that occur independently of loading and are attributable to swelling and shrinkage. Consequently, this volume changes can give rise to ground movements that can cause building damage. Vulnerable buildings include low rise structures which have insufficient weight or strength to resist ground movement.

Auckland is a wet city with annual precipitation of 1240mm of rain. This makes it vulnerable to liquefaction, ground shaking and lateral movement in the event of a major earthquake. In this respect, soil property and behaviour become vital when designing for seismic resilience. It can be argued that land use planning can be an important strategy when planning and designing for mitigating seismic resilience since through microzonation and risk assessment maps (Bansal,Mukherjee & Gairola 2012) areas with soils vulnerable to liquefaction can be zoned off for non-building activities.

The Auckland Council's position on ground shaking states that in the event of an earthquake, shaking maybe more intensive on softer soils on the Manukau low lands and flood plains from the Waitekere Ranges but minimal in much of the central city which has been built on hard bedrock or ancient mud and siltstones with the only susceptible areas being the reclaimed areas around the Ports of Auckland and the flood plains of the Kumeu and Kaipara Rivers.)This view highlights the minimal role of land use planning in mitigating seismic activity in the event of an earthquake.

Lessons from Christchurch

The lessons from Christchurch centred around building foundations' behaviour during the earthquake. In this respect the behaviour of soils was vital.Graeme (2011) summarizes the performance of building materials in Christchurch earthquakes. He points out that most residential foundations on flat ground consisted of concrete perimeter foundation with concrete piles inside. Others were slab on grade reinforced and unreinforced. Hill foundations of new houses consisted of benched slab on grade while perimeter foundations-consisted of concrete, masonry and stone and cut in basements with slab on grade floors.

The claddings consisted of clay/concrete brick veneer. Weatherboard, stucco and EIFS were other notable claddings. Some houses were steel framed, occasional reinforced masonry. Others consisted of non-standard systems like concrete sandwich panels. Roofing type comprised of 45% corrugated steel, 25 % concrete tiles 20% pressed metal tiles and others about 10% (Graeme 2011).

The initiators of house damage on flat land consisted of soil liquefaction, lateral spreading and a combination of the two (liquefaction and lateral spreading). On hillsides damage was initiated by ground shaking, combination of ground distortion and shaking, rock falls and rolling stones.

Structural design lessons from the seismic experience in Canterbury earthquake 2011

Timber framed housed performed well with no collapses while high rise Unreinforced Masonry concrete URM buildings including heritage and commercial buildings performed poorly (Goldsworthy 2012). Heavy masonry claddings that were poorly attached to the structure or of plan irregularities that induced strong torsional response resulted in considerable damage in low rise buildings especially those with timber or RC frames.

Shelton (2014) has distilled the key lessons from the Canterbury earthquake into six main themes;

Site location and conditions are crucial-low lying coastal areas are vulnerable to tsunami damage. Low lying riverside sites adjacent to estuaries can be vulnerable to liquefaction while hillsides require extra care to achieve resilience.
Reduction in the complexity of the structure: the performance of a complex structure under earthquake action is more difficult to predict than a simpler one and is likely to have a higher risk of weather tightens problems.
Heavy buildings are vulnerable to seismic activity besides having heavy foundations and higher construction costs.
Structural stiffness-provision of lateral stiffness to the structure so that its deflections under seismic action are low enough to avoid damage to non-structural components and finishes.
Care with connections between structure and non-structural elements are vital in building resilience.
Robust building Services-most non-structural components including building services (hot water cylinders leaking water pipes) fail as a result of excessive building deflection, lack of structural stiffness and toppling or failing due to lack of anchorage.

Another key lesson from the Canterbury earthquake was the appreciation of adopting preventive rather than reactive strategies in earthquake mitigation in light of the impact of earthquakes on lifelines. Giovinazzi (2011) in discussing the performance and management of lifelines following the February 2011 earthquake state that significant damage to lifelines was caused by strong ground motions and widespread liquefaction throughout the Christchurch urban area and its surroundings.

The value of resilient design, interdependency planning, mutual assistance agreements and extensive insurance cover and highly trained and adaptable human resources as the keys that enabled many systems to continue to function even though in a reduced state, effectively mitigating the impact of the earthquake in Christchurch and New Zealand economies and communities (Giovinazzi 2011).

Fenwick (2012) points out that this substantial programme of seismic mitigation undertaken by the Christchurch lifeline utilities, since the *Risks and Realities Report* (Centre for Advanced Engineering 1997; Giovinazzi et al 2011)) served Christchurch well in reducing losses and facilitating emergency responses and recovery. The three elements according Fenwick (2012) that contributed to this mitigation were;

Asset awareness and risk reduction-such as identifying points of particular vulnerability
Readiness-taking steps to improve organizational performance in emergencies
Perseverance; maintaining the effort overtime while communicating realistic expectation.

The relevance to Auckland city is that some lifelines and infrastructure may not have the external support or alternative dependencies to remain resilient. For instance, if the main sewer line in Mangere were to be disrupted, there is a high possibility that most high-rise buildings will have to close as a lack of alternative sewer disposal options.

To mitigate against this, the issue of asset awareness and risk reduction and identifying points of vulnerability as pointed out by Fenwick (2012) becomes vital. Sewerage provision, food distribution and supply systems and other lifelines in a future compact city such as Auckland become points of particular vulnerability and weakness due to lack of back up lifelines or inbuilt alternative resilience mechanisms.

Auckland has a lower seismic hazard which is consistent with its history of low seismicity Centre for Advanced Engineering (1997) than Christchurch and much of NZ and therefore a correspondingly lower seismic design level (Cousins, Nayyerloo, Deligne 2014). However, it is arguable that implicitly, the overall risk for Auckland is lower.

But this lack of knowledge on the vulnerability of Auckland's lifelines in the face of disaster leaves it vulnerable hence inherently increasing the overall risk.

The Unitary plan states the following in regard to managing high risk disasters like earthquakes and tsunamis;

"The risk from some natural hazards, such as low-frequency high-magnitude events like tsunamis and earthquakes, is impractical to address through land use planning as there is little detailed information regarding where and when these events could occur. Instead, the risks from these natural hazards are better addressed through measures put in place by emergency management groups such as Civil Defense. This includes education, warning systems and emergency preparedness. As more information becomes available on these types of natural hazards, it will be added to the council hazard database and used in the evaluation of proposed development and subdivision activities. Earthquake risk to buildings is addressed through structural codes under the provisions of the Building Act 2004." Auckland Council (2011).

The key structural lesson from the quake was design for resilience, whereby buildings should not only resist earthquakes long enough to save lives, but be useable long after the quake has subsided (Wilkinson 2014). The current standards in Auckland Building Act 2004 are designed to address life safety and damage to buildings. Specifically, lessons learnt related to how the foundation behaved due to ground shaking and vertical acceleration. The following was observed;

Risk of further liquefaction or spreading due to seismological forces
Extent of liquefaction and spreading on subsurface conditions

The effects of this is differential settlement, lateral strain and possible flooding.

The Unitary Plan and lessons learnt from the Canterbury earthquake.

Soil properties and behaviour

Soil properties and behaviour determine the type of foundation that will support a building. (Charleson2008) details an analysis of the recommendations for seismic design and construction of building foundations in CBDs of New Zealand cities. Building on these recommendations, this section will address how land use planning can be used to mitigate or enhance some of these recommendations.

Land use planning

The Royal Commission recommended the awareness by local authorities of the seismic activity of their region and incorporate such knowledge in local and regional planning. Local authorities need to provide information on liquefaction risk and how this can be mitigated (French, & Isaacson 1984; Olshansky 2001).

The dearth of soil information on Auckland soils would form the basis for land use planning in relation to disaster management and resilience. Zoning could be used a tool to isolate areas in Auckland that are known to have soft under laying soils and/or expansive clays.

Such areas would naturally be prone to liquefaction, ground shaking and lateral movement in the event of an earthquake. Land uses in such areas could be designated for other activities such as Urban Agriculture (UA) (Munya 2016). This could be one strategy used to achieve urban as well as earthquake resilience through 'greening of the city and food production.

Bansal, Mukherjee, Gairola (2012) state that, "integrating urban disaster management tools like risk mapping and micro zonation results in the production of technical information for the identification of hazardous areas which can be used in developing zoning restrictions, establishing population density levels and enabling managers to design mitigation action plan". This is a classic integration of socioeconomic and technical factors such as housing, infrastructure, lifelines and critical facilities.

French & Isaacson (1984) use a probabilistic approach for earthquake risk analysis to estimate and map the levels of expected ground motions liquefactions and land sliding in order to compute the overall risk hazard. The object of this is that damage estimates by structure, can be produced for the existing land use pattern or for alternative future scenarios, with such information being used to evaluate land use patterns with respect to their potential for earthquake damage. One land use pattern that has low potential to earthquake damage with potentially high returns to the city resilience during an earthquake is urban agriculture (UA).

Risk mitigation (Fenwick 2012) of lifelines through preventive rather than reactive strategies.

CONCLUSION

This paper looked at the key structural lessons learnt from the Christchurch earthquake and their relevance to that PAUP 2013. It also considered how they could be included in the plan. The reason for this was that Auckland's unique position as New Zealand's premier city requires that preventive rather than reactive disaster management strategies be adopted so that its economic productivity continues uninterrupted post disaster.

The experience from the Canterbury earthquake and subsequent analysis by various studies (Graeme 2011; Goldsworthy 2012) has shown that the goal of meeting the established minimum standards in and of itself is inadequate to satisfy the goal of designing for resilience which was the overarching lesson from the Christchurch earthquake.

The PAUP 2013 has not specifically considered lessons learnt from the Canterbury earthquake. The reason given is that there is lack of detailed information regarding where and when such risks as earthquakes and other natural disasters would occur to enable effective address through land use planning. Where seismic design is concerned the plan depends on the minimum standards as stipulated by the Building Act 2004.With regard to post emergency preparedness, management and evacuation strategies, the plan refers to the Civil Defence strategy.

This paper argues that the promise to effectively mitigate against natural disasters, lies not in the urban form but in the effective response to and adoption of the lessons learnt from previous experiences. In view of this, focussing on the urban form *per se*, is inadequate in addressing risk associated with natural disasters. A holistic approach is needed, incorporating both structural and socioeconomic lessons learnt from previous experiences.

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MANAGING JAKARTA'S FLOOD RISK AFTER *HYOGO*: POLICY & PLAN ANALYSES

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ABSTRACT

Equatorial megacities dominated by rivers (e.g., Jakarta, Bangkok, Kuala Lumpur) are particularly vulnerable to disasters, given the confluence of rapid urbanization and tropical climates. Climate change exacerbates flood hazards and places already vulnerable populations at higher risk. Jakarta's February 2007 flood, regarded as the worst in recent history, affected approximately 70% of the city. Although measures put in place after 2007 somewhat reduced risk, floods in 2013, 2014, and 2015 indicate that significant flood events are becoming an annual problem requiring further mitigation. This paper provides a brief overview of flood risk exposure within the Jakarta province, and recounts levels of impact from the 2007 and more recent major flood events. The paper also presents succinct summaries of flood risk management policies and plans relevant to Jakarta, many of which are only available in *Bahasa Indonesia*, complicating dissemination to and review by international audiences. These documents are analysed relative to the *Hyogo Framework for Action 2005-2015* using a qualitative content analysis.

The research found that policies and plans in the regional and national level serve as frameworks to translate the new paradigm of disaster management in Indonesia. In spite of strong policy frameworks underlying flood risk management strategies, there are opportunities for improvement of collaboration mechanisms in decision-making processes and in implementation of plans to strengthen Jakarta's disaster resilience. It also potentially widens participation in dialogues regarding the effectiveness of policies and plans for flood risk management in Indonesia and across equatorial mega-cities facing similar challenges.

Key words: collaborative planning, disaster resilience, flood risk reduction, Hyogo Framework for Action, mega-cities

INTRODUCTION

DKI (*Daerah Khusus Ibukota*) Jakarta has a unique administrative structure, exists both as the capital of Indonesia and as an autonomous province, determining its own policies and budget allocations. Jakarta both benefits from and is challenged by urbanisation and globalisation (World

Bank, 2011a). Strong and sustained population and economic growth have resulted in densification, land use change and vast increases in urbanised areas (Dickson, et al., 2012).

In recent years, severe floods have become more frequent and intense. During these events, significant portions of the city are inundated as a result of inadequate drainage and flood control capacity, clogged waterways, and high landscape imperviousness (Akmalah and Grigg, 2011). The February 2007 floods, regarded as the worst in recent history, affected approximately 70% of the province, with floodwaters directly impacting 400,000 people, resulting in 79 deaths, destruction of 100 homes within informal settlements, and causing nearly US$1 billion in total losses (Texier, 2008; Ward *et al.,* 2013; Akmalah and Grigg, 2011). By comparison, the 2013 floods were less extensive; however, the floodwaters remained for nearly two months and caused US$2 billion in economic losses (BPBD DKI Jakarta, 2013). Subsequent floods in 2014 remained for almost three months; there was decreased flood intensity, duration and damages in the 2015 floods. Robust policies and plans are required to improve the effectiveness of disaster risk management strategies, as are coordination mechanisms and increases in the capacity of governmental agencies to craft disaster risk management strategies.

This research involves qualitative content analysis on relevant documents. Documents were selected based on the relevancy to disaster risk management and flood planning in Jakarta. The formats of documents vary, including master plans, and guidelines, planning documents, project reports, governmental regulations and reports from the provincial into international level. The following sections provide an overview of the Indonesian planning system and the history of its disaster management policies and plans, followed by an analysis of those plans including the identification of strengths and weaknesses relative to the *Hyogo Framework for Action (HFA) 2005-2015*.

BRIEF OVERVIEW OF INDONESIA'S PLANNING SYSTEM

Indonesia's planning system encompasses legislation, policies, guidelines, plans, and decision-making processes related to land use and development. There are two types of planning products, each of which has strategies and guidelines – one focussing on development[8] while the other has a spatial context (Hudalah & Woltjer, 2007; World Bank, 2011b). While these products are unique to each level of governance, Indonesia's governmental structure historically places the highest authority at the national level (Hudalah & Woltjer, 2007). This system of governance is a legacy of the *New Order Regime*, which limits the authority and capacity of local governments to manage development through spatial plans. Following the 1998 fall of the *Regime,* Indonesia commenced decentralisation of its

[8] The National Development Plan also gives general directions for plans and policies relevant to disaster risk management.

planning system. Consequent formulation of regulations for local governance has delivered a new system of governance (Hudalah & Woltjer, 2007).

In October 1992, the Indonesian parliament passed the nation's first spatial planning law, the *Spatial Planning Act 1992 No. 24* (Ind.). The Act recognises that governance traditions and political culture strongly shape the Indonesian planning system, and lays out a hierarchy of spatial planning and decision-making. The subsequent *Spatial Planning Act 2007 No. 26* (Ind.) enables multiple levels of government to direct spatial and development plans (Rukmana, 2015) as shown in Figure 1, and to coordinate with other government bodies (Hudalah & Woltjer, 2007).

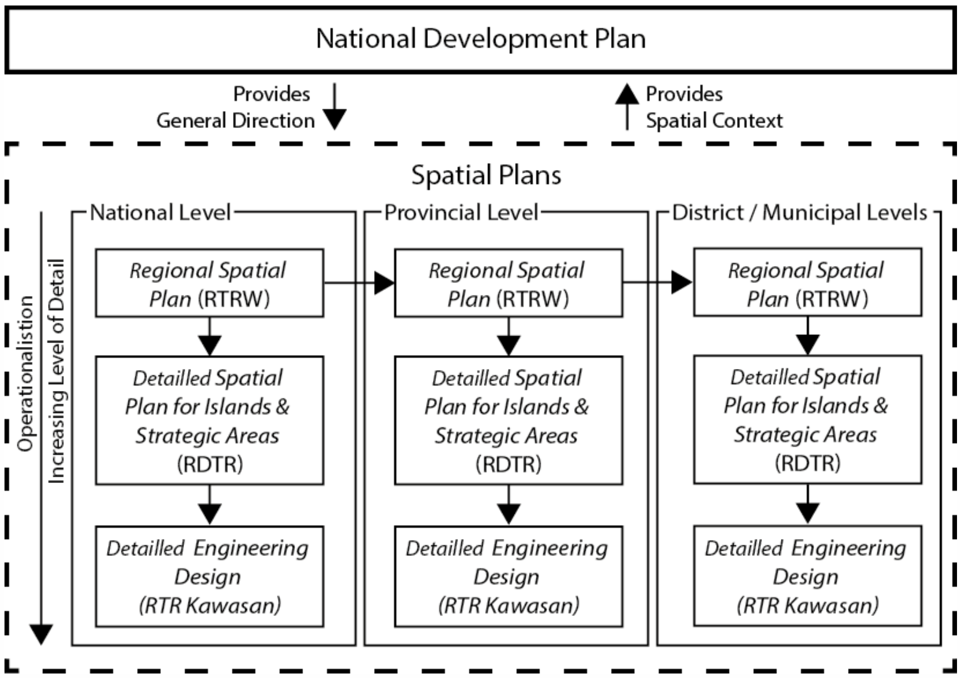

Figure 1: Indonesian Planning Framework
(Modified from Hudalah & Woltjer, 2007; World Bank, 2011c)

DISASTER MANAGEMENT POLICIES & PLANS

Reflecting upon the 2004 tsunami, which resulted in over a quarter million fatalities and US$14B in economic losses, the Indonesian government acknowledged that its national level disaster management plan was insufficient to respond to major disasters (Center for Excellence, 2011, and prompted *the Water Resource Management Act 2004 No. 7* (Ind.) and initiating the series of policies shown in Figure 2.

At an international level release of the United Nations Office for Disaster Risk Reduction's (UNISDR) *HFA 2005-2015,* specifically targeting "*substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries"*

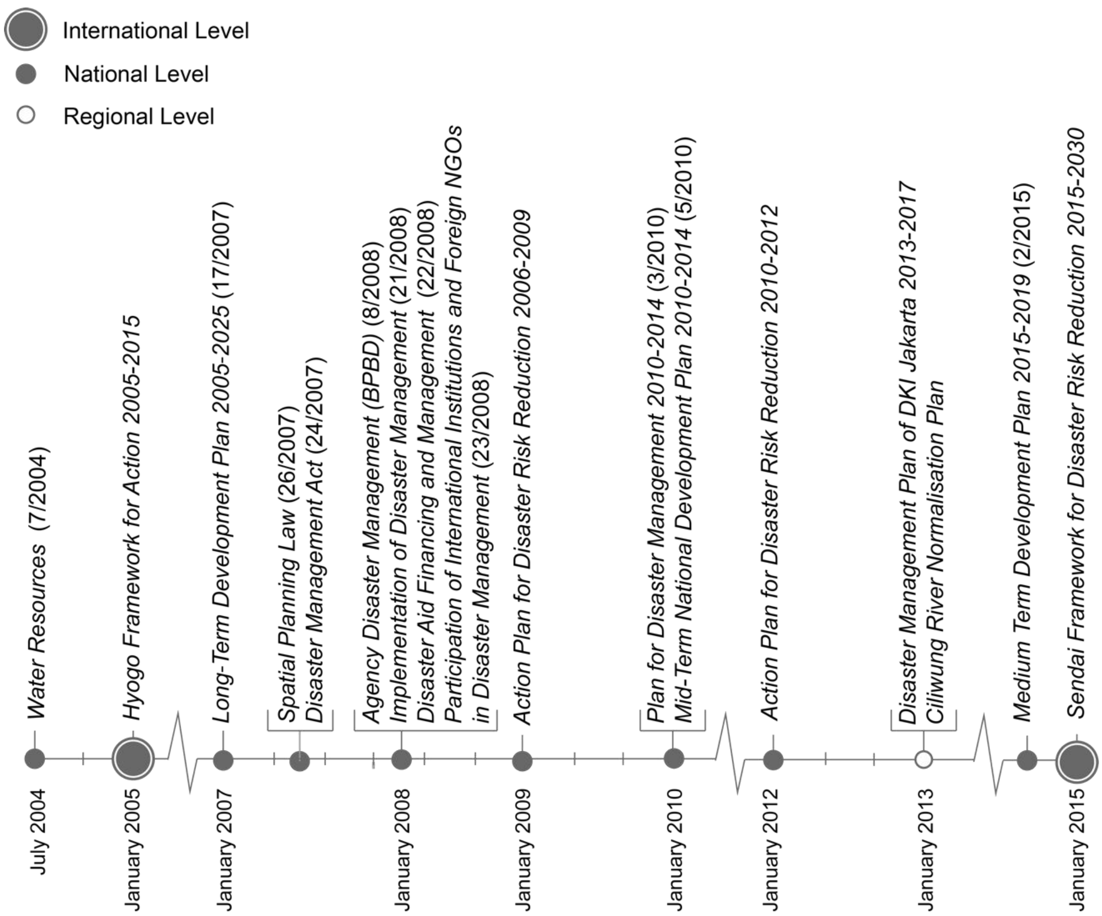

Figure 2: Timeline of Policy Frameworks Relevant to Disaster Risk Reduction, 2004 – 2015

(UNISDR, 2005, p. 3), required multi-level coordination towards strategic goals, being:

(a) The more effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, with a special emphasis on disaster prevention, mitigation, preparedness and vulnerability reduction; (b) The development and strengthening of institutions, mechanisms and capacities at all levels, in particular at the community level, that can systematically contribute to building resilience to hazards; (c) The systematic incorporation of risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programmes in the reconstruction of affected communities (UNISDR, 2005, p. 3-4).

The *Disaster Management Act (DMA) 2007 No. 24* (Ind.) provides a national policy framework for disaster management in Indonesia and specifically references the *HFA 2005-2015.* The Act stimulates formulisation of three more specific policies, addressing: Implementation of Disaster Management (*Government Regulation 2008 No. 21* (Ind.)); Disaster Aid

Financing and Management (*Government Regulation 2008 No. 22* (Ind.)); and Participation of International Institutions and Foreign Non-Governmental Organisations in Disaster Management (*Government Regulation 2008 No. 23* (Ind.)). These policies have led to a new paradigm of disaster management in Indonesia, emphasising decentralised disaster risk reduction as shown in Figure 3 and launching the National Disaster Management Agency (BNPB) responsible for multi-level coordination.

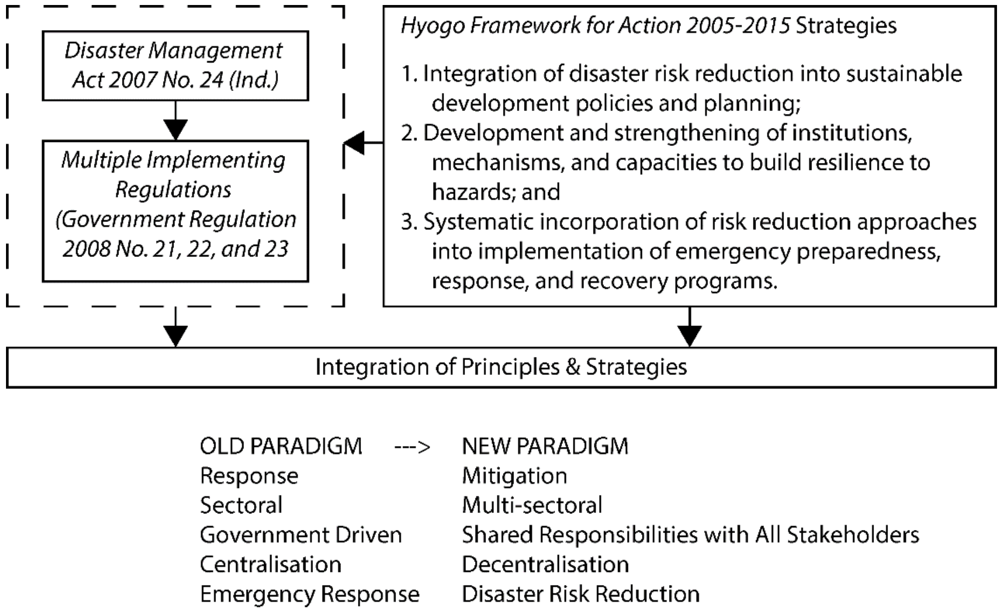

Figure 3: Paradigm Shift in Disaster Management in Indonesia

In 2010, BNPB published the *National Plan for Disaster Management (NPDM) 2010-2014, a* five-year plan intended to guide disaster management across Indonesia, with most action occurring at the national level (UNDP, 2010). The *NPDM 2010-2014* differed from the *DMA 2007* in that it described roles for stakeholders and mandates coordination mechanisms. The Plan emphasised the importance of community engagement and included assessments of disaster risk, explicitly identifying hazards, exposure, and vulnerability. These assessments led to formulation of the *National Action Plan on Disaster Risk Reduction (NAP-DRR) 2010-2012,* which further embedded the *HFA 2005-2015* into national policy (Tokyo Development Learning Center, 2011) while retaining legal links to the *DMA 2007*. The *NAP-DRR 2010-2012* established priorities for action, formulated more detailed action plans for multiple levels of government, and identified necessary funding for implementation (UNDP, 2010), with recognition that collaboration with nongovernmental organisations (NGOs) would be required. The *NPDM 2010-2014* was also integrated into the *Mid-Term National Development Plan 2010-2014* which underpins the spatial plans as referenced in Figure 1, further embedding disaster risk reduction into planning practice.

More recently, decentralisation and power sharing has resulted in increased levels of responsibility for disaster management at local levels, albeit with influence from policies at the national and international levels. Figure 2 reflects this diversification in the origin and level of policies. In 2013, Jakarta's Disaster Management Agency (BPBD) launched the *Disaster Management Plan of DKI Jakarta (DMP-DKI Jakarta) 2013-2017*, drawing upon disaster management principles from the *DMA 2007*. The plan is intended to broaden stakeholder participation, improve collaboration and coordination amongst agencies, and build partnerships to aid in implementation of disaster risk reduction activities within the province. Concurrently, the province's Cisadane-Ciliwung River Basin Agency issued its *Ciliwung Normalisation Plan (CNP)*, providing more technical and specific plans for flood risk reduction in Jakarta. The CNP outlines measures to normalise the river's flows, reducing flood risks within the highly urbanised river basin. The plan requires structural modifications to the river, including dredging and stabilisation of existing channels and introduction of shortcut canals, as well as clearance of informal settlements along the river banks (BBWSCC, 2013).

ANALYSIS OF POLICIES & PLANS

As detailed above, the *HFA 2005-2015* informs the *DMA 2007*, which shapes both national and provincial flood risk management strategies. It is not clear, however, how fully these devolved strategies reflect the *HFA 2005-2015's* key priorities, prompting the analyses that follow.

As Table 2 shows, implementation and incorporation of the key priorities of the *HFA 2005-2015* approaches sufficiency at national and regional levels but is lacking at local levels. Assessed efforts to address the key priorities varies, with two (KP2 and KP4) of five priorities addressed with relative strength – these efforts should be maintained. The current research indicates that the remaining key priorities (KP1, KP3, and KP5) are comparatively weak, and require significant effort to reach full achievement. Activities to address these priorities include: building resilience at the community level; engaging and otherwise involving communities in decision-making processes associated with flood risk management; and increasing communication and collaboration mechanisms between governments and communities.

Table 2: Analysis of Jakarta's Flood Risk Management Relative to Key Priorities of the *HFA 2005-2015*

KP1. Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation

National institutional and legislative frameworks

National frameworks (NF) support formulation and strengthening of integrated disaster risk reduction (DRR) mechanisms

National and regional level development policies and plans (DPP) integrate DRR

principles
Legislation has been formulated to support DRR; implementation of disaster management; disaster aid financing and management; and participation of international institutions and foreign NGOs in disaster risk management (DRM)
NF do not yet mandate a broad-based dialogue with relevant stakeholders at district and sub-district levels
DRR principles have not yet been integrated into district levels
DRR legislation does not yet include mechanisms that provide incentives for risk reduction and mitigation activities, especially for at-risk communities (A-RCs)

Resources

National and regional governments have allocated resources and budgets to prioritise DRM development and implementation
Provincial governments have: demonstrated strong political determination to integrate DRR into DPP; and undertaken capacity-building of government officials
DRR capacity development has not yet occurred at district levels, perhaps as there has not yet been significant support, allocation of resources, and budgets to prioritise local level DRM development and implementation

Community participation

Frameworks for DRR in Jakarta include provisions to promote community participation
Implementation of provisions related to community participation to gain local knowledge has not yet been executed effectively

KP2. Identify, assess and monitor disaster risks and enhance early warning

National and local risk assessments

Development and dissemination of risk maps and information to decision-makers, the public and A-RCs has occurred
Technical literacy of A-RCs has limited the effectiveness of risk maps and information disseminated to A-RCs

Early warning

Early warning systems (EWS) are in place, empowering local leaders to disseminate information to A-RCs, with plans for upgrade

Capacity

Jakarta government have supported development and sustainability of infrastructure, technical, and institutional capacities to observe, analyse and map flood hazards
Jakarta government have established capacity to disseminate and exchange statistical information related to flood risks
Jakarta governments have not fully empowered and educated local governments so as to strengthen their capacity to analyse flood hazard maps
Jakarta government have not intensively educated local governments and A-RCs to be able to understand information released, particularly related to flood risk management

Regional and emerging risks

Jakarta government has cooperated with regional, national and international organisations/agencies with regard to management of the Ciliwung River basin

Climate change has exacerbated the flood-hazards and increase the exposure of communities to flood risks

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KP3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels

Information management and exchange

Flood risk information can be accessed via government agencies' websites
A-RCs may not be able to access the online flood risk information when the flood is occurring
Information with regard to flood risk has not incorporated traditional knowledge, cultural and social factors
Institutions dealing with urban development, particularly relevant to relocation plans, have not provided adequate information to A-RCs relevant to options prior to construction, land purchase or sale

Public awareness

Little or no strong stimulation to raise public awareness at all levels of society

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KP4. Reduce underlying risk factors

Environmental and natural resource management

Structural and non-structural measures have been incorporated into communities to reduce DR
Design of such strategies has not yet effectively involved local and A-RCs in decision-making, nor has it in design and implementation processes.

Social and economic development practices

DRR measures have been incorporated into post-disaster recovery processes, coordinated by BPBD
There has not been any promotion to diversify income options for communities living in high-risk settlements to reduce their vulnerability to hazards
Financial risk-sharing mechanism, including insurance and reinsurance against disaster, is not familiar to local and at-risk communities

Land-use planning and other technical measures

DR concepts have been mainstreamed into planning procedures for major infrastructural projects
Local spatial plans do not yet incorporate DR assessments, particularly with regard to informal settlements located in high-risk or disaster-prone areas

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KP5. Strengthen disaster preparedness for effective response at all levels

Strengthen policy, technical, and institutional capacities

Jakarta governments have improved capacity related to technology and human resources
Such efforts have not been effectively executed at local levels

Promote and support dialogue, exchange information and coordination

Most documents include recommendations to coordinate and collaborate with other stakeholders and with government across sectors and levels of authority

Some planning documents (PDs), particularly at the regional level, indicate an approach to engage in community participation in design processes
Not all documents have a clear approach to collaboration – they do not lay out procedures and mechanisms to aid in plan implementation
PDs are often not accessible to the public via official websites of relevant government agencies and institutions

Develops specific mechanisms to engage active participation of relevant stakeholders

Communities have been engaged in DRR strategies
Such engagement is not necessarily meaningful – A-RCs do not share decision-making power in government initiated processes

CONCLUSIONS

With nearly twenty policies relevant to flood risk management in Jakarta introduced at national and regional levels since 2004, it is clear that the provincial and national governments recognise the importance of managing and reducing disaster risk. Over this time, the paradigm of disaster management in Indonesia has been changed, stressing preventative instead of responsive actions. Further, the current systems emphasise comprehensive disaster management rather than simply emergency response, and shared responsibility for disaster management between governments, stakeholders, and communities. Analyses undertaken in this research indicate that Jakarta's existing flood risk management efforts are well supported by policy frameworks with clear goals, strategies, priorities, and programs. They are deficient, however, with specific regard to activities at the local level, mechanisms for collaboration and shared decision-making, and in the overall implementation of policies and plans. Increased focus on these deficiencies would result in improvements to the overall resilience of the province.

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THE RESILIENCE OF PLACE AND SOCIAL CAPITAL OF RAPAKI

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The Lyttelton Harbour area of Christchurch has been occupied by Maori for over 700 years with the first Europeans arriving in 1770. Rapaki Pa was founded by Ngai Tahu explorer Te Rangiwhakaputa, who on landing from his canoe on the foreshore, took off his rapaki (his waist mat) and laid it on the ground as his claim to the area. The area was known as Port Cooper to non Maori and around 1850 was renamed to Lyttelton. The 850 acres of the Rapaki Native Reserve were gazetted as part of the Port Cooper Block which had a Deed of Sale date of August 10th 1849; though Rapaki had been occupied well before then.

With that history and background, does resilience mean something different especially in terms of place and social capital? To answer that question key people from the community were interviewed following the February 2011 Earthquake to ascertain the following:

What were the significance of pre and post-earthquake examples of social capital and sense of place as determinants of post disaster community resilience
How can this information inform response and recovery
How do they integrate scientific information into their constructions of risk

The conclusions suggest that the resilience of the people clearly existed in the place. Moreover, the place seemed to have healing power and was often referred to in the first person. This connection to place seems to cut across much of what is seen as contemporary design and seemed to be part of the invisible DNA passed on by earlier generations.

KEY WORDS: Maori, resilience, place, social capital

TRAINING AND EDUCATION FOR RESILIENCE TO GEOLOGICAL DISASTERS: BEST PRACTICES FROM INDONESIA

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ABSTRACT

Indonesia is located in a highly prone region to Earthquakes, Tsunamis, and Volcanic Eruptions due to its position on the convergence zone of three different tectonic plates. Landslides are often triggered during times of heavy precipitation and take place in the mountainous areas of the peninsula. Building disaster resilience among the society is therefore an essential but challenging task for the Indonesian Government. Two Indonesian best practice examples from governmental institutions show how important effective information and training concepts are to build resilience among the society: 1) Awareness raising in schools with the Geomobil, managed by the Provincial Department for Mining and Energy of Aceh tackles playful learning and capacity building for geological hazards in schools; 2) Technical trainings for Landslide Survey and Georisk Sensitive Spatial Planning for Indonesian authorities are provided by the Education and Training Center for Geology to improve resilience through technical capacity development at local government level. The Indonesian government in both cases is supported through the German Technical Cooperation Project "Mitigation of Georisks", implemented by the Federal Institute for Geosciences and Natural Resources (BGR, Germany). Both best practices show the importance of education and training for different audiences and levels in enhancing disaster resilience in Indonesia.

Key Words: Geological Hazards, Awareness Raising, Mitigation, Education, Training

INTRODUCTION

Due to the countries location, earthquakes, volcanic eruptions and tsunamis are common geological threats in Indonesia (Sulaeman, 2011). Especially during the rainy season, also landslides cause loss of life and damage infrastructure; adding to the various severe geo-hazards occurring regularly. In any case, latter is still underestimated and the implementation of landslide risk mitigation instruments are still insufficient on a common basis.

Indonesia borders three major subduction zones that are the source for frequent earthquakes. One stretches from western coast of Sumatra to South coast of Java, one from North Papua to East of Mindanao and one to the north of Sulawesi. The magnitude 9.2M_W earthquake on 26th December 2004 that took place near the West Coast of Aceh triggered the Indian Ocean Tsunami that gained notoriety due to the high death toll with over 250.000 victims all over South-East Asia, Indonesia bearing the brunt of it (Doocy et al., 2007). In Indonesia, the Tsunami showed, that especially children and elderly people are prone to disasters and that reducing their vulnerability, among others is necessary to create resilient communities (UNESCAP, 2012).

Even though the disaster in 2004 was followed by a number of law revisions and a new institutional set up in the Indonesian Government regarding disaster risk management (IFRC, 2014), strengthening disaster sensitive policies and measures, Indonesia still struggles with effectively implementation, especially on local government level (Georisk-Project, 2015). One reason is the lack of standardized data on susceptibility and geological hazard information, due to the low proficiency especially in local governments to apply standardized geological survey methods. But also awareness raising and public education remains a key task for the implementation of disaster risk management (Mathbor, 2007).

Both issues, the role of local governments and education has been stressed already in the (first) Framework for Action (HFA) in Hyogo (UNISDR, 2005). The renewed framework set up in Sendai (SFA) emphasizes again the importance of these elements for successful disaster risk reduction and resilience building (UNISDR, 2014). In order to be able to deliver good public services for disaster mitigation for the population, data availability is a basic need, and for a proper data survey capable technicians and common methodologies are indispensable. In order to create resilient communities, the role awareness raising and education needs to be taken out as a continuous task of the government.

BEST-PRACTICE EXAMPLES FROM INDONESIA

The administrative set up in Indonesia is helpful to overcome these issues. Having an insight to the geological sector, besides being mandated with data survey and analysis for geological hazards, Geological Public Agencies are also carrying a mandate in the field of professional technical training and education.

The Local Department for Mining and Energy (Local Geological Departments) are interacting with the community as they are having the task for socialization of geological hazards.
The Ministry of Energy and Mineral Resources has a subordinated resort for education, namely the Education and Training Center for Geology (Pusdiklat Geologi), which is responsible for the capacity building of public servants

from national and local governments in the field of geological hazards and disaster mitigation, among others.
This administrative setup can play an important role for the implementation of the Sendai Framework for Disaster Risk Management. On the one hand, these institutions are intermediary between public authorities and the community, by translating scientific information into easy to understand materials for school education. On the other side, the Training and Education Center for Geology is a mediator for knowledge from national to local governments.

One step towards disaster resilient communities is the generation and improvement of interlinked learning concepts and the promotion of best practices in the field of awareness raising and enhanced technical trainings.

The German Technical Cooperation has been and is still supporting two best practice samples for both topics:

Awareness Raising in Schools with the Geomobil
Technical Training for Landslide Surveying
The following sections give an overview of both activities, the role of public education, governmental responsibilities and its interlinkages.

Awareness Raising In Schools with the Geomobil

Aceh province is one of the very prone provinces in Indonesia to geological disasters and was one of the regions where the Tsunami 2004 hit worse. The analysis of the event showed, that the most effected social groups in that time were children and elderly (UNESCAP, 2012), which made clear that public awareness raising especially among these groups are an important governmental task to build disaster resilience.

Besides the local Geological Disaster Management offices, also the Department for Mining and Energy of Aceh (Distamben Aceh) has the task to socialize geological disaster mitigation and geological hazard information to government officials at the district, sub-district and village level. Besides that the socialization of such information to the general public is also stated as one of the task and functions of the geological department.

In line with the needs and the department’s task and function, the translation of scientific findings into easy to understand materials to creation an understanding about and awareness for the geological hazards has been implemented by means of a “Geomobil”. It specifically targets children in the region and is deployed by the geological section of the Distamben Aceh. The “Geomobil” consists of a specially equipped minibus that includes a small library, teaching materials, audiovisual equipment, games and tools for disaster simulations. A team of geologists educate in cooperation with the schools during regular class-hours. Children learn in a playful manner about the most important geological hazards in their region and practice personal safety and response drills. The activities include inside classroom lessons, experiments and outside activities.

Figure 18: Children reading in front of the Geomobil.

The majority of the schools visited are primary schools, which usually facilitate the event to all students. Since 2015, the Geomobil visits can also be requested by teachers and the schools directly via telephone.

Geomobil activities started in 2006 after the tsunami disaster in Aceh, and are one result of the collaboration between the Department for Mining and Energy of Aceh Province and the ManGeoNAD Project, implemented by the Federal Institute for Geosciences and Natural Resources (Germany) in the framework of the German Technical Cooperation. Since 2014 a new approach for the Geomobil has been supported, including the promotion of new media utilization during the education sessions. To assure economic sustainability and proper budgeting a business plan has been developed as well.

Results and Outlooks

The public perception and response to the Geomobil's activities is very positive, due to the interactive approach. Every student is able to get involved in a practical way based on their specific learning preferences and by using various teaching methods. The interactive approach, using simulation, drills and games helps to socialize information but targets also the improvement of preparedness for geological disasters. The success of Geomobil is also evident from the number of repeated requests from schools and individual teachers.

Since 2006, the Geomobil reached 56 schools in Aceh province and educated around more than 3000 children between the age of 7 and 15 (Pusat Data dan Informasi Distamben Aceh, 2016). With further funding the coverage could be enhanced. A business plan analyzing the current situation and future challenges with the help of a SWOT analysis shows that the Geomobil is an approach that is in line with the targets and needs of Aceh province (Georisk-Project, 2015). The findings of the business plan also indicate the benefit of further investments to promote additional funding for the Geomobil.

The transfer of this successful example to other regions could leverage national intentions to raise awareness and educate the public.

Figure 19: Earth Science Education and Earthquake Drill for Primary School

Technical Training for Landslide Surveying

Training to improve the technical capability to perform geological surveys and socialize knowledge for geological risk mitigation has been implemented by the Education and Training Center for Geology since 2009. Trainings specifically target national public servants and communities on various levels. Employees from local Disaster Management Offices, Police, Army, the Departments for Mining and Energy, but also volunteers for disaster preparedness participated in training courses in the past. The variety of the participants reflect the need for training in the field of disaster risk mitigation. All trainings in Pusdiklat Geologi consist of classroom sessions in combination with fieldwork training for practical experience.

The "Landslide Survey Training" for example consists of the following elements: During the classroom session the introduction to geological methods, basic soil sampling and landslide surveying is given. The participants learn about technical approaches to analyze landslide susceptibility theoretically. The second part consist of field work and training at a landslide site nearby. Usually experts from the local geological department are supporting the trainers in conducting this particular part of the training.

Figure 2. Training activities in the class and in the field

In addition, participants are encouraged to learn about mitigation measures of landslide through expert's presentation, role plays, and video presentations. Additional training materials like posters, and leaflet are given to the participants in the form of training kits to assist them in dispersing their newly acquainted knowledge to the broader society.

The standardized Landslide Survey Data Sheet (LSDS) is the basis for statistically sound susceptibility mapping techniques done by the Geological Survey of Indonesia (GAI) and therefore a tool contributing to the mitigation of landslide risk. Despite the fact, that Indonesia witnesses landslides on a very frequent basis in almost all provinces, the persisting lack of good quality data remains a challenge for such analysis. A chance to overcome the lack of expert personnel for landslide survey on national level is through the training of local authorities.

The German Technical Cooperation Project "Mitigation of Georisks", implemented by the Federal Institute for Geosciences and Natural Resources (Germany), supports Pusdiklat Geologi since 2015 in updating the Landslide Survey Training to the latest scientific advancements. As the landslide survey data of those trained participants feed into the national landslide database (LIDIA), harmonized registering is of utmost importance. Therefore the LIDIA database has been developed within the Georisk-Project (Balzer & Kuhn, 2013) implemented in Microsoft Access® and is run since 2011 by the GAI.

Results and Outlooks

To reflect didactical and scientific advancements, the content of the training and method of training has been improved throughout the years in a continuous effort to provide the best learning experience for participants. Nevertheless, approval processes of new curricula remain an enduring formal process.

A new training set up has been prepared, separating the previous training outline (Pusdiklat Geologi, 2012) into different courses, namely one course for beginners and one course for advanced participants (Pusdiklat Geologi, 2015a,b). Both training courses and their modules are structured sequentially, to ensure that the participant of the first course, benefit from the second course. This harmonization process results in a one week introductory beginner's course and a two week advanced course, with practical approaches to simulate realistic landslide surveying situations. A field trip to a landslide scene is obligatory for each course, in which the participants have to go through the whole LSDS, supervised by the trainer team and local experts.

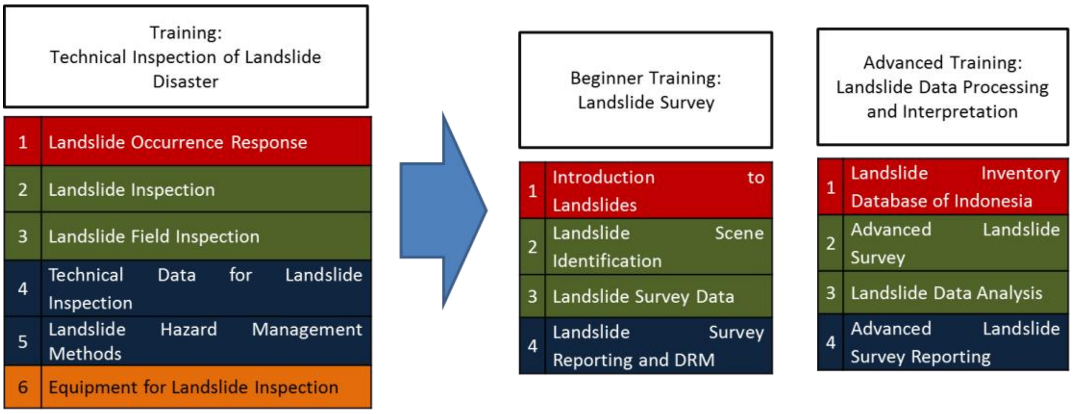

Figure 20: Change of Training Set Up for Landslide Survey in Pusdiklat Geologi (Georisk-Project).

For 2016 it is planned, that the LSDS that is promoted in the trainings will be available as an Android App to support the simple utility of the data entry form and to improve communication mechanisms between local authorities and the GAI who is managing the survey data in the LIDIA database.

CONCLUSIONS

Both best practices show the importance of education and training for different audiences and levels in enhancing disaster resilience in Indonesia.

On local level, the public authority is an important mediator between scientific hazard information and the general public, while awareness raising for pupils targets one specifically vulnerable group. The Geomobil is an effective tool in Aceh to achieve enhanced awareness and education. Nevertheless, the connection between the public education sector and the services of local authorities as mediator in the field of geological disaster information is still not recognized sufficiently.

On national level, the Education and Training Center for Geology is mandated to take out training in the field of geological topics subordinated to the Ministry of Energy and Mineral Resources. The institution plays an important role in transferring knowledge and implementing of methodologies for geological hazard assessment to the local level. This mandated function needs highest quality training setups. The given sample for the landslide training overhauling and updating shows the importance to understand the linkages between data quality from local surveyors, database integrity, and advanced landslide analysis. The fact, that Indonesia has mandated institutions for training of public servants is a great opportunity to implement instruments and methods in the field of disaster risk mitigation in a harmonized way.

The Geomobil is a positive example of proactive involvement of geological authorities in awareness raising, showing that higher professional knowledge transfer to communities is beneficial. It also shows how science can be transferred to kid friendly education material. A replication in other provinces of Indonesia or even the support through social media via an open learning system would be an interesting perspective for the future.

Nevertheless, constant commitment from all concerned parties and the government is necessary.

Figure 21: Education for DRR: The link between national and local capacities in the Geological Sector in Indonesia (Georisk-Project).

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DISASTER RECOVERY AND THE RESILIENCE NARRATIVE: WHERE IS VULNERABILITY?

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ABSTRACT

Disaster recovery has been a subject that has been under-researched compared to other areas in disaster research. There is growing literature on disaster resilience. However, there is lack of evidence and discussion on bringing resilience into recovery strategies. This paper aims to highlight the need for interlinakges between vulnerability and resilience in disaster recovery. Further, while mainstreaming resilience has been at the core of many debates, this paper highlights that many aspects of vulnerability needs to be discussed in aligning different activities and approaches during recovery.

Key words: disaster recovery; resilience; vulnerability

INTRODUCTION

Disaster recovery has been considered as one of the least studied aspects of disaster research (Raju 2013). Rubin (2009) noted the disappointing fact that recovery had lacked attention from researchers for over twenty years; and a similar observation was made by Smith and Wenger (2007). This may be attributed to the huge focus on post-disaster relief, which leaves little room for attention to long-term recovery, or at best, a fragmented approach (Lloyd-Jones 2006). However, at present "notions of recovery have evolved in ways that recognise the non-linear and often iterative character of recovery" (Tierney and Oliver-Smith, 2012: 126). There is growing scholarship in disaster resilience narratives. However, there is not much integration of vulnerability into this debate and more so in recovery settings. This paper is an attempt to highlight the need for an integral approach of vulnerability and resilience in disaster recovery.

Disaster Recovery

Recovery may be defined as "a differential process of restoring, rebuilding and reshaping the physical, social, economic and natural environment through pre-event planning and post event actions" (Smith and Wenger 2006: 237). This definition emphasises that recovery is a process shaped by several conditions occurring both before and after the disaster. It is worth saying that reducing vulnerability and addressing resilience needs to be a key focus in all recovery settings.

Vulnerability

According to Wisner et al (2014:15) "The characteristics of vulnerability have causes. These causes related to access to a wide variety of resources, and these causes are rooted in the workings of political, social, and economic structures in each particular society". "The root causes are embedded in development topics, with examples being limited livelihood options; restricted land use; external exploitation of people, places, and resources; and perpetuating poverty, lack of control, and oppression" (Kelman et al 2016). While the fact that disasters are not natural but a consequence of vulnerability is well established in literature (Hewitt 1983; Blaikie et al 2004); 'natural disasters' continues to be seen in many writings. There is much needed effort to further work towards addressing disasters as a serious concern in the light of vulnerability.

Resilience

Resilience has been defined in many different ways by scholars. It is a concept used in many disciplines such as ecology, psychology, engineering (see Mayena 2006; Alexander 2013). Many studies have explored resilience from a socio-ecological standpoint (Folke 2006; Berke 2007). Further, there is great attention paid to linakages between vulnerability; resilience and adaptation (Lei et al 2013). Although resilience has taken a new agenda on global platforms, many questions around its definition and measurements continue to be debated.

"The choices and processes of ensuring that society can deal with hazards and hazard drivers are usually termed 'building resilience' " (Kelman et al 2016). Resilience has been used vaguely in many instances (Strunz 2012). Many countries have been almost equating good evacuations measures to solving the resilience puzzle. For example, after the Orissa cyclone in India in 2014, the strong evacuation measures taken by the government resulted in no loss of life. While this is to be applauded, it is dangerous to measure resilience solely on having strong evacuation measures. This claimed resilience proved to be the reverse during the Chennai floods of 2015 in India. The massive urban floods raised serious concerns of the city's resilience to flooding (not to forget Chennai was severely affected the tsunami of 2004). It is worth noting one of the weakness of resilience highlighted as "resilience—whether derived from natural (ecosystem) or technological (physics or engineering) usage - is dangerous because it is removing the inherently power-related connotation of vulnerability and is capable of doing the same to the process of adaptation" (Cannon and Muller-Mahn 2010:623).

DISCUSSION

The Concepts

Lindell (2013:813) argues that social vulnerability has come a long way in disaster literature and identifies three premises- (a.) "systematic variations in people's hazard exposure"; (b.) "systematic variations in people's vulnerability based on the quality of the structures in which they live and work"; (c.) "systematic variations in the social impacts". While there is not only a danger of using vulnerability and resilience as opposites, researchers also seem to miss the point of a nuanced understanding of the various elements of the two concepts (Cutter 2016). In this regard, it is certainly a continuous process of defining and redefining these concepts. However, as Wisner et al (2014) argue, this is not a mere definition game.

"While resilience and vulnerability have some converse characteristics, they are not necessarily exact opposites since aspects of both can exist simultaneously." (Kelman et al 2015). However, we see many times in daily life these concepts being used as opposites. It has been argued that "the concept of vulnerability involves a clear, economically and politically induced condition that theorises the way that people are exposed to a lesser or greater degree of risk" (Cannon and Muller-Mahn 2010:632). The danger with the complete shift in narrative from vulnerability to resilience is ignoring these aspects of power; cultural dynamics of society and structures of inequality that have been built over long periods of time.

Integration

With regard to vulnerability and resilience, there tends to be a "mutually exclusive analyses" (Collins 2013). There are clear linkages between the two. However, the majority of the work in this field tends to disregard the other. While a lot of focus on vulnerability has been shifting to resilience, the questions around vulnerability remain unanswered. The need for vulnerability research continues to be as important as before (since decades) and so is the need to advocate for building community resilience.

There is immense literature calling for integration of climate change issues with disaster risk reduction. In other words, to bring these fields more close- debates around vulnerability and resilience need to synthesize. There is a growing trend and a widening gap in setting up two camps of academia and practice (one that is focused on keeping the two fields of DRR and CCA separate and the other of keeping vulnerability out of the resilience debate). While one can argue the political nature of such developments given the global agenda on climate, international frameworks such as the Sendai framework for DRR will have no impact without a synergized approach. Resilience is seen a key in the SFDRR and the sustainable development goals. However as Cutter (2016:112) notes, we are obligated to answer the "question of resilience to what, but more importantly, resilience for whom".

While it has been argued disaster recovery is a time to address vulnerability, one can clearly see a pattern of neglect to build sustainable institutions (Raju 2013). However what we see is a trend of building parallel institutions to address different sides of the same coin (Becker et al 2013). There is a growing need to address issues of disaster recovery governance (Djalante 2012; Renn 2008; Fung 2006; Ikeda et al. 2008; IGRP 2010). Governance is not the same as government (Jordan 2008; Lemos and Agarwal 2006) as it encompasses all stakeholders and should "cover the whole range of institutions and relationships" (Pierre and Peters 2000: 1). Disaster recovery as referred to many as a window of opportunity is surely a time to integrate approaches addressing vulnerability and resilience.

"Every post-disaster recovery manifests tension between speed and deliberation" (Olshansky 2006: 148). For example, post-tsunami reports suggested that affected communities measured speed by the time it took to construct permanent housing. Along with speed, it is essential to bring all stakeholders on board and address issues of holistic planning, interdependencies, community participation, goals of different stakeholders (starting with the community) and other related factors. This may create the tension that Olshansky (ibid.) refers to. Further, vulnerability, resilience and recovery are all social processes. Social processes take immense amount of time to address. This needs to be done with the long-run perspective.

Stakeholders

There are growing numbers of stakeholders in the field of disaster risk management and climate change adaptation. This increase in the number of stakeholders and the change in stakeholder backgrounds arguably have important repercussions on efficient actions in disaster settings (Telford and Cosgrave 2007). Interaction between stakeholders in disaster situations raises questions of power, jurisdictions, interdependence and accountability (Raju and Van Niekerk 2013). As Quarentelli points out 'government and private groups may have different interests, tasks and goals' (Quarentelli 1997:48). Similarly different stakeholders have different mandates during recovery- which prioritizes different themes. Currently, we see a vast expansion of not only literature but also a growing number of resilience programs. This is in the positive direction only if 'addressing vulnerability' continues to remain as a theme at the heart of these programs. A key disaster recovery principle involves taking a comprehensive integrated approach, and giving importance to stakeholder participation in the process (Smith 2004; Duxbury and Dickinson 2007). This integration is incomplete today without bringing resilience and vulnerability together.

CONCLUSION

While 'vulnerability' has been a major focus of disaster research over a few decades- many questions around this theme continue to linger. Further, it is time to rethink the role of 'resilience' in disaster recovery debates and approaches around the world given its increasing attention. Disaster recovery, as discussed by Tierney and Oliver-Smith (2012) needs more research to theorize. There is a growing concern for disaster recovery in terms of theory-building and it is crucial to highlight the need for vulnerability to be at the centre stage along with resilience. This cannot be done with varied stakeholders continuing to work separately or in parallel. However, given political and organizational mandates, one needs to arrive at common ground in addressing these concerns. It is also important to remember that a universal approach (one solution to all problems) is not the way forward. The need for Contextual analysis and the ability to tailor-make approaches to local contexts is far more important in building resilience.

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BUILDING BACK BETTER IN HAIYAN-AFFECTED AREAS IN LEYTE ISLAND, PHILIPPINES

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ABSTRACT

In November 2013, tropical cyclone Haiyan brought about record high wind speeds that destroyed 550,928 houses and severely damaged over half a million others in the Philippines. Among the hardest hit areas was Tacloban City and nearby municipalities, in the island of Leyte, Central Philippines. With the ongoing recovery and rehabilitation comes the reconstruction of damaged residences. This paper investigates the post-disaster reconstruction of houses in the area, whether or not the concept of building back better was considered, and what factors affect the people's decision to do so. One hundred six households were surveyed. Results show that building back better is not widely practiced in the area. Higher income groups have more propensity to reconstruction their houses better while lower income groups are limited to do so because of cost implications and because of lack of access to the know-hows of reconstruction. Interventions could be done by providing aid in the procurement of materials and training in how to make buildings resilient for lower to lower-middle income households.

key words: building back better, Haiyan, post-disaster reconstruction, severe winds

INTRODUCTION

On November 8, 2013, Typhoon Haiyan (Yolanda), a category 5 hurricane according to the Saffir-Simpson Hurricane Wind Scale, made landfall on the Philippines. In what was one of the most powerful storms ever recorded, the country was forced into a national state of calamity. Widespread death and destruction, as well as untold amounts of damage were brought down upon the country, especially in the seven most affected provinces: Samar, Leyte, Capiz, Aklan, Cebu, Iloilo, and Palawan. The typhoon affected 9 of the 17 administrative regions of the country, covering 12,122 barangays in 44 provinces, 591 municipalities, and 57 cities.

Typhoon Haiyan's massive trail of destruction left 179,823 houses totally damaged, with another 167,180 partially damaged in the province of Leyte alone, and more than 1 million nationwide (National Disaster Risk Reduction and Management Council, 2014). The super typhoon destroyed billions in infrastructure and local housing. All types of structures were destroyed as the immense force of the winds disintegrated even concrete houses. Most structural damage occurred in the roofing, as it is the component that is most vulnerable to strong wind forces. During Haiyan, corrugated galvanized iron roofing sheets were either torn or pulled out from the roof framing. In almost all houses that were not totally destroyed by Haiyan, it was its roofing system that suffered most damage.

An estimated PhP571.1 billion in total damages and losses were incurred as a result of the calamity (National Disaster Risk Reduction and Management Council, 2014). The total property damage in the entire country reached close to PhP90 billion. As a direct result of the economic damage brought about by Haiyan, an additional 2.3 million people were plunged below the poverty line, causing an increase in the poverty rate from 41.2 percent to around 55.7 percent in the areas worst affected. Nearly a million families were left homeless in the aftermath of Haiyan, as their houses were either blown away by the incredibly strong winds or washed away by the colossal storm surge. Millions of residents were displaced by the typhoon, including those who lost their homes and livelihoods.

It was not the first time a cyclone of similar intensity hit the area. On November 5, 1991, Tropical Storm Thelma (local name Uring) hit the province, along with other areas in eastern Visayas. In its wake, widespread damage and casualties of at least 5,000 people and another 3,000 others missing and presumed dead (Pearson & Oliver, 1992).

"Build Back Better" is a phrase that is now commonly used to refer to the principle of proper reconstruction following disasters (Mannakkara & Wilkinson, 2014). The phrase emerged during the recovery efforts following the Indian Ocean Tsunami in 2004. The phrase leaves room for many interpretations, however, former U.S. President Bill Clinton proposed 10 ways in his report to the UN Secretary-General's office. According to the report, the "Build Back Better" concept encourages reconstruction that reduces vulnerability and improves living conditions, while also promoting a more effective reconstruction process. The "Build Back Better" principle serves as the guiding framework in the development and implementation of rehabilitation and recovery interventions by the Office of Presidential Assistant for Rehabilitation and Recovery (OPARR) and is also the ultimate goal of post-disaster reconstruction (National Disaster Risk Reduction and Management Council, 2014).

This research aims to analyse the reconstruction practices in Haiyan-affected areas of the Leyte province, to check if these efforts are done considering the build back better principle, and to infer on the factors that influence the people's decision to do so.

The study provides insights for the government to address the factors that hinder people from building back better. It is also significant in the sense that it may be utilized to assess the vulnerability of a community or an individual household by knowing how it is built; know where to improve, determine points of weaknesses and determine high-risk areas.

The respondents come from 3 cities and municipalities in Leyte, covering 7 barangays. The documentation of reconstruction practices focuses on the perceived improvements on four wind-sensitive components (Li, Ahuja, & Padgett, 2012; Merritt et al., 2001; Rosowsky, 2011) of a house: the roof, roof framing, walls, and the doors and windows. Changes in 2 characteristics of the house were also documented: the roof inclination/configuration, and the floor elevation. Most of the respondents of this research belong to the low income socio-economic group, hence, the variation for reconstruction practices increases, and the presence of more unorthodox practices can be observed. The results of this research relate the reconstruction practices in relation to poverty and location.

METHODOLOGY

Survey-interviews were conducted with 106 residents from seven barangays in Tacloban City and the municipalities of Palo and Tanauan in the province of Leyte regarding the reconstruction practices they undertook in the aftermath of Typhoon Haiyan. The study is limited to those who rebuilt their houses in the same area where their houses stood before the cyclone.

In the survey, the respondents were asked about the improvements that they made to four components and two characteristics of their respective houses, namely: roof, roof framing, walls, doors and windows, roof inclination or configuration, and floor elevation, respectively. They are also asked if they perceive their respective reconstructed houses to be safer as compared to their previous ones that were partially or totally damaged by Haiyan.

Trends in reconstruction practices were determined by the frequency of responses. The trends are grouped by component, and then grouped by the two (2) factors that influence them: location and socio-economic status. The evaluation of the adequacy of the reconstruction practices will be done through the use of existing manuals and guidelines for reconstruction. Aside from obtaining the frequency and mode of the responses, no other statistical tests will be done on the data.

RESULTS

There were 106 respondents: 6% of which are high-income households, 22% are middle income households and 72% are low-income households. The average age of houses from the time of initial construction up to when Haiyan hit the area is 19 years.

Almost 69% of the total respondents' respective houses were completely destroyed as a result of the immense winds of Typhoon Haiyan. For the other houses that were not completely destroyed, 100% incurred damage on the roof, 84.85% on the roof framing, 63.64% on the walls, and 75.76% on the doors and windows. No respondent house was left undamaged.

32% of the respondents believe that their reconstructed house is stronger and safer compared to the ones they had before the cyclone. Interventions done on the roof, roof framing, walls, and the doors and windows, and other measures are herein discussed.

Roofing

Of the houses surveyed, 61.32% had improvements on their roofing, while the remaining 38.68% either showed no improvements or worse, have been degraded into makeshift materials. All high-income houses had their roofs improved, as opposed to middle and low income houses, with 54.17% and 36.84% not showing improvements, respectively.

Of these, 42.45% have improved their roof sheathing by using a thicker grade corrugated GI sheets than before, or by upgrading from nipa (thatch roof) to CGI sheets. Other upgrades observed include conversion into concrete roofing, shortening of eaves, and addition of ceiling. The thicker CGI sheets were mostly donations from aid organizations.

Some 25.47% of houses have the roof sheathing connections improved by closely spacing the roof nails. In high-income houses, wood nails and cyclone washers were observed. Among low-income houses, other remedies to keep the roof from being blown such as tying the roof using ropes and putting weights over were observed.

In terms of the roof framing, less than half (43.40%) showed improvement. 23.58% used stronger materials for the roof truss, mostly from raw bamboo to treated coco lumber. One in five houses had their roof truss design strengthened by the addition of truss members. This is observed in 33.33% of high-income houses, 29.17% of middle-income houses, and 17.11% of low-income houses. The use of steel braces was also observed in 4% of the low-income houses. The prevalence of the use of coco lumber is primarily due to the increase in the supply due to the multitude of fallen coconut trees in the aftermath of the cyclone.

Walls

Only 22.64% of the houses had improvements on the walls. The concrete and CHB constituting the walls of most high-income and middle-income houses remained intact; hence, none of the high-income houses had their walls improved and only 30% of the middle-income houses had wall improvements. The improvement is usually a shift from the use of light materials such as plywood or bamboo matting to CHB, whether in part or in full. It is also interesting to note that among low-income houses, around 30% have resorted to using scrap materials and making makeshift walls.

Doors and Windows

Around 37.74% retained their partially damaged old windows and doors or have replaced them with the same window or door as the previous ones they used. Only 13.21% had the window and door material upgraded. Less than 1% use storm shutters on windows to prevent breakages during a cyclone. Further, 48.11% of houses now use makeshift windows and doors, such as old GI sheets, tarpaulin material or worn plywood. A bulk of these come from low-income houses, 61.84% of which resorted to such practice due to the high cost of procuring new windows and doors.

Other Remedies

18.87% raised their floors at an average of 6” to 1ft. in order to prevent floodwater from getting in to the house. Many have also reconfigured their roofs. Two high-income houses have upsized their columns in order to resist a bigger load.

Disparity among socioeconomic classes

There is a big distinction between the reconstruction practices of the different socio-economic classes. Those that belong to the low-income group lag behind in terms of building back better. Although there are many improvements in different components when it comes to the low-income houses, what they have improved to is often what the other socio-economic classes improved from. An example would be switching from bamboo to coco lumber as roof framing. While the coco lumber can be seen as an improvement by the low-income group, such practice has been abandoned by some of the members of the high-income group in favor of a harder species of wood or steel.

For the high-income group, all respondents either made improvements, or restored components to the same quality as previously. No one in the high-income group reconstructed components of decreased quality. The middle-income group does have respondents that made no improvements in the various components of their house, however, the number of respondents that stated that a component in their house is makeshift is kept at a minimum – the most is 2 for the roof framing. Their reconstructed components are either of the same quality or of a decreased quality, although permanent. It can also be seen from the data that there is a large number of respondents that used to live in nipa huts when the typhoon passed. This is proven by the number of respondents who have upgraded their roofing material from nipa to corrugated galvanized iron sheets. These CGI sheets are often donations by charitable institutions. Focusing on the frequency of those who answered 'No Improvements' in the low-income group, it can easily be seen that the majority of those who did not make any improvements in their house from that socio-economic class built makeshift houses or installed makeshift components. It can also be seen that the low-income group employ unsophisticated practices like tying the roof to other parts of the house and tying PET bottles filled with water to weigh the roof down. Most of the materials that they use to reconstruct the damaged components are either donations or scrap materials.

Findings are consistent with observations in previous disasters: that socio-economic status is a determinant to the ability to build back better (Anderson, 2000; Blaikie, Cannon, Davis, & Wisner, 2014; Cardona et al., 2012; Hughey, Bell, & Chatman, 2011; Mannakkara & Wilkinson, 2014; Matsumaru, 2015; Saldaña-Zorilla, 2007). This is due to two things: inability to purchase good quality and appropriate materials and lack of access to information on proper reconstruction. Members of the lower income classes need to be supported, otherwise they will continually be stuck in cycle of building and rebuilding after disasters.

CONCLUSION AND FUTURE WORKS

There is still a long way in the furtherance of building back better in the study area. This is impeded primarily by the lack of resources to buy stronger and more appropriate materials. As such, the ability to build back better is associated with the socioeconomic status of the house owner. To address this, aid must be accorded to people who have financial difficulties, particularly the lower and lower-middle income groups.

There is also lack in the knowledge on how to reconstruct a house stronger. This is evidenced by some unsoundly designed house components and practices that could do more harm than good. Trainings must be given to community-based builders and recommended designs and specifications should be published.

Finally, among those that practiced building back better, the efforts are concentrated on making the roofs stronger, as this was the most heavily affected component by the cyclone. Less effort was put into walls. Windows and doors were accorded last as evidenced by the makeshift windows and doors observed during the survey.

Future works may include expanding the survey to include other Haiyan-affect areas including those primarily damaged by storm surges. The study can also go into investing how much it would cost for the houses to comply with the code and how much more is necessary to make them withstand Haiyan-scale cyclones.

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THE ROLE OF ACCOUNTABILITY WITHIN DISASTER RISK GOVERNANCE

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ABSTRACT

During the decade that followed the adoption of the Hyogo Framework for Action in 2005, calls for greater public, private and civic accountability to reduce risk and vulnerability became increasingly vocal. It also provded guidance to the focal point on Disaster Risk Reduction at the central government level on how to improve leadership in risk governance, transparency, sharing of risk information, stakeholder participation and public awareness and encouraging and action on stakeholder feedback.

Accountability in disaster risk reduction is intended to enable scrutiny and understanding of actions taken at different levels, and of those responsible for such actions. Article 19(e) of the Sendai Framework articulates the principle that disaster risk reduction depends on coordination mechanisms within and across sectors, full engagement and clear responsibilities of all State institutions and stakeholders, to ensure mutual accountability.

In contributing to this agenda, a workshop on "Ensuring Accountability in Disaster Risk Management and Reconstruction" was organised as a part of a global, regional and national partnership. This workshop and the subsequent policy dialogue had the participation of disaster risk management experts and state and non-state stakeholders to deliberate on and develop a possible framework for social accountability to be considered for inclusion in a national disaster management plan.

BACKGROUND

Natural disasters are becoming more frequent and more devastating in almost all parts of the world. UN Secretary-General Ban Ki-moon warned that "growing global inequality, increasing exposure to natural hazards, rapid urbanization and the overconsumption of energy and natural resources threaten to drive risk to dangerous and unpredictable levels with systemic global impacts." (UN, 2015). The 2015 Global Assessment Report on Disaster Risk Reduction (GAR15) states that economic losses from disasters are now reaching an average of US$250 billion to US$300 billion annually (GAR15, 2015). GAR15 estimates that an investment of US$6 billion annually in disaster risk management would result in avoided losses of US$360 billion over the next 15 years. The report states that this US$6 billion is just 0.1% of total forecast expenditure of US$6 trillion annually on ew infrastructure.

This situation calls for better disaster preparedness and greater readiness to minimize adverse impacts of disasters. Once a disaster strikes, the prudent management of its aftermath can facilitate quicker recovery and restoration of normal life for the affected individuals and communities. Yet, all these depend on the actions of many stakeholders such as governments, various state institutions, national and international non-governmental organizations, private businesses and community groups. On the other hand, actual outcomes of various interventions depend on a range of factors such as resources, planning, coordination, quality control and monitoring. So, the life chances of potential and actual disaster victims depend on the performance of a whole range of institutions.

An important question that arises is how we could optimize performance of key stakeholders. In this regard, institutionalizing effective accountability mechanisms appears to be a one key ways to move forward. The accountability mechanisms are supposed to play a key role in different phases of disaster management cycle: response, recovery, rehabilitation, reconstruction, prevention, mitigation and preparedness. The absence of such mechanisms will reduce the effectiveness of interventions in many situations.

As is well known, accountability is an integral aspect of good governance. Yet, in many countries accountability rarely goes beyond financial accountability. While financial accountability is important to eliminate corruption and wastage of public resources, and ensure that benefits reach the intended target groups, the measures of financial accountability do not go far enough to ensure the satisfaction of the needs of disaster victims, both potential and actual. Some critics claim that the failure of accountability in collaborative working (collaborative accountability) is caused by the lack of communication. Others have stated that accountability cannot meet the criteria that have been set such as vertical and horizontal accountability and social accountability to the victims and civil society organizations (Taylor, et. al., 2014). It is this reality that calls for an enlargement of the scope of accountability to include the concerns of the beneficiaries. In general, what is necessary is develop bottom up accountability tools in order to measure the actual impact of external interventions in terms of their outcomes on the ground.

Any investigation of the outcomes of external interventions following a disaster will reveal the nature and extent of recovery in terms of relief, resettlement, livelihood, community building, and access to services, etc. According to Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015), it is also important to look at related accountability issues within the pre-disaster phase as there is more emphasis now on disaster risk reduction, and what we could do to prevent disasters and/ or to minimize losses.

Many shortcomings that may be present might have been avoided if there were effective accountability mechanisms built into the intervention program. Moreover, a comprehensive social audit following the implementation of an intervention program could help rectify weaknesses of an intervention provided such a mechanism was built into the disaster management plan of a government or any other institution.

ACCOUNTABILITY AND ITS RELEVANCE IN DISASTER RISK REDUCTION

As the growing literature on the subject indicates, the relevance of accountability in DRR is increasingly recognized by both researchers and practitioners. In fact, accountability is perceived and observed as an important governance mechanism to minimize disaster risks.

Accountability, rather than being a bureaucratic or legal term, is about improving democratic processes, challenging power and claiming citizenship. It is best claimed from below by citizens themselves, rather than only being provided by the state. Supporting citizen-led initiatives is important as they address accountability failures in very direct ways (Mahendra, 2007). Accountability in terms of Disaster risk reduction is more social than political. Ensuring social accountability can address the disaster risk management in many ways than it does with political accountability. When the social accountability is present, as stressed by Polac, Luna & Bercilla (2010), it ensures that citizens keep an eye on the process of governance persuading governments to fulfil its obligations.

As they further stressed, "accountability in emergency contexts has advanced, with a number of significant initiatives to develop voluntary and legally binding standards and mechanisms to improve transparency and accountability of humanitarian agencies and States operating at all levels. These have improved the tools available to civil society in times of disasters. Developing an approach to accountability in DRM as a whole has been a challenge, with a lack of a legally binding international agreements and the high initial costs to governments of investing in risk reduction, but also those associated with tackling widespread underlying vulnerability to disasters."

It is significant that the Sendai Framework (UNISDR, 2015) highlights the importance of identifying and addressing policy gaps, reducing exposure and vulnerability and in so doing, minimizing the risk of economic, social and human failures and the costly losses for countries and humanity that these involve. As highlighted in the Sendai Framework, ensuring clear accountability and transparency, and avoiding the creation of new and unnecessary risks will help open opportunities for a safer and more resilient future. Further it emphasizes the importance of accountability frameworks that transcend central government, relevant national and local authorities, as well as different sectors and stakeholders. The enhancement of clarity in responsibility, accountability and monitoring of implementation will benefit from moving from a framework based on concepts and activities, to one structured around specific and strategic public policies, which can be complemented by stakeholders' commitment (Bahadur, 2014).

POLICY RELEVANCE

The year 2015 presented an unparalleled opportunity to align landmark UN agreements through the convergence of three global policy frameworks: Sendai Framework for Disaster Risk Reduction (March 2015), The Sustainable Development Goals (September 2015; SDGs) and the Climate Change Agreement (December 2015: COP21).

The Sendai Framework (UNISDR, 2015) emphasizes the pivotal role of the states in ensuring the development and implementation of evidence based policies. It highlights the need for an improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics with a view of strengthening disaster risk governance. States also have reiterated the commitment to address disaster risk reduction and the building of resilience to disasters with a renewed sense of urgency within the context of sustainable development.

To put this into action, in terms of the Sendai Framework, it requires integrating both DRR and the building of resilience in to planning, plans, programmes and budgets at all levels. DRR is a cost effective instrument in preventing future losses. Eventually, effective DRM contributes to sustainable development. This is particularly important in developing countries where financial and other resources are of limited supply and they are disproportionately affected by disasters.

It is important to anticipate, plan for and reduce disaster risk in order to effectively protect persons, communities and countries, the livelihoods, health, cultural heritage, socio-economic assets and eco system, and to strengthen overall resilience of societies and communities.

As is widely acknowledged, unplanned urbanization, poor land management, weak institutional arrangements, non-risk informed policies, lack of regulations and incentives for private disaster risk reduction investment, limited availability of technology, unsustainable use of natural resources have raised the vulnerability to disasters and disaster risk. In order to address these issues, strengthening of good governance is key. In this regard, some DRR strategies, a build back better policy, a more people cantered preventive approach to disaster risk (Multi hazard, multi sectorial) can be followed.

The overall aim of the Sendai Framework is sustainable reduction in disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of person, business communities and countries. On the other hand, the realization of the outcome requires strong commitment and involvement of political leadership in every country at all levels in the implementation and follow up of the present framework, and the creation of the necessary condition and enabling environment.

In other words, the states have the overall responsibility to reduce disaster risk, but it is a shared responsibility involving governments and many other stakeholders. This however, cannot be a simple moral responsibility but a statutory obligation. The stakeholders having responsibilities in DRR have to be made accountable to citizens and communities that they serve.

Disasters continue to undermine efforts to achieve sustainable development. UN initiatives in sustainable development call for disaster risk reduction and building resilience to disasters to be addressed with a renewed sense of urgency. The Sustainable Development Goals (SDGs) (Sustainable development knowledge platform,2016), are an intergovernmental set of aspiration Goals with 169 targets, which set out quantitative objectives across the social, economic, and environmental dimensions of sustainable development—all to be achieved by 2030. The goals provide a framework for shared action "for people, planet and prosperity," to be implemented by "all countries and all stakeholders, acting in collaborative partnership."

To reduce disaster risk; assessing and understanding DR, sharing information, strengthening disaster risk governance and coordination across relevant institutions and sectors and the full and meaningful participation of relevant stakeholders at appropriate levels are important. These objectives are re-affirmed under Goal 11 of the SDGs - Make cities and human settlements inclusive, safe, resilient and sustainable. Making cities safe and sustainable means ensuring access to safe and affordable housing, and upgrading slum settlements. It also involves investment in public transport, creating green public spaces, and improving urban planning and management in a way that is both participatory and inclusive.

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C. Within the context of transparency and global stocktake, Governments agreed to track progress towards the long-term goal through a robust transparency and accountability system.

METHODOLOGY

Experience of researchers as well as practitioners in the field of Disaster

Risk Reduction and Reconstruction has pointed to the need for developing, validating and institutionalising social accountability mechanisms and tools as part of intervention programs of both governmental and non-governmental organisations. This could be done more effectively if the relevant authorities develop appropriate policies regarding accountability. Accordingly, an international workshop and a policy dialogue was organised in December 2015 in Colombo with the participation of disaster risk management experts and state and non-state stakeholders to deliberate on and develop a possible framework for social accountability to be considered for inclusion in a national disaster management plan. There were 38 invited experts representing a cross section of important stakeholders attended the workshop and the composition of the workshop participants included academics, UN (e.g. UNISDR and UNDP) representatives, NGO representatives (e.g.Red Cross), Dept. of Meteorology, National Building Research Organization, National Water Supply and Drainage Board, and Ministry of Disaster Management. 10 selected papers were presented under two thematic sessions : Accountability of government and other institutions for their conduct , performances in preventing and managing disasters and accountability in the built environment after major disasters, and Contextual and cultural appropriateness of the accountability tools , tools of accountability and access to information and Role of the organised and capable citizen groups in establishing social accountability.

The workshop was focused on key aspects of accountability, but was not entirely on the government but looked at other stakeholders and a wide range of DRR settings. It is hoped that incorporating social accountability into disaster management would improve significantly the outcomes of external interventions leading to an improvement of life chances and quality of life of potential and actual victims of disasters. it culminated on the theme with a view to determine the scope of accountability in DRR within a public policy framework.

The 10 Papers presented dealt with the following empirical issues in the context of social accountability in disaster management.

The role of government agencies, NGOs and public/citizen groups in pre and post disaster situations.
The possibilities of developing culturally and politically suitable strategies and programmes to promote the institutionalisation of social accountability in disaster management with reference to disasters such as tsunami, floods, landslides, cyclones, etc.
The role of accountability in facilitating collaboration among the government agencies, civil society organizations, NGOs from being passive recipient of relief to active partners in Disaster Risk Reduction (DRR)

To understand the accountability tools that can be used to monitor the disaster management priorities, implementation of policies and programmes and the outcomes.
Mapping of institutional responsibilities and tasks in disaster mitigation and prevention.
Developing social accountability tools that can be used to measure the impact of DRR interventions in the context of built environment

The panel discussion that too was held as part of the workshop was expected to come up with evidence-based recommendations as to how effective accountability mechanisms could be built into intervention programs in different but interrelated fields. Panelists were expected to approach the issue from the point of the organisations they represent and the subject areas that come under their purview. Particular attention needs to be paid to specific accountability tools that might be developed and institutionalised, and their contextual and cultural appropriateness. Panel discussion provided a basis for the formulation of a draft policy outline and a set of accountability tools dealing with both prevention and management of disasters. An underlying assumption has been that incorporating social accountability into disaster risk reduction and management will improve significantly the outcomes of external interventions leading to an improvement of life chances and quality of life of potential and actual victims of disasters.

DISCUSSION

One of the most important lessons has been the lack of accountability on the part of many state and non-state institutions and agencies involved in the above processes. Major findings to emerge from the papers presented and from the policy dialogue were summarises by means of a policy brief (Haigh et al, 2016). Following are key highlights arising from the workshop (adapted from Haigh et al, 2016) :

What is accountability?

Obviously, it is an integral aspect of good governance. But what is important to emphasise here is that accountability has several important dimensions, namely, financial, legal and social. Given the increasing significance of DRR today, accountability needs to be defined in broader rather than narrower terms in order to ensure that state and non-state actors live up to public expectations with regard to vulnerability reduction and preparedness improvement at all stages of disaster management.

Disaster cycle and accountability

Disaster risk reduction is a long term process covering pre-, during and post disaster situations. So, accountability issues are also related to all three periods. In other words, accountability in DRR begins before a disaster occurs. The same applies equally to the other two stages.

Better governance of mitigatory processes

The lived experience of disaster victims and the findings of researchers who conduct assessments of recovery processes point to the fact that better governance of mitigatory processes including pre-disaster risk assessments and risk reduction measures can not only save many lives but also reduce or minimise losses in economic, social and psychological terms.

Institutions and authorities that can be held accountable

How to identify and define preventable adverse impacts? This naturally is a vast and complex area for study, as the likely impacts can vary widely depending on a whole range of factors such as the nature and scale of disasters and social, political, economic and spatial context. So what is equally important is to identify the institutions and authorities that can be held accountable. This also needs to be carefully examined in order to apportion responsibility, both legally and morally, for various aspects of DRR. This includes establishing a clear understanding of the state's legal and moral obligations and capacity to deliver all components of Sendai Framework.

Stakeholder involvement

However, accountability for risk reduction is an obligation on the part of many stakeholders from central government downwards and include state institutions, business organisations, various professional groups, local government, media institutions and civil society organizations. Availability and accessibility of data and timely information can create an enabling environment to promote accountability on the part of many actors.

Joint responsibilities and collaboration

Given the diversity of potential actors and institutions involved in DRR, accountability is often a joint responsibility. In the case of slow onset disasters like sea level rise and pollution, scientific data can be critical for planning but sharing of such information is not common. Collaboration between actors, including effective communication mechanisms, is vital. An accountability systems approach, emphasises the need to move beyond a narrow focus on supply-side versus demand-side accountability support, or a focus only on formal institutions, and instead to look more closely at the linkages among actors and how these can be strengthened over time.

Lack of accountability

The lack of accountability on the part of governments, state institutions and public officials, as well as diverse private sector stakeholders, tends to magnify material and human costs of disasters. While it is necessary to find effective ways to ensure accountability, these may include both penalties as well as incentives. Accountability is not about pinning responsibility on one centralised body like a national disaster management agency but enlisting multiple actors to take responsibility, both individually and collectively. It is important to ensure that their failure to do so is not inconsequential, in terms of both penalties and rewards.

Regulatory bodies

The role of regulatory bodies, in particular those relating to coastal resources, human settlement, construction and social and physical infrastructure, is critically important to ensure accountability on the part of many stakeholders such as land developers, industrialists, construction firms and state institutions.

Characteristics of the community and enabling environment

It is important identify the characteristics of the community and characteristics of the enabling environment, including how to encourage broad-based participation, strengthening the political involvement of citizens in decision-making processes, and in mechanisms for legitimacy and control. There is also a need to strengthen downward accountability by supporting feedback channels from the community and civil society to subnational and even national government to articulate local needs and preferences.

Supporting infrastructure

There is a need to support citizens, particularly those most vulnerable to disasters, to understand relevant rights, policies and possible accountability pathways. This includes citizen involvement in monitoring DRR progress based on locally conceived priorities at every scale, including policy formulation and implementation.

Monitoring

Monitoring processes are needed. This includes the need to provide indicators, providing clarity on components of monitoring, focusing on data management, improving systems to track and gauge disaster risk.

CONCLUSION

The role of relevant public, private and civil society organization in DRR cannot be overemphasized. Their contributions encompass the entire process of disaster mitigation commencing from pre disaster situations to post disaster intervention. Though various institutions, groups and stakeholders have played a vital role in disaster mitigation, in many situations, there had been no sense of accountability for their actions and inactions. On the other hand, a sense of accountability on the part of various stakeholders can be critically important to ensure that they can be held accountable for their actions and inactions that have direct bearing on

DRR. Strong accountability mechanisms will lead to better planning and budgeting, and better coordination. They can also lead to more effective political oversight and greater assurance that relief and recovery efforts will continue until recovery is fully achieved.

The development of policies, norms, rules and regulations, standards and tools reacting to DRR is critically important to prepare a sound institutional basis for institutionalizing accountability processes. Accordingly, accountability systems and effective rules concerning stakeholders' responsibilities and opportunities for engagement are necessary. Ultimately, sound accountability mechanisms can only be rooted in a strong acceptance of personal responsibility and commitment to behavioural change. In this regard, the governments at all levels have a major responsibility. But, other stakeholders need to fit into a wider accountability framework. Since they cannot be left to voluntary action it is necessary to lay a normative and legal foundation through legislation.

Many countries emphasized that regulation and law at the national level can essentially set out an accountability framework for DRR which led to the strong positioning of accountability within Sendai Framework. During the consultations and negotiations that led to its finalisation, strong calls were also made to develop practical guidance to support implementation, ensure engagement and ownership of action by all stakeholders, and strengthen accountability in disaster risk reduction - 'Words into Action'. This provides a way forward in implementing sound accountability principles within the DRR context.

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LOCAL GOVERNMENTS AND DISASTER RISK REDUCTION: A CONCEPTUAL FRAMEWORK

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ABSTRACT

A conceptual framework visually illustrates the linked concepts of a broader research. Hence, it is considered to be a key part of the research design. Therefore, developing a conceptual framework is an important aspect of the research process and guides the researcher in the data collection and analysis. The paper elaborates the conceptual framework of a research study aimed at making recommendations to empower local governments in making disaster resilient built environment within cities. The conceptual framework was developed based on literature review and further refined based on expert opinions. Through the literature review it was able to identify the key concepts for research and these were further refined through the opinions of experts. The key concepts identified are: increased disaster risk in cities; the need for disaster resilient cities; the role of stakeholders in making disaster resilient cities; the role and challenges for local governments in creating disaster resilient cities; and the need for empowering local governments in making cities disaster resilient. The paper discusses these key concepts and explains the development process of the conceptual framework. The process includes, identifying the key concepts, their inter-relationships and the boundary of the study. Accordingly, the conceptual framework illustrates the process for empowering local governments in making disaster resilient built environments within cities.

Key words: Conceptual framework; disaster resilience; resilient cities; local governments; empowerment

INTRODUCTION

A conceptual framework is a visual illustration which explains the main parameters to be studied, including the key factors, constructs or variables and the presumed relationships among them, in graphical or narrative form (Miles and Huberman, 1994). It articulates the pathways through which an intervention takes place to arrive at the desired outcomes (John Hopkins University and Bertrand, 2006). Accordingly, a conceptual framework consists of concepts, assumptions, expectations, beliefs and theories that support and inform the research (Miles and Huberman, 1994). Hence, it is considered to be a key part of the research design.

The aim of this research is to make recommendations to empower local governments in making cities resilient to disasters in the built environment context. In doing so, the research intends to develop theories applicable to the local government sector to empower them to create disaster resilient built environments. In the main, the study adopts an inductive approach and uses case studies as the main strategy for the research. Inductive approaches usually begin with empirical observations and it is important to have an initial definition of the research questions prior to building theory from case studies (Eisenhardt, 1989; Yin, 2009). Therefore, when designing a good case study, the researcher is forced to construct a preliminary theory (Yin, 2009). This directs pre-establishment of theories prior to data collection and analysis and enables the researcher to identify the main concepts of the study, their inter-relationships and boundaries for the research (Yin, 2009). Developing a conceptual framework is an important aspect of the research process and guides the researcher in the data collection and analysis process. This study has, therefore, developed a conceptual framework before the primary data collection. The conceptual framework was developed based on the literature review and further refined based on expert opinions.

The paper elaborates the conceptual framework of the above discussed research study. Firstly, key concepts, identified through literature and expert opinions, are discussed. Secondly, the process of developing the conceptual framework is discussed. Finally, the conceptual framework of the study is presented.

KEY CONCEPTS IDENTIFIED THROUGH LITERATURE AND EXPERT OPINIONS

Through the literature review it was able to identify the key concepts for the research and these were further refined through the opinions of experts. The key concepts identified through literature and expert opinions are discussed below:

Increased disaster risks in cities

Urban areas are growing rapidly all over the world, particularly in lower and middle-income countries (UN, 2014; UNFPA, 2015). As a result of rapid urbanisation, majority of the world’s population now resides in urban areas or cities which home to 54% of the world’s population in 2014 (UN, 2014). In general, urbanisation refers to the population shift from rural to urban areas (McGranahan and Satterthwaite, 2014). The reason for the population shift from rural to urban can be divided into two: push factors, which pushes people away from rural areas and pull factors which pulls people to live in urban areas (BBC, 2014). Push factors include, lack of job opportunities, low wages and poor standards of living and pull factors include, better job opportunities, better services and high standards of living. According to UN (2014), urbanisation will continue to rise and it is projected that 66% of the world's population would be urban by 2050.

Disasters usually occur as a result of an interaction between natural hazards and vulnerable conditions (Wamsler, 2014). Aforementioned, shift in the population results in unsafe conditions where people live in marginal and hazard-prone areas which increases the vulnerability to threats posed by natural hazards (Malalgoda et al, 2013). Moreover, cities are one of the main contributors in generating hazards (Wamsler, 2014) from the high levels of green house gas emission and waste with consequent climate change and rising sea levels (O'Brien et al, 2009). The high concentration of population and economic and cultural capital in cities bring much increased disaster risks (Cook and Chatterjee, 2015) and also climate change risks (UNISDR, 2012). Urban disasters can substantially disrupt the economic function of the city, its political regime and infrastructural integrity where productivity and access to external markets can be halted or curtailed for some time (Pelling, 2003). As such, it is evident that cities are increasingly vulnerable to threats posed by natural and human induced disasters. The experts also acknowledged the importance of focussing on cities due to their growing vulnerabilities. However, one of the experts stated, "Focussing on cities is important, but focussing on rural areas is also important as if a disaster happens in a rural area it would be very difficult for them to recover". However, the particular expert accepted that the study needs to have a manageable focus and also agreed with the fact that the cities are at high risk of disasters.

The need for disaster resilient cities

In responding to the aforementioned vulnerabilities literature suggests the importance of focusing more on cities and the need for converting cities into disaster resilient cities. 'Resilient city' is a comparatively new term which is now widely used in disaster related literature and policy documents published by various institutions such as UN-ISDR (Malalgoda et al, 2013). In reviewing the literature, different definitions have been put forward for the term 'resilient city'. One such definition was "*a city that has developed the systems and capacities to be able to absorb future shocks and stresses over time so as to still maintain essentially the same functions, structure, systems, and identity, while at the same time working to mitigate the present causes of future shocks and stresses*" (RecilientCity.org, 2010). Accordingly, it is expected that a resilient city can withstand, cope with and overcome the adverse impacts of disasters and at the same time protect the people from the adverse impacts of disasters. According to Satterthwaite (2013), the resilience of a city could be investigated in different contexts based on whom or what is resilient. Consequently, investigating the resilience of a city can involve various studies ranging from the resilience of individuals, families and communities, the resilience of institutions as well as the resilience of physical systems of the city. One of the key elements of physical systems is the built environment. Therefore, in achieving disaster resilient cities, it is important to build a resilient built environment. Since the research is focussed on a built environment context the next section highlights the concept of resilience in the context of the built environment.

Any destruction to the built environment disturbs the functioning of human society and the economic and social development of the country due to its strong connection with the human activities (Malalgoda et al, 2013). Thus, it is clear that achieving a resilient built environment is of paramount importance to achieving resilient cities. As such, due to the complex and interrelated nature of the built environment it is important to adequately recognise and rectify every failure in advance, to avoid any possible disaster and to withstand the situation at a time of a disaster (Voogd, 2004). In doing so, it is important to focus on sound development practices with good regulations; well maintained infrastructure and participatory and sustainable urban planning and development (UNISDR, 2012). All interviewees agreed with the literature that there is a need for disaster resilient cities and built environments.

Stakeholders in making disaster resilient cities

Based on the literature findings, it was clear that a number of parties are required to be involved in the process of making cities resilient, including community and citizens' groups, local governments, the private/corporate sector, the national government, civil society organisations, external actors, academic and professional groups and the media (Niekerk, 2007). It is further observed that none of these role players can act in isolation and a successful and effective system requires integration and coordination of all these role players (Malalgoda et al, 2013). Many authors have argued that out of all the stakeholders the local government is the key stakeholder in the process of making cities resilient to disasters and as such there is widespread agreement within the literature that local governments have a vital role to play in implementing disaster risk reduction initiatives and to create cities resilient to disasters (MacManus and Caruson, 2006; Kusumasari et al, 2010; Manyena, 2006; Albrito, 2012; Wamsler, 2014; UNISDR, 2010, Red Cross, 2010).

Roles and challenges for local governments in creating disaster resilient cities

Local governments are, therefore, required to play a key role in making cities resilient to disasters as they are rooted at the local level where disasters happen. UN-ISDR (2010) has identified four broader roles that local governments are expected to play in implementing disaster risk reduction, namely: play a central role in coordinating and sustaining a multi-level, multi-stakeholder platform to promote DRR in the region or for a specific hazard; effectively engage local communities and citizens in disaster risk reduction activities and link their concerns to government priorities; strengthen their own institutional capacities and implement their own practical DRR actions; and devise and implement innovative tools and techniques for disaster risk reduction which can be replicated elsewhere or scaled up nationwide.

However, it was evident that local governments are facing a number of challenges in making their cities resilient to disasters (Malalgoda et al, 2013; Manyena, 2006; Niekerk, 2007). Some of the major challenges identified through the literature review were: the lack of knowledge of disaster risk reduction initiatives; lack of interest and political will; human resource constraints; lack of financial capability; internal organisational and administrative weaknesses; lack of community engagement; managing a long term process; lack of focus and reactive approach to DRR; inadequate urban planning; lack of tools and techniques for DRR; lack of monitoring and supervision of new developments; competing priorities; capture of local level responsibilities by the central government; lack of authority; multi-layered governance arrangements; unstable political systems; and relationship issues with central government. All the experts agreed with the literature and recognised local government to be a key stakeholder in making disaster resilient cities and built environment.

Need for empowering local governments in making disaster resilient cities

In responding to aforementioned challenges, the importance of empowering local governments has been identified as a key priority in the current context. As explained earlier, empowerment can be done through capacity development (UNDP, 2011; Kusumasari et al, 2010; Collins and Kapucu, 2008; Manyena, 2006; Malalgoda & Amaratunga, 2015) and conferring power and authority by reforming the existing governance (UN-ISDR, 2004; ADPC, 2004; Ahrens and Rudolph, 2006; WMO, 2010; Malalgoda & Amaratunga, 2015). As such, capacity development and improved governance relating to local governments have been given a very high priority in the existing literature and by the experts in order to empower local governments to make cities resilient to disasters.

The conceptual framework of the study was then developed based on the key concepts identified in this section. The process adopted to develop the conceptual framework is explained in the next section.

DEVELOPMENT OF THE CONCEPTUAL FRAMEWORK

Key concepts

As explained earlier, five key concepts have been identified through the literature review and further justified through expert consultations. Both literature and the experts were in agreement that the cities are increasingly vulnerable to threats of natural disasters. Accordingly, the importance of making cities resilient to disasters has been highlighted. The literature further highlighted the increased vulnerability of the built environment to disasters and the need for developing built environments with an effective degree of resilience to withstand a disaster and to protect the physical and human communities of the city. The experts also acknowledged the importance of focussing on cities and their built environments, as the built environment is the core element of every city and facilitates the everyday life of the human beings. Both literature and experts were in agreement that a number of stakeholders need to be engaged in making disaster resilient built environments within cities and identified local governments as the key stakeholders in the process of making disaster resilient built environments within cities. Furthermore, it was highlighted that local governments are supposed to play a key role in making disaster resilient built environments and their inadequate contribution was further acknowledged by literature and experts. All these have justified the need for empowering local governments to make disaster resilient built environments within cities.

Inter-relationships between the concepts

After identifying the key concepts the next task was to identify the inter-relationship between the concepts. In the context of this research, it is important to identify the inherent vulnerabilities of cities in order to arrive at the required role of the local governments in making disaster resilient built environments within cities. This leads to the identification of the challenges faced by local governments in making disaster resilient built environments. Based on the challenges, recommendations are made as to how these could be overcome and how local governments could be empowered to make disaster resilient built environments within cities.

Boundaries of the key concepts and inter-relationships

Having identified the key concepts and their inter-relationships the next task was to identify the boundaries of the key concepts and inter-relationships. As explained earlier, the built environment is a core element of every individual and when moving towards disaster resilient cities it is important to provide built environments with an effective degree of resilience to threats posed by disasters. Therefore, the study is limited to the context of the built environment and examines how the local governments could be empowered in making disaster resilient built environments within Sri Lankan cities.

Accordingly, the conceptual framework was developed incorporating the key concepts, their inter-relationships and their boundaries. It indicates the unit of analysis for the study, which is 'empowerment of the local government'. The framework was then populated with the key literature findings and is presented in Figure 1.

CONCLUSIONS

This paper elaborates the process of developing the conceptual framework of a research aimed at developing a framework to empower local governments in making disaster resilient built environment within cities. The process includes, identifying the key concepts, their inter-relationships and the boundary of the study. The conceptual framework is developed based on the literature review and further refined based on the findings from three expert opinions gathered as part of the study. Accordingly, the conceptual framework illustrates the process for empowering local governments to make disaster resilient built environments within cities.

As discussed in the paper, both natural and human induced disasters can have extreme effects on cities. Therefore, firstly it is important to understand the vulnerabilities and challenges experienced by the cities, and how these could be overcome. Accordingly, at the second phase of the research, it is proposed to conduct case studies to identify the vulnerabilities and challenges experienced by the cities, and to explore the role of the local government in contributing to disaster resilience and the challenges that they face. Based on the analysis, the research will develop a framework and propose recommendations to empower local governments in creating disaster resilient built environment in cities.

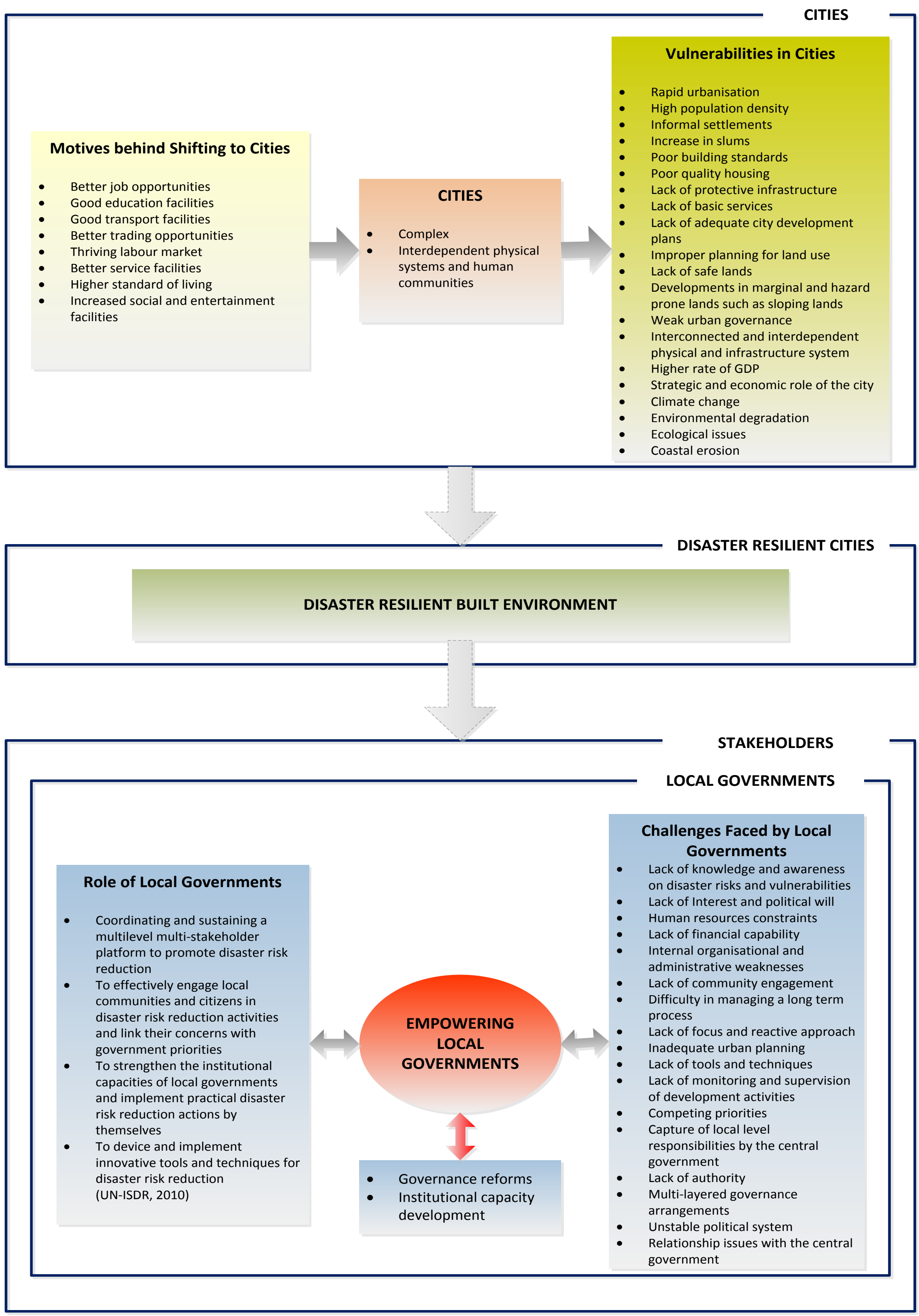

Figure 1: Conceptual framework of the study with key literature findings

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AGGREGATED RESPONSES OF HUMAN MOBILITY TO SEVERE WINTER STORMS: AN EMPIRICAL STUDY

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ABSTRACT

The northeastern part of the United States has witnessed an increasing frequency of heavy seasonal snow and extreme winter storms in recent years. These storms have resulted in costly damages and a disruptive impact on infrastructure systems and the public transportation. Therefore, it is of great importance to understand human mobility patterns and behaviors during such storms in terms of resource access and delivery, humanitarian relief operations, and post-disaster reconstruction. However, comparatively few studies have examined the correlation between winter storms and human mobility. This study examines the effects of winter storms on human mobility during January 26th to 28th during a 2015 blizzard in the northeastern United States. The perturbed displacements, shifted centers of mass and radii of gyration were analyzed and compared. The characteristics and predictability of human mobility patterns during the storm were further explored by comparing the radii of gyration of the top most frequently visited locations of distinct users under normal circumstances. The research findings can provide a quantitative view of pattern and behavior changes of human mobility. This also has potential long-term implications on emergency detection, effective emergency response planning and development of strategies and policies to improve urban resilience in severe winter storms.

Key words: disaster resilience, human mobility, winter storms, Twitter

INTRODUCTION

Extreme winter storms continue to occur with greater frequency in the eastern two-thirds of the contiguous United States over the past century (NOAA, 2016). The increased damages from these storms has caused costly and disruptive effects on people's daily lives. Large accumulations of snowfall and ice can incur catastrophic effects on infrastructure (Kunkel et al., 2013), specifically, electrical system emergencies and disturbances, and transportation delays and closures (OCIA, 2014). These can further lead to communications breakdowns and public health issues. However, the effects of severe winter weather are not well understood. There still are grand challenges for increasing winter storm resilience in terms of flexible and effective mitigation strategies and winter storm preparations (Subcommittee on Disaster Reduction, 2008). The severity of the damages from winter storms calls for innovative research, particularly a ground-up understanding of human behaviors and activity patterns under the influence of the natural disaster. Recently, researchers have realized the importance of understanding and predicting human mobility for disaster resilience and risk management. Recent developments in information technology have provided an unprecedented amount of crowd sourced spatial-temporal data to study human mobility (Brockmann, Hufnagel, & Geisel, 2006; Gonzalez, Hidalgo, & Barabasi, 2008; Peng, Jin, Wong, Shi, & Liò, 2012; Sapiezynski, Stopczynski, Gatej, & Lehmann, 2015; Q. Wang & Taylor, 2014). Unlike other acute disasters (e.g., earthquakes and hurricanes), severe winter storms may not force residents to evacuate from their homes to safer places on a large scale, which may result in different perturbation patterns. And, yet, relatively few studies have examined the relationship between winter hazards and human mobility in great detail. To enhance urban resilience of areas subject to severe winter storms, and to better understand of the effects of large-scale winter storms on patterns and behaviors of human mobility, we specifically analyzed a severe winter storm in January 2015 in the northeastern part of United States using geo-tagged Twitter data. We adopted three measurements to quantify the change of human mobility patterns, and further tested the possibility of characterizing the perturbed mobility pattern with most frequented locations.

LITERATURE REVIEW

Characterization of human mobility patterns plays a critical role in developing models of urban planning (Horner & O'Kelly, 2001), traffic forecasting (Toole et al., 2015), spread of diseases (Wesolowski et al., 2012), and disaster resilience (Q. Wang & Taylor, 2014, 2016). Interesting findings about daily patterned human movements have fundamentally changed our understanding of human mobility. However, human mobility patterns under perturbed states like natural disasters also require a deeper understanding in order to prepare for unfamiliar conditions in the future (Bagrow, Wang, & Barabasi, 2011). A few scholars in the disaster research area have devoted their efforts in finding the scaling law and evaluating the predictability of human mobility during and after extreme events using mobility patterns from non-perturbed states. Lu, Bengtsson, and Holme (2012) used approximately one year of mobile phone data of 1.9 million users, and found that population movements following the Haiti earthquake had a high level of predictability, and destinations were correlated with normal-day mobility patterns and social support structure. Similar results have been found in the research of Song, Zhang, Sekimoto, and Shibasaki (2014) on human mobility following the Great East Japan

Earthquake and Fukushima nuclear accident. A study by Q. Wang and Taylor (2014) showed that human mobility was significantly perturbed during hurricanes but also exhibited high-levels of resilience. A more recent study on multiple types of natural disasters around the world (Q. Wang & Taylor, 2016) revealed a more universal pattern of human mobility as well as the limitations of the urban human mobility resilience under the influence of multiple types of natural disasters. They found that resilience can be significantly impacted by more powerful disasters which could force urban residents to adopt entirely different travel patterns from their norms. Other scholars have conducted a longitudinal study on the relationship between large-scale natural disasters and population mobility. For example, Gray and Mueller (2012) investigated the effects of flooding and crop failures on local population mobility and long-distance migration over 15 years. However, limited research has focused specifically on severe winter hazards on human mobility. More detailed quantification of effects of winter hazards on human mobility is needed.

The effects of snow on traffic have been examined in transportation research. Snowstorms have been found to impact different dimensions of the traffic, e.g. traffic demand, traffic safety, traffic operations and flow (T. Maze, Agarwai, & Burchett, 2006). The impact varied by trip purposes. For instance, commercial trips became a higher percentage of the traffic stream and they are least likely to be deferred, while long-distance trips are more likely to be postponed during snowstorms (T. Maze et al., 2006). Moreover, snow affected different types of vehicles in distinct manners and the impact varies among areas (Call, 2011). The impact of cold and snow on traffic volume also varies within hours of a day, and days of a week. According to a study by Datla and Sharma (2008), traffic is more susceptible to cold in the weekend compared to weekdays, and Friday traffic responds differently to cold from other weekdays. In addition to traffic, heavy snow has been shown to have a negative impact on foot travel frequencies (de Montigny, Ling, & Zacharias, 2011). More specifically, temperature and precipitation were found to have different levels of impact on human behavior. However, these empirical studies on limited traffic modes and in small scales cannot represent the population well, and cannot reveal the overarching impact of large-scale storms. We need a better urban scale understanding with aggregated data to achieve more effective snowstorm preparation and to build more resilient cities. Based on the findings of studies on human mobility in disasters and the impact of snowstorms on traffic, we specifically investigated three research questions: (1) can trips of different distances be significantly perturbed by a winter storm, (2) can radii of gyration of human mobility be affected by a winter storm, and (3) can human mobility patterns during a winter storm be characterized by the most frequented locations in normal conditions.

MATERIAL AND DATA COLLECTION

We selected the January 2015 winter storm in the northeastern United States, for the seasonality and high frequency of this type of damage in this area and its large-scale impact. This severe storm caused a snow emergency to be declared during January 27 to 29 in six states by FEMA (FEMA, 2015). This winter hazard brought heavy snow to southern New England with blizzard conditions to much of Rhode Island and Massachusetts, beginning during the day on January 26 and lasting into the early morning hours of January 27. We narrowed the area within the spatial bounding box coordinates of Massachusetts (Latitude: 41.19 to 42.89, Longitude: -73.51 to -69.86) due to the population distribution, and the statewide impact. Much of the affected area received 2-3 feet of snow and experienced severe winds with gusts over 70 mph (NOAA, 2015b). The Category of Regional Snowfall Index is three out of five with Index value of 6.158 (NOAA, 2015a). A statewide driving ban was issued and MBTA public transportation service was suspended, thousands of flights were cancelled, and schools and activities saw weather-related cancellations for one or more days (NOAA, 2015b). The raw data for this study is comprised of geotagged Tweets collected from Twitter Streaming API in the Civil Engineering Network Dynamics Lab at Virginia Tech (Q. Wang & Taylor, 2015). We use geotagging as the only filter to collect real-time data. The studied time period includes four pre-storm weeks, a during-storm week, and a post-storm week – from December 29, 2014 to February 8, 2015. In total, 2,691,346 Tweets were collected for the 42 days and the average daily data volume was about 64,080. The Twitter geotags are based on GPS Standard Positioning Service which offers a worst-case pseudo-range accuracy of 7.8 meters with 95 per cent confidence, and the positional accuracy are affected by weather and device factors (Swier, Komarniczky, & Clapperton B., 2015).

ANALYSIS AND RESULTS

Daily Displacements and Travel Patterns

To explore if severe winter storms can perturb people's daily trajectories, displacements of each distinct user during thirty-five 24-hour periods over January 5 to February 8, 2015 (Eastern Time) were calculated and studied. Six groups of distances were set, including 1-100 meters (r_1), 100-500 meters (r_2), 500-1,000 meters (r_3), 1km-5km (r_4), 5km-10km (r_5), 10km and more (r_6). Data volume of displacements per day varied from 16,098 to 96,219. Percentages of the number of displacements within different sets were then computed and compared. The percentage of short trips (r_1) was much higher than for longer trips. To analyze the perturbation on human mobility caused by the winter storm, we compared displacements of different length between pre-snowstorm weeks and the snowstorm week (Figure 1). The grey lines for the four-week normal state show the regularity of people's trajectory while the colored line for the snowstorm week exhibits obvious perturbation on different displacements. Specifically, the Monday, Tuesday, and Wednesday during the affected week were experiencing the winter storm. Displacements of different travel distances showed regularity over the four weeks before the storm. Average percentages of short trips (r_1) decreased from Monday (75.41%) to Friday (68.13%), and increased from Friday to Sunday (81.21%). However, during the week of the storm, the percentage of short trips achieved the peak at 89.18% on Tuesday (January 27) and decreased sharply to 60.85% on Friday. It returned to a relatively non-perturbed percentage (83.03%) on Sunday. In contrast, the percentage of long trips (exceeding 10 km) decreased to its lowest percentage on Tuesday (1.60%) compared with the increasing trend from Monday to Friday under normal circumstances. It then achieved its highest value of 7.78% on Friday.

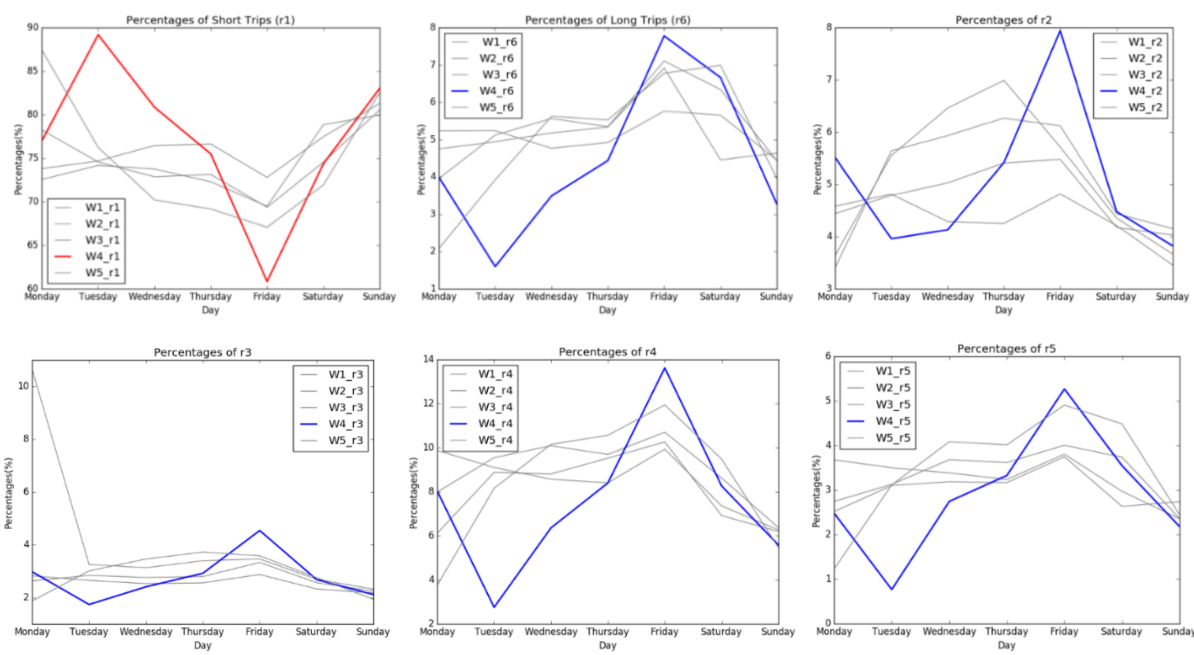

Figure 1. Human mobility affected by snow storms.

To get a detailed understanding of the daily displacements, we further fitted daily displacements from January 5 to February 8 into distributions including log-normal, exponential, stretched exponential, power law, and truncated power law, using a python package–powerlaw (Alstott, Bullmore, & Plenz, 2014) and found *log-normal distribution* can best characterize their distributions based on the loglikelihood ratio and the corresponding p value.

$$P(x) \sim \frac{1}{x\sigma\sqrt{2\pi}} e^{-\frac{(Inx-\mu)^2}{2\sigma^2}} \quad [eq. 1]$$

For the fitted parameters, the values of mean (μ) in all fittings are in the range 2.235 $\pm$ 0.337 except for the most severe snowy day, January 27th, with the mean value of 2.654. However, all the snowstorm days and the following clearing days have relatively higher mean value than normal days. Besides, the standard deviation (σ) of January 27th is the smallest which indicates less differences in frequencies of different-length displacements.

Radii of Gyration and Shifting Distance of Center of Mass

Radii of gyration (r_g), a measurement of object movement from physics, has been widely used to quantify the size of trajectory of individuals since the study of Gonzalez et al. (2008). To achieve a more nuanced understanding of the perturbation on human mobility pattern, we computed the daily r_g of each distinct user from January 12th to February 8th to identify the change of daily radius of gyration the week before, during and after the winter hazard. We adopted the formula below (Wang Q. and Taylor J. 2016) to calculate the r_g of distinct Twitter user.

$$r_g = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left[2r \times sin^{-1}\left(\sqrt{sin^2\left(\frac{\emptyset_t - \emptyset_c}{2}\right) + cos\emptyset_1 cos\emptyset_t sin^2\left(\frac{\varphi_t - \varphi_c}{2}\right)}\right)\right]^2} \quad \text{[eq. 2]}$$

Where n is the total frequencies of visited locations of one individual, t is each location visited by the individual during a certain period, c is the center of mass of trajectories, $\emptyset$ is the latitude, and φ is the longitude.

Truncated power law provides a better approximation of daily r_g than both exponential and log-normal distributions. The scaling parameter was to evaluate the status of human mobility pattern as well as the perturbation duration. During the two weeks before the winter storm, the scaling parameter was relatively steady, ranging from 1.53 to 1.74. This steady pattern also lasted until the beginning two days of the winter storm (Jan 26 and Jan 27), however, with the declarations of the statewide travel bans the scaling parameter peaked at 1.7846 on Jan 28. The values returned back to a normal range on Jan 29 and Jan 30. The values of the scaling parameters dropped to the lowest points (1.00 and 1.41) in the weekends of the storm week. This may indicate that the mobility patterns changed significantly. It may be that following the inconvenience caused by the heavy snow during the weekdays, people needed to take longer-distance trips to undertake activities that would have normally occurred in that week.

We also computed the shifting distance of the center of mass (Δd_{CM}). The average center of mass of distinct individuals under four normal statuses and one in snowstorm period were calculated separately. The shifting distance Δd_{CM} was the change of the average center of mass from the normal state to the perturbed snowstorm state. The equation for calculating the shifting distance is included below:

$$\Delta d_{CM} = \left| \vec{r}_{CM}^{\,S} - \vec{r}_{CM}^{\,N} \right| \text{ [eq. 3]}$$

Where $\vec{r}_{CM}^{\,S}$ is the average center of mass of a movement trajectory during the storm days, and $\vec{r}_{CM}^{\,N}$ is the average center of mass during the first four sets of Monday, Tuesday and Wednesday.

The *truncated power law* distribution was found to be the best distribution of Δd_{CM} using the KS fit method. Fitting and comparison results are in Table 1.

Table 1. Truncated Power Law Fitting and Comparison Results of Δd_{CM}

β Value	λ Value	κ Value (m)	*KS*-test	Lognormal Comparison	p-value	Exponential Comparison	p-value
1.373	0.740	0.027	0.013	47.807	1.452e-30	1441.284	3.504e-55

Characterizing Perturbed Mobility Pattern with Most Frequented Locations

The mobility patterns of individuals are dominated by their recurrent movement between a few primary locations. These most frequently visited locations include home, work, school, along with several less active subsidiary locations (Bagrow & Lin, 2012; Pappalardo et al., 2015). To examine if most frequented locations (MFLs) can better represent human mobility patterns under the winter storm or following clearing days than under normal status, we compared the radius of gyration of MFLs (r_g^{MFLs}) with both r_g^n (normal status) and r_g^s (storm status) of each distinct individual. We defined the MFLs as the centroids of different clusters. Only users with at least two MFLs (two clusters) during normal days and at least two geolocations in a day under storm status were studied. MFLs of each distinct user were extracted from their four-week trajectories before the blizzard utilizing DBSCAN algorithm. We set the required two input parameters for the clustering: the maximum search radius as 20 meters, and the minimum number of points to form a cluster as 2. The initial settings are based on the accuracy of the Twitter geotags, and the sensitivity analysis results on distance parameters of DBSCAN for Twitter data (Swier et al., 2015). The MFLs of distinct individuals were then ranked according to their visitation frequencies, and MFLs with the same visitation frequencies have different but consecutive rankings. To quantify the human mobility pattern characterized by MFLs, we adopted the definition of the k-radius of gyration $r_g^{(k)}$ (Pappalardo et al., 2015), which is the radius of gyration of k-th MFLs of an individual. The correlations between $r_g^{(k)}$ and r_g^s allows us to quantify the similarity between k-th MFLs and mobility pattern during the winter storm. We plotted the scatter graphs to observe the correlations with the point density which is colored from blue to red (Figure 2). The comparisons with different k values demonstrate that (a) with the increase of k, the radius of gyration of MFLs does not present a better predictor for r_g^s, and (b) the k-th MFLs cannot characterize the perturbed human mobility pattern of all individuals.

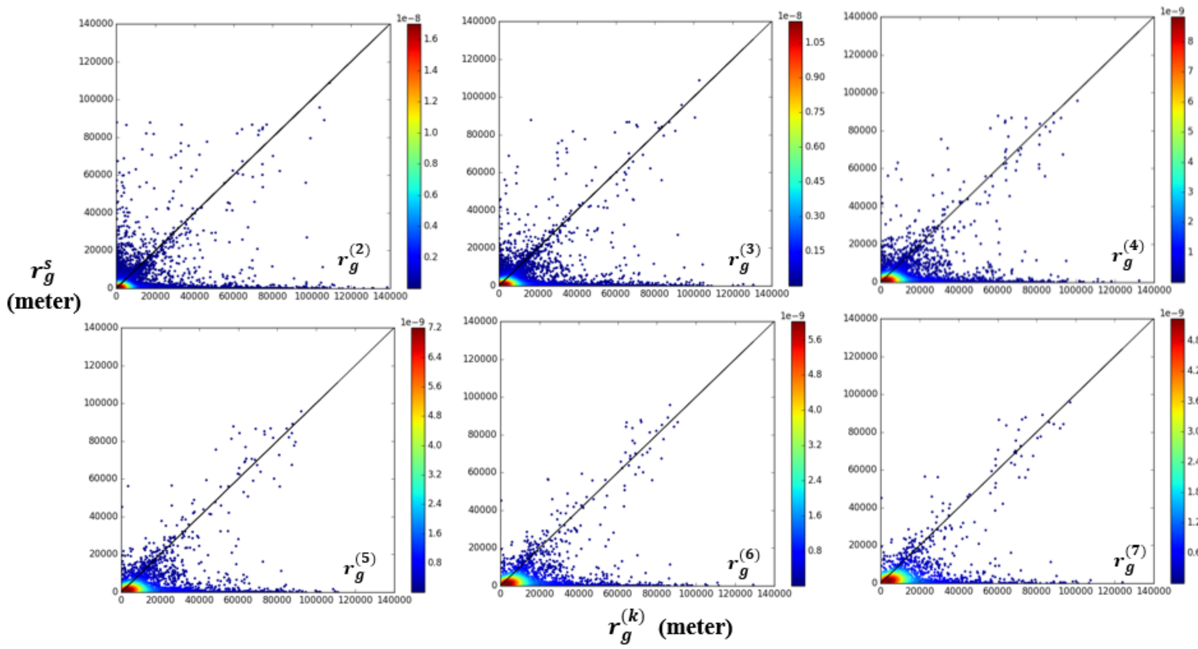

Figure 2. Comparisons between r_g^s and $r_g^{(k)}$for k=2, 3, 4, 5, 6, 7.

CONCLUSION

Previous research has found that natural disasters, e.g., hurricanes, floods, and earthquakes, can cause significant impact on human mobility patterns (Bagrow, Wang, & Barabasi, 2011; Lu, Bengtsson, & Holme, 2012; Gray & Muller, 2012; Song, Zhang, Sekimoto, & Shibasaki, 2014, Wang & Taylor, 2014, 2016). We extend this research to severe winter storms showing that they can also impact mobility patterns. They caused substantial reductions in percentages of long-distance trips and increases in percentages of short trips. We found radii of gyration on a daily basis can reflect the perturbation in mobility patterns caused by the severe storm. This change on mobility pattern can also be measured by shifting distances of center of mass. Moreover, by comparing the radii of gyration of individual's most frequented locations and the one of all individual's locations, we found that most frequented locations cannot characterize all individuals' mobility pattern during the winter storm well. There are several limitations in this study deserving further research effort in the near future. First, apart from the geotagged tweets for this paper, the self-reported locations in the text of tweets during disasters may also be included in future research data collection to achieve a broader sample. Second, additional data, including a longer period before the winter storm, would have allowed better differentiations of people's most frequented locations and pre-disaster mobility patterns. Finally, specific impact on human mobility of climate elements (e.g., snowfall and wind speed), should be taken into consideration in further studies. Our work contributes to a growing body of literature aimed at enhancing disaster resilience and risk management by understanding and predicting human mobility using crowd-sourced data. The investigated mobility patterns in this paper could be combined with transportation data and detailed weather data to inform governments and policymakers regarding disaster response and relief strategies.

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COMMUNICATING DANGEROUS KNOWLEDGE, KEY POINTS FOR ENGAGING WITH COMMUNITIES

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Engaging communities for resilience is a specialised field that requires being able to communicate different levels and types of risk, to diverse end users, in a way that is empowering. Specialised understandings of how people communicate and also how they respond to both short and long term risks are needed. How things are communicated and by whom, is as important as the information being conveyed.
This presentation will outline some of the key lessons learnt to date from engagement practitioners who communicate risk in the area of natural hazards and adaptation. It will explore what has worked, what hasn't and why and explore how these techniques can be used to support resilience activities across communities. It will also outline why communicating dangerous knowledge is not a simple transaction, but a negotiated space where trust and common understandings provide the foundation for action.

KEY WORDS: Communities, engagement, risk communication

BUILDING RESILIENCE TO NATURAL HAZARDS: STRATEGIC DECISION MAKING FOR RISK OWNERSHIP

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ABSTRACT

The introduction for disaster management in Australia of resilience as a key policy direction started with the directive that resilience is a "collective responsibility" (NEMC, 2011). This has provided a major challenge to practitioners because resilience is systemic, and a long-term proposition which needs strategically-based decision making to support its implementation. This requires a fundamental shift from current models of practice which focus on short to medium-term planning horizons. This paper discusses how understanding and exercising risk ownership can contribute to building resilience. This has been undertaken through the development of framework papers, an exploration of current patterns of risk ownership through desktop study and workshops with risk owners and practitioners. We have identified risk ownership as a major contributor to resilience at the individual to institutional scale and are working to build the two aspects of ownership: the value owner and designated risk manager, into a process-based framework. This will support the implementation of risk ownership into decision making frameworks contributing to ongoing planning and implementation.

Key words: Risk ownership, systemic risk, resilience, values-based decision making.

INTRODUCTION

Resilience is being promoted as a key policy area by all levels of government for managing complex disaster risks such as natural hazards. However, the ways in which resilience can be implemented through governance mechanisms at a range of scales, remain unclear. This paper discusses how risk ownership can contribute to resilience in the area of natural hazard strategic risk management. It explores the current application of risk ownership at an institutional, organisational and community level in Australia, using an economic lens.

Currently, disaster resilience at a policy level is defined as "the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals" (NEMC, 2011). The identification of risk ownership is essential to understanding and implementing disaster resilience because it can show where these responsibilities are being exercised. Through ownership, risks can be managed, shared or may be unowned. Unowned risks are highly likely to be unmanaged, potentially leading risk amplification and uncontrolled damage and loss.

Many organisations are struggling with the task of practically implementing resilience, due to a large gap in theory-to-practice and a shortage of resources allocated to closing this gap and to implementation. Although there is broad agreement that investment in prevention and preparedness can provide significant returns through improved resilience and reduced damage and loss (Deloitte Access Economics, 2013; Kelman, 2013; Hallegatte, 2015), spending patterns do not reflect this. Current expenditure in areas of preparation, preparedness and recovery are difficult to ascertain because estimates omit private expenditure or spending in other areas, such as adaptation, where actions contribute to these activities. Currently in Australia, the Productivity Commission (2014) estimates that government funding for mitigation is 3% of post disaster relief and recovery.

One of the keys to changing this pattern is (1) greater clarity and visibility of who owns what risks and how they are owned across different temporal and geographic scales and, (2) understanding what the real tangible and intangible costs of these events are beyond the shorter term.

In part, this issue is the result of a focus on short- to medium-term planning and a risk-based approach that focuses on individual hazards. The Australian National Emergency Risk Assessment Guidelines (NERAG) strongly recommend a shift to an all-hazards, all-values approach (AEMI 2014), which focuses on outcomes. This approach is longer term and likely to prove more robust in strategic areas of natural hazard risk related to resilience. It has also identified risk ownership as a key attribute for understanding resilience at the institutional scale (Jones et al., 2015a, 2015b; Young et al., 2015a, 2015b).

Risk ownership is represented in this paper by the following definitions (Young et al. 2015):

As an asset owner: "Asset owners are generally best placed to manage risks to their property" (PC, 2014 p. 314).
As a designated risk manager: "…a person or entity that has been given authority to manage a particular risk and is accountable for doing so" (ISO, 2009).
As there is currently a disconnect between these two types of risk ownership, a key purpose of our research project is to develop a framework that

integrates these two areas into a single process. This is particularly needed to support strategic decision-making and to implement resilience.

We have defined resilience in the following way: the capacity of a system (or organisation) to cope with a hazardous event or shock by responding or reorganising in ways that maintain its essential function and identity. Central to this is the ability to learn, adapt and transform (Adapted from Arctic Council (2013)).

UNDERSTANDING OWNERSHIP OF SYSTEMIC RISK

The systemic nature of natural hazard risk makes understanding and exercising ownership to build resilience an area of complex decision making. As a result, it is important to understand how the system of risks interact and can effect an institution, organization or community (Figure 1). It is important to be resilient to risks that are both internal and external, requiring ownership to be clearly identified in these areas.

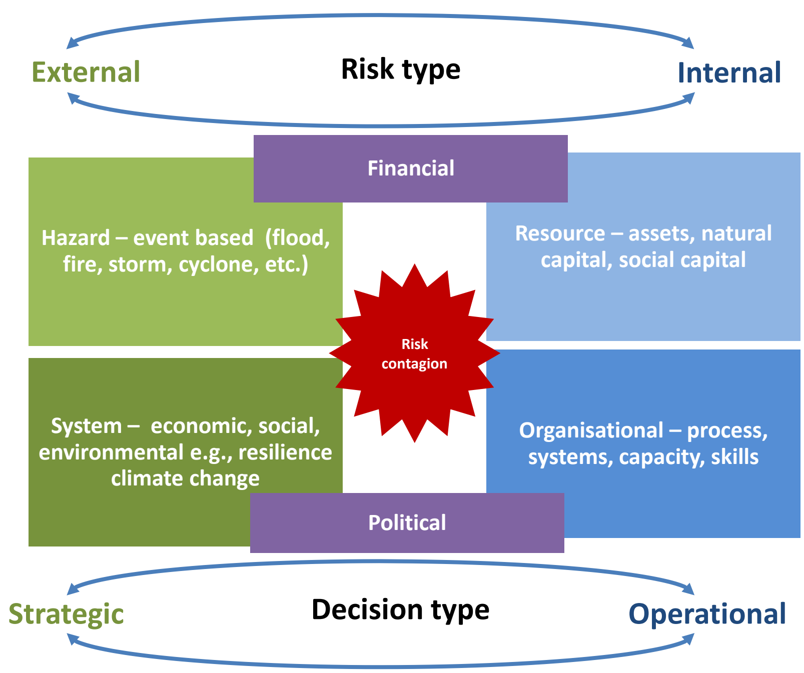

Figure 1: Risk system with internal and external components (Young et al. 2016 – adapted from PCW (2013) and Kambil et al. (2005)).

Internally-based risks are more likely to be considered in a bounded system and as such, are more likely to be manageable, giving internal actors agency. Effective management of these internally-driven risks is a key part of building organizational resilience and building the capacity to pro-actively respond – rather than react – to external risks such as natural hazards.

Externally-based risks are usually systemic and highly dynamic. They are often unbounded, spanning multiple areas and timeframes. They can be prepared for but not predicted and, because of high levels of uncertainty regarding the future, often have unanticipated outcomes (Young et al., 2016a).

It is also important to account for risks that have both internal and external aspects, such as political and financial risk. The internal aspects of these risks will influence perceptions and decision making at individual and organisational scales. Internal risks can arise from external policy and financial markets can influence the level of risk different organisations are exposed to. How these risks are dealt with in an organisation has a large influence on risk culture and organisational resilience, so are important when another class of external risk, natural hazards, are considered.

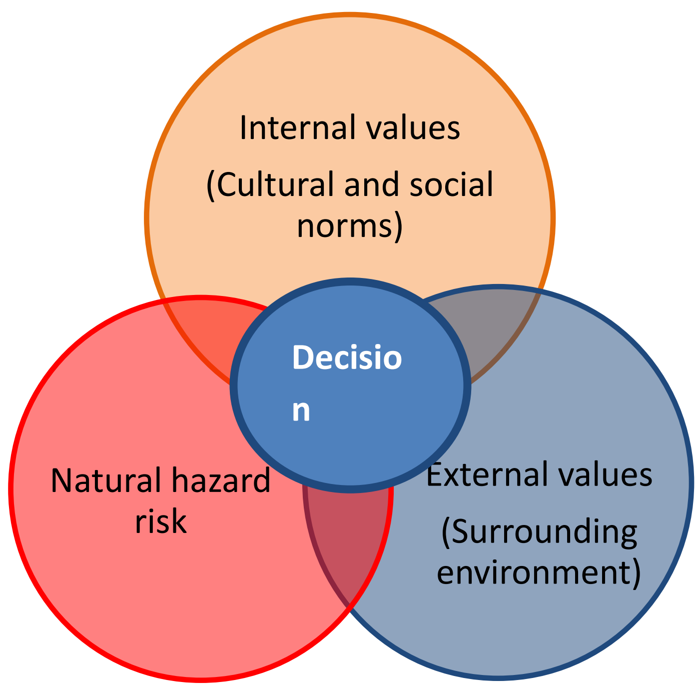

Figure 2: Different value and risk components in relation to decision making (Young et al., 2016a).

The values associated with these risks are also systemic and have a significant influence on decision making (Figure 2). Our focus is primarily on the interaction between the external and natural hazard risk, however how these risks are perceived and evaluated by individuals and organisations is determined by their internal values, both formal and informal. These values will determine how ownership is allocated, to whom and how it is accepted.

Values also provide a way of prioritising areas of risk and are a powerful tool for bringing together "multiple perspectives" in a way that supports decision making (Hall & Davis, 2007). This is particularly useful for strategic planning and decision making where multiple possibilities, perspectives and agendas need to be considered and agreed upon by diverse stakeholders.

We propose that the strategic risk management of natural hazards should be built on a foundation of values at risk covering economic, social, environmental and built infrastructure values, rather than on the specific hazards. The process we are developing allows the ownership of key values to be linked with the ownership of actions that address risks to those values. This links the two types of risk ownership listed above: asset owners and risk managers, with values being the assets. This expands the concept of assets well beyond the conventional notion of assets with a well-defined market value to intangible assets that contain important social and environmental aspects.

As risk ownership is a 'negotiated process' (Young et al., 2016a) and values can be highly subjective, this process is not without challenges. It requires collaboration and meaningful engagement to achieve fruitful outcomes. It is a long-term proposition that involves multiple parties and requires the development of fit-for-purpose frameworks to support this.

How risk ownership changes

Risk ownership is highly dynamic and when exposed to natural hazards, ownership can change abruptly. Two of the key ways this can happen are as a result of:

risk contagion, and
the exceedance of capacity thresholds.
'Risk contagion' is a term most commonly used in relation to financial risk and describes how financial shocks travel through an economic system and can 'infect' other areas of the economy. It is not necessarily synonymous to catastrophe where direct impacts cause rapid knock-on effects, but is longer lasting where direct and indirect impacts and consequences mutate and change as they travel through systems. Impacts are seen to spread across geographical and institutional borders 'like a contagious disease' (Bordo & Murshid 2001), creating a cumulative effect far larger than the initial event. This type of systemic understanding of risk is well understood in the natural hazard literature in areas where natural hazard risks amplify through social and environmental systems (Hewitt & Burton 1971; Burton et al., 1993). This is particularly relevant to resilience where risk ownership may be allocated for direct impacts but not indirect knock on effects (e.g., Hallegatte 2015).

The other aspect associated with changing risk ownership is the breaching of capacity thresholds (environmental, social or economic; Jones et al. 2013) where the original risk owner will transfer the responsibility of the risk to another owner (either by a prior arrangement or by default), because they lack the capacity to address or manage the risk. This can occur through both catastrophe and contagion.

In terms of risk ownership, identifying how the risk is changing is important as this determines where ownership may be transferred and risks become unowned. It can also help identify potential areas of vulnerability and support better long term management of these risks (Young et al., 2016b?).

Exploration of allocation of risk ownership

Allocation of risk ownership of natural hazard risk was explored through undertaking a desk top review and asking the following three questions:

Who is responsible for the risk?
Who is accountable for the risk?
Who pays for the risk?
This was examined within a matrix of broad institutions (federal, state/territory and local government, business and industry, and community) and values (built, social and environment assets, and infrastructure). Risk ownership across this matrix was found to be allocated according to individual hazards, ownership of assets, tasks associated with the risk management process and policy/legislative instruments.

This was further explored during four workshops which explored decision making preferences across the different institutions, using scenario based exercises for flood, fire and heatwave. This was examined across three different temporal scales – short term 2 months–1 year, Medium term 1–2 years and long term 2+ years.

This was then synthesised using a basic statistical analysis to ascertain current perceived ownership of risk across institutions.

The findings from these workshops are now being used to develop a process based framework for risk ownership that will support decision makers as part of their ongoing planning activities.

Complexities related to risk ownership

A number of complexities were identified during these activities. These were as follows (Young et al., 2015a?):

Natural hazards are dynamic in nature. Risk ownership throughout the management cycle is changeable, depending upon context and the event itself.

Hazards may require several potential owners depending on the level of impact.
Different types of hazard may require specific owners who specialise in aspects of that hazard, making the all-hazard approach difficult.
Differences between the levels of perceived risk associated with these hazards can affect who assumes ownership.
Incomplete knowledge about natural hazard risks and limited access to information may limit the ability to allocate ownership appropriately.
Differing expectations from within, and external to, institutions that compete for limited resources and/or that promote competing agendas.
Different approaches by state level agencies; e.g., comprehensive, all hazards, all agency, multi-hazard, single hazard.
Uneven transition of public institutions to being more flexible and collaborative.
Areas where ownership is not clearly delegated or shared.
Systemic interdependencies where ownership actions in one area create impacts in another area.
Related policies and plans that contribute to a specific region, activity or set of outcomes that are being addressed separately; e.g., adaptation to climate change, regional economic development.

KEY FINDINGS TO DATE

To date our research has found that there are a number of challenges to establishing risk ownership across the Emergency Management Sector in Australia. This is because this sector has been primarily focused on response and short to medium term activities. If resilience is to be achieved, a fundamental shift from this mental model to longer-term thinking and operational frameworks are required. In particular, there is a need to address the following:

There are gaps in understanding and practice and further work is needed to develop more robust institutional and organisational arrangements that support risk ownership and strategic planning of natural hazards.
There are major gaps in long term ownership of risks in the 2+ year category, particularly in the social and environmental categories. It is notable that there were no long term strategies found for recovery in these areas.
The cultural changes that are needed to support this point towards a need for more flexible, innovation-based practice and funding models and governance structures to support future development.
There is a need for a structured process that examine the system of values and risks together, rather than assessing these aspects in isolation.

Perceived allocation of risk ownership exercises indicate imbalances with current public/private sector ownership of values and ownership of risk (Figure 3).
Skills and capacity in the area of strategic decision making are patchy and need development.
Areas of shared ownership need clarification to ensure that there is understanding and acceptance of who is allocated ownership, what it is allocated for and how this is to be achieved.
Further research is also need to better understand how ownership is shared between institutions and what new arrangements may be needed to support better and more sustainable risk ownership across all institutions.
Uptake of risk ownership requires that actors who are delegated ownership have the capacity and capability.

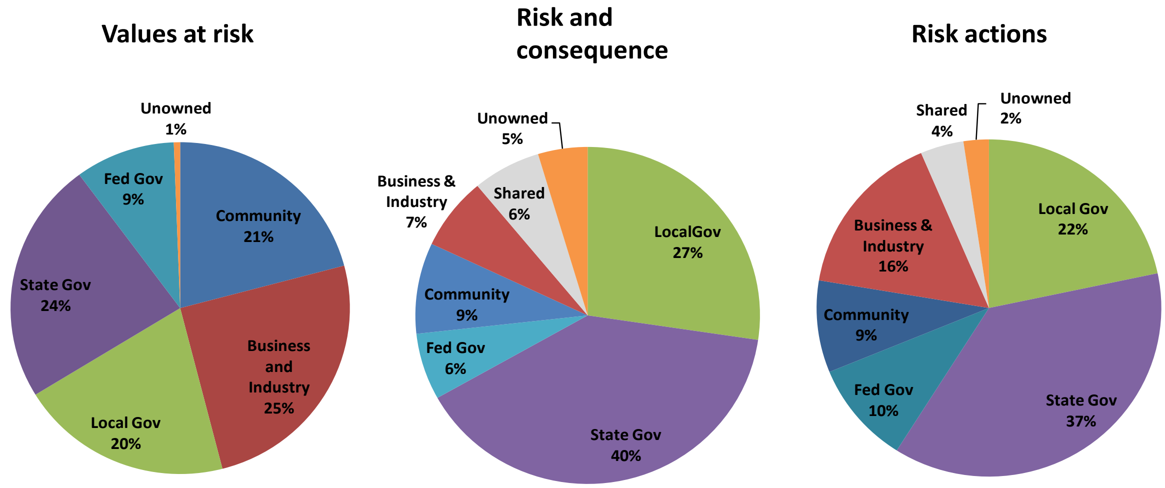

Figure 3: Allocation of institutional ownership across key decision-making areas.

CONCLUSION

The changing nature of natural hazards and the socio-economic context in which they occur is leading to the emergence of new and different types of risks being encountered by society. Communities, businesses and governments require a strategic focus that builds greater capacity, if they are to effectively build resilience to these events. It also requires systemic thinking that starts with the understanding of what values are at risk and how they are at risk.

We have identified risk ownership as a major contributor to resilience at the individual to institutional scale, and are working to build the two aspects of ownership: value ownership and designated risk manager, into processes for the strategic management of natural hazards.

A key message from our workshops was that there is a need to rethink expectations in relation to institutional ownership because the current arrangements are unsustainable. To achieve this requires substantial cultural change, in particular (Young et al., 2016a):

The building of robust risk cultures across communities and public and private organisations.
Organisational flexibility and responsiveness and the frameworks to support this.
A willingness to work with what is unknown and to accept that there is no one perfect solution or answer. To ask 'what if' rather than state 'what is'.
An understanding of current perceptions of how success, failure and risk appetites can impede progress.
he development of values-based decision making and governance.
Capacity and capability building that can be achieved in the face of resource constraints is needed across all institutions.
Long-term communication, coordination and engagement across diverse stakeholders.
If resilience is to be everyone's business, this then requires recognition and understanding of what the risk is, who owns it and levels of ownership acceptance. It also requires strategic and systemic thinking and the ability to identify and coordinate the multiple agendas, institutions and organisations that contribute to resilience activities. Risk ownership is a thread that can bind these aspects together, with values providing a foundation. If we are to build resilience to natural disasters, embedding value-based decision making frameworks and governance that builds and supports implementation of risk ownership in planning frameworks is crucial.

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POST-DISASTER CONSTRUCTION WASTE MANAGEMENT STRATEGIES: CASE STUDY CANTERBURY EARTHQUAKE

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ABSTRACT

Natural disasters generate enormous amounts of waste, which adversely impacts on public health and the environment. The increasing number of natural disasters has made post-disaster construction and demolition (C&D) waste management a crucial component of disaster recovery. This became apparent in New Zealand after the Canterbury region suffered enormously from the 2010 and 2011 earthquakes. The East Coast City of Christchurch was severely affected, with the resulting demolition of around 1,400 commercial properties and 7,500 residential properties. It was estimated that this generated approximately 4 million tonnes of debris and probably more than a million tonnes from repairs. The government-appointed Canterbury Earthquake Recovery Authority (CERA) led and coordinated the recovery effort, including post-disaster C&D waste management. This paper reflects on the post-earthquake C&D waste management processes and their limitations, and makes recommendations to improve operations in future disasters. In-depth semi-structured interviews were conducted with government and non-government organisations involved with C&D waste management, including CERA and accredited demolition contractors.
Findings revealed that the “pick and go” strategy introduced by CERA was very effective, as it directed debris straight into the end-use market. This study identified a number of limitations in the current C&D waste management process, such as lack of pre-event planning; poor coordination between local authorities and contractors during the recovery, incomplete policies and acts, and insufficient capacity in C&D waste facilities to process waste. The findings from this research contribute to a growing body of literature on Post-disaster C&D waste management. This paper recommends the creation of a powerful organisation with a clear responsibility and goal to fully control waste management in future disasters in New Zealand.

Keywords: construction and demolition waste, post-disaster construction, waste management strategies, Canterbury earthquake

INTRODUCTION

Disaster occurs in many forms, natural and man-made including “sudden onset” such as earthquake, fire, flood, tsunami, hurricane and volcano, or “prolonged onset”, for instance civil conflict or drought (Brown, Mike and Seville, 2011). Most disasters overwhelm the capacity of the affected regions to react to them in an appropriate way to save people, to protect property and to maintain the social and economic stability of these regions. In some cases, debris volumes from a single event are five to fifteen times greater than the waste generated by affected regions in normal situations (Reinhart & McCreanor, 1999). As urbanisation and complex infrastructure increases, the community becomes more vulnerable to such disasters (Brown, et al., 2011). Karunasena, Amaratunga, and Haigh (2012) stated that during a post-disaster situation, the types and volumes of waste generated change drastically. Hence, post-disaster C&D waste management is one of the most crucial activities during the recovery period (Karunasena, Rameezdeen and Amarathunga, 2013). The C&D waste generated by an earthquake can impede emergency services and pose an adverse public and environmental health local impact. Consequently, both short-term and long-term recovery could suffer, due to inappropriate and poor post-disaster C&D waste management.

In September 2010 and February 2011, the Canterbury region of New Zealand experienced massive earthquakes. According to government statistics,1,400 commercial properties and at least 7,500 residential properties needed demolition. It was estimated that approximately 4 million tonnes of debris was generated by the demolition and reconstruction work and probably more than million tonnes from reparation activity (Mike, 2011). In addition to that, more than five hundred thousand tonnes of liquefaction silt needed disposing of after the earthquake (C.C.Council, 2012). The debris from many buildings (commercial and residential properties) needs special handling. Earthquakes cause significant damage and put more social, environmental and economic burdens on living conditions, recovery and waste collection processes. In recent decades, New Zealand has been more prone to natural disasters, mainly earthquakes and tornados. Therefore, effective post-disaster C&D management has become a critical issue in responding to a disaster.

This paper aims to investigate the post-earthquake C&D waste management process implemented in Christchurch, and present recommendations to improve limitations in existing practices.

POST DISASTER WASTE MANAGEMENT STRATEGIES

Suitable and sustainable waste management could minimise the generation of waste, and encourage the reuse, recycling and recovery of waste.
Different authors have classified C&D waste from a disaster using different

approaches. For instance, Karunasena, Amaratunga, and Haigh (2009) categorised C&D waste according to types of material. Canterbury Earthquake Recovery Authority (CERA) came up with a broader categorisation than the above and categorised all waste into four major categories: clean-fill materials; sorted materials; hazardous materials and mixed materials.

The generation of C&D waste is not avoidable after a disaster. Normally, disaster debris management will start immediately following a disaster and last throughout, until completion of reconstruction (Pike, 2007). The majority of the published research has focused on pre-disaster activities (protecting water supply systems, developing effective evacuation plans), but less attention has been given to post disaster response activities such as debris disposal and infrastructure rebuilding (Fetter and Rakes, 2012).
However, Lorca (2015) stated that effective waste management must be initiated in two phases: pre-disaster and post-disaster. In the pre-disaster phase, protective disaster waste-management strategies should be introduced, by offering an imperative solution to reduce the risks posed by hazards and to attain speedy recovery after disaster. Post-disaster debris management mostly focuses on policy-related issues such as assigning responsibility and listing administrative procedures. Further, Fetter and Rakes (2012) mentioned two phases of disaster debris cleanup operations. The first phase begins immediately after the disaster, to clear debris from evacuation routes and other important pathways to ensure access to the disaster-affected area. Phase two is the longest period, including: organise and manage debris collection, and manage operations related to debris reduction, separation, recycling, and disposal.

Governments and other responsible authorities have initiated various waste management guidelines or debris management plans, which vary from country to country based on the situation, such as debris management guidelines by a Federal and Emergency Management Agency (FEMA), Japan’s Society of Material Cycles and Waste Management manual for strategies for separation and treatment of disaster waste, and planning for disaster debris by the United States Environmental Protection Agency (USEPA) (Asari et al., 2013). The Government of Japan has initiated conventional biomass Combined Heat and Power (CHP) plants to generate energy from waste as a solution to country's energy shortage (Portugal-Pereira and Lee, 2016).

In addition, various researchers are investigating and developing numerous types of disaster waste management strategies, based on relevant case studies using both qualitative and quantitative approaches. Lorca (2015) introduced a mathematical model to use in both the pre-disaster stage, to

prepare strategic debris-management plans, and in the post-disaster stage, to determine decisions at an operational level. Onan, Ulengin, and Sennaro (2015) developed a multi-objective optimisation model for determining the locations of temporary storage facilities, and planning for the collection and transportation of disaster waste. Fetter and Rakes (2012) reported on a decision model with recycling incentives for locating temporary disposal and storage reduction facilities in support of disaster debris cleanup operations. A facility location model was proposed, to incorporate the unique assumptions, objectives, and constraints of disaster recovery in light of the FEMA policy.
Hu and Sheu (2013) suggested a reverse logistics approach for post-disaster debris management, to minimise economic, risk-induced and psychological costs. Numerical results indicate that the proposed system reduces psychological costs by 54.93%.

Brown (2012) identified the six main elements of disaster waste management systems as: strategic management, funding mechanisms, operational management, environmental and human health risk management, and legislation and regulation. The author further developed key decision-making guidance and management principles for each of the elements. Considering the characteristics of building waste, some suggestions and applications on potential reuse and recycling of building waste could be applied in reconstruction work in earthquake disaster areas. Baycan (2004) provided information on collection, separation, recycling activities and disposal of disaster demolition waste following the Marmara earthquake, and offered guidelines for emergency planning for managing various waste types. Brown and Milke (2016) further demonstrated that: volume of waste, degree of mixing of waste, human and environmental health hazards, the real extent of the waste, community priorities, funding mechanisms and existing and disaster-specific regulations need to be assessed, to determine the feasibility of disaster-waste recycling programmes. The appropriateness of on or off-site waste separation depends on four factors: time constraints, resource availability, degree of mixing of waste and human and public health hazards. Accordingly, the authors mentioned that a successful recycling programme requires good management, including clear and thoroughly enforced policies (through good contracts or regulations) and pre-event planning.

Karunasena et al., (2009) concluded that the poor implementation of prevailing rules and regulations, poor standards of local expertise and capacity, inadequate funds, and a lack of communication and coordination were the main challenges to overcome in the post-disaster phase. According to Kaklauskas et al. (2009), post-disaster management has various approaches that should be reasonably compatible with disaster-level economic, social, cultural, institutional, technological, technical, cultural, environmental, and legal/regulatory situations in the country under consideration. The strategies, issues, and challenges associated with waste management vary according to the type of disaster, magnitude, location, and country (Karunasena et al., 2009). It was obvious that effective waste management strategies should be tailor-made to the disaster conditions.

METHODOLOGY

A comprehensive literature review and qualitative approach was adopted in this study to identify post-earthquake C&D waste management processes, challenges and improvement opportunities. Data was gathered from local councils, CERA and accredited demolition contractors in Christchurch. Six local institutes responsible for managing C&D waste were selected for data collection (two from each), covering both government and non-government organisations. Interviewees were selected ranging from top management to field professionals, in both government and non-government organisations, who have been involved in the post-earthquake C&D waste management process. Apart from the above, nine interviews were conducted with CERA-accredited demolition contractors. In-depth semi- structured interviews were conducted, to obtain in- depth views and opinions of stakeholders within the research area. Content analysis was used to analyse data collected from interviews.

FINDINGS AND DISCUSSION

Christchurch earthquake C&D waste management process

Prior to the Canterbury earthquake, post-earthquake waste management was not considered in training and planning in Christchurch. Although there was a debris disposal guideline published by the Wellington Region Civil Defense, this was not adopted during the post-disaster recovery phase of the Canterbury earthquake. Initially, there was no set procedure to manage C&D waste. Hence, waste management mainly relied on coordination between demolition contractors and regional authorities, as well as the different government organisations. In order to accelerate the recovery and removal of all C&D waste as soon as possible, treating (separation of) this waste at the debris site is necessary. However, both the government and organisations involved often ignored this step, intentionally or unintentionally. In Christchurch, initially, no on-site separation was carried out post-earthquake (Brown et al., 2011).

The government established CERA under the CER Act to accelerate the recovery process. In order to manage post-earthquake debris, CERA introduced a clean method called “quick pick and go”, which directed waste straight to its end-use market. In fact, a similar method had been used after

the 2004 Sri Lanka Tsunami (Karunasena et al., 2012). It was compulsory for all the demolition contractors who intended to undertake demolition work to be accredited by the project management office under the CERA, according to the CER Act. The accreditation process ensured contractors were suitably experienced for relevant projects, maintained consistent standards, raised awareness and allowed contractors to undertake more complex demolition as they developed their expertise and experience.
However, at the initial stage of the disaster, there was no specific way to obtain a job. Due to the urgency of some essential demolition works, contracts were granted without following a proper tendering process.

Although CERA plays the key role, a variety of professionals and many organisations, including Civil Defence and regional councils, were given enormous help to plan and execute waste strategy, as per the CER Act. Due to the scale of the earthquake, the decision-making process involved integrated and timely decision-making across a range of organisations. CERA is the main organisation that facilitates the coordination needed to help restore the social, economic, cultural and environmental wellbeing of the greater Christchurch community, and lead or partner with local communities to return greater Christchurch to a prosperous and thriving place to work, live and play, as quickly as possible. CERA had power to determine what demolition works should be done and the corresponding waste management. A demolition team in the CERA includes professionals such as project managers, contractors and engineers.

Since most C&D waste can be recycled, a lot of post- disaster recovery and operations can utilise the waste, such as aggregates for concrete or road filling (Karunasena et al., 2012), and recycled aggregated bricks and blocks (Xiao, Xie, & Zhang, 2012). The recycling of C&D waste is routine in a disaster, as most waste can be separated, crushed and then exported. A number of authors released a hierarchy of C&D waste disposal options, which consist of six levels; reduce, reuse, recycle, compost, incinerate and landfill (Blengini, 2009; Tam and Tam, 2006). The findings clearly show that the aforesaid hierarchy was utilised in post-disaster C&D waste management in the Canterbury earthquake. The Burwood Resource Recovery Park (BRRP) was established urgently, to manage the reception and resource recovery processing of mixed demolition waste from Christchurch city. The facility delivers a series of quick, low risk solutions to address the problem of waste. It is estimated that around 4.25 million tons, mainly of mixed demolition waste from demolition of properties, was processed at this site. Within this facility, there were a manual sort line and a mechanical separator including screens, magnets and density separators. This facility plays a crucial role in the waste management process, as it enables the reuse and recycling of C&D waste that would otherwise have been sent to landfills. However, interviewees mentioned that BRRP of Christchurch was not adequate to manage a great number of waste materials, and hazardous materials (such as asbestos) were not processed appropriately.

Landfills were considered the final step of the waste management process. Due to insufficient separation, more waste was dumped in the landfill. However, the landfill space was not sufficient for the C&D waste generated from the earthquake cleanup. For instance, the landfill site located in Kate Valley near Christchurch only had additional capacity to take 300 – 500 tons per day. If BRRP had not existed, the Kate Valley and other transfer stations could not have handled the amount of C&D waste. In order to reduce the public health risk of landfills, a surcharge was applied at the landfill for receiving asbestos in Christchurch, due to the extra operation (separation) and handling needed.

Additionally, land reclamation was used to dispose of the “clean” waste. It mainly accepted specific materials such as stone, bricks, tiles, aggregates, reinforced concrete, asphalt and glass, as ordered by the Ministry for the environment (MfE), according to CERA under the provisions of the CRE Act.

Apart from the CER Act, existing legislation applied to the post-earthquake C&D waste management process. For instance, the Resource Management Act (RMA) carefully monitors waste disposal activities to protect natural resources in New Zealand from discharges to air, water or land. The provisions in the building Act 2004 have to be followed to obtain demolition consent for buildings. In general, the Waste Minimisation Act 2008 aims to minimise the amount of waste sent to landfill, by imposing a levy on waste disposal. However, during the post-earthquake recovery period, the levy was suspended to accelerate the recovery process. The Health and Safety in Employment Act 1992 aims to provide a safe working environment when dealing with asbestos waste in the demolition process. However, CERA has strong powers beyond the regulations above. This has been a substantial legal debate, where the public was not given an opportunity to comment or made recommendations (Milke, 2011).

The Figure 1 shows a summary of the C&D waste management process used in Christchurch during the post-earthquake recovery period.

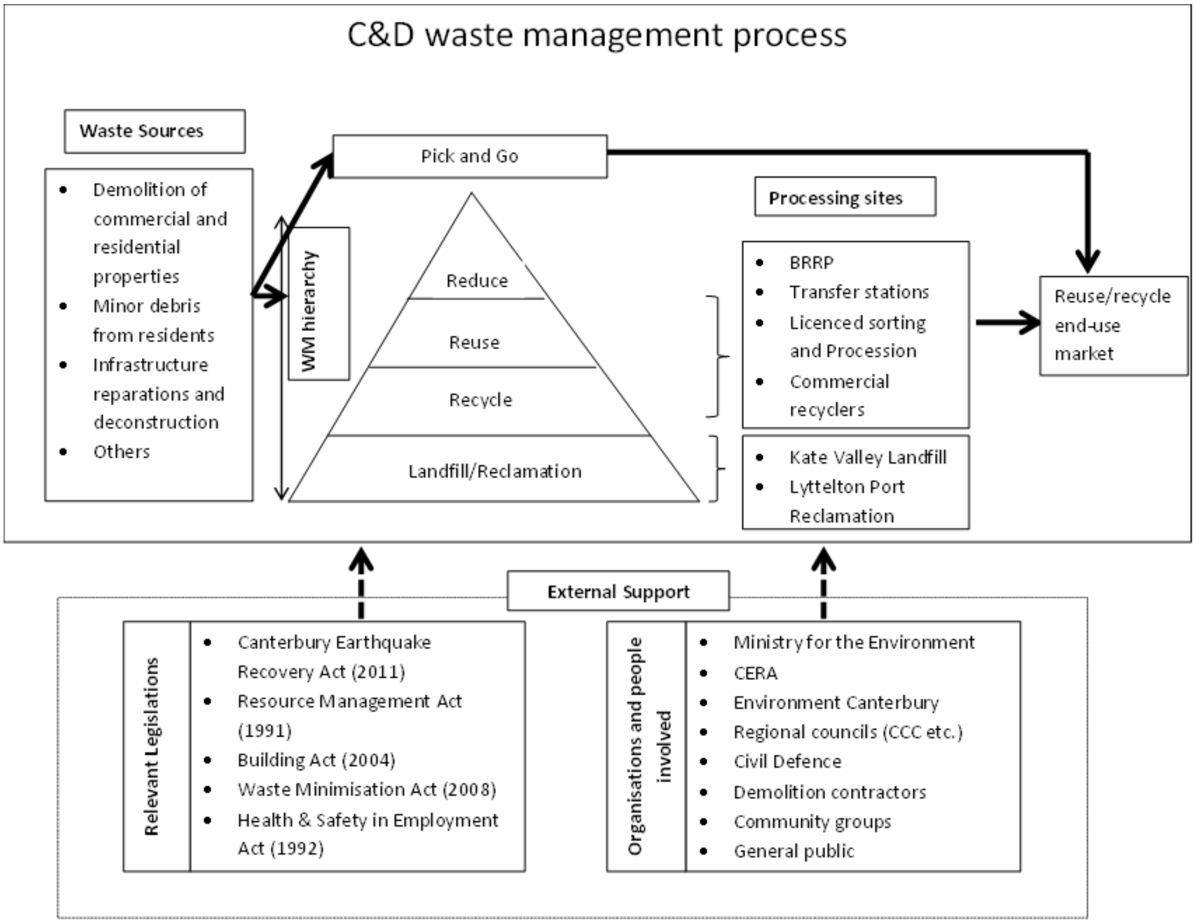

Figure 1: C&D waste management Process

Limitations and improvement measures for post-earthquake C&D waste management

During the recovery period in Christchurch, restoring the social, economic and environmental wellbeing of greater Christchurch communities was the desire of the people of Christchurch. In order to achieve this, different methods from previous experience had been implemented. During the interviews, interviewees stated a number of limitations in the Canterbury earthquake C&D waste-management process. They highlighted that even though the establishment of CERA and CER Act was reasonably quick after the first earthquake, CERA was not functional as quickly as authorities imagined. The transition period from the earthquake to the CERA Act implementation took almost three months from the earthquake. Prior to the establishment of CERA, many organisations (Ecan, CCC, Civil Defence etc.) were involved in waste management, and this resulted in overlaps in waste management. This was emphasised by a number of interviewees (12 of 21) as the main reason for delays in the whole waste management process.
They strongly believe that if legislation like CERA had been established before earthquake, the waste management process would have been far

more effective. Consequently, the findings highlight that unclear roles and responsibilities confused organisations and professionals involved in the process. Although the CER Act was issued with the good intention of managing the C&D waste in an orthodox manner, accredited contractors believe the provisions designed in Act and CREA management did not meet reality. According to the interviewees, the efficiency of the waste management process was significantly affected, as CERA required monitoring and approving of all demolition plans. Most demolition contractors were not satisfied with the consent approval process, and found the great deal of paperwork to be completed every week very time consuming. Also, the coordination between contractors and CERA was poor in practice. The main conflict was about poor reactions in reality, such as the facilities, qualifications, and consent approval process. This finding is totally different from the experiences of other countries and not anticipated by CERA. Furthermore, in a previous study, Milke (2011) mentioned that there was little opportunity for public comment before establishing CERA. After analysis of the interview data, the contentions were proved justified to some extent. There were a number of limitations on the equipment and methods used by demolition contractors, according to the provisions of the CER Act.
This also significantly affected the overall waste-management process. For instance, a waste airburner was prohibited from use onsite, although it complied with European and USA legislation. Additionally, the contractor's own processing facility was forced to stop. Because of the new legislation, CERA was granted strong powers to override a large number of regulations.

In addition to the above, the capacity of waste management facilities, hazardous materials management, and protection of personal contents were significant challenges during the process. Also, limited dump sites in Christchurch created a number of environmental issues, as waste often contains different kinds of hazardous material. The literature shows that seventeen dump sites were used after the Marmara earthquake in Turkey (Baycan, 2004), and seven dump sites after Hurricane Katrina (Stephenson, 2008). However, the strategy named 'pick and go' is used to deliver demolition waste to the end-use market directly, which minimises the volume of demolition waste onsite (Brown et al., 2011).

Although a number of organisations, ranging from Civil Defence to local councils, worked hard on waste management, lack of a pre-event disaster waste management plan is a significant fault in this case. Therefore, some interviewees (9 of 21) suggested that "the post-disaster C&D waste management needs to be improved in future, and a pre-event plan is crucial". Furthermore, residents and contractors strongly believe the organisations involved in C&D waste management require more authority to meet real situations in future disasters. Most interviewees (14 of 21) highlighted that they were confused with the decision-making process needed to continue the work, and that bureaucracy has influenced people’s judgement. Therefore, a majority of interviewees (15 of 21) suggested the need for a powerful organization, with a clear responsibility and goals, to take full charge of the waste management in future disasters.

CONCLUSIONS AND RECOMMENDATIONS

New Zealand has become more prone to natural disasters, mainly earthquakes and tornados. After the Canterbury earthquakes in 2011, post- disaster C&D waste management has become a critical issue in reinstating lifestyles affected by earthquake. There was no pre-established C&D waste- management plan prior to the earthquakes. This resulted in a number of initial inefficiencies and delayed the whole recovery process. The situation was reasonably managed after the establishment of CERA under the CER Act. The “pick and go” strategy introduced by CERA facilitated fast C&D waste management, as debris collected was transferred straight to the end-user market. However, a number of inefficiencies were identified in the study including: poor coordination between contractors and authorities, insufficient capacity for waste processing, conflicts in existing legislation and lack of a pre-disaster waste-management plan. The study recommends developing a robust C&D waste- management plan, covering both pre- and post- disaster stages, and a more powerful organisation than CERA to handle emergency situations more effectively and efficiently, by taking timely decisions.

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DISASTER RISK AND RESILIENCE IN INFORMAL SETTLEMENTS: THE CASE OF GUINEA-BISSAU

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ABSTRACT

Despite in 2013 the World Risk Index positioned Guinea-Bissau as one of the fifteen countries more exposed to disasters in the world, up to now little work has been done to reduce disaster risk to houses and cities. The current research is based on fieldwork conducted by the NGO Building 4Humanity (B 4H) within communities of the informal settlements of Bissau, the capital city, where the vast majority of the city's population lives in precarious conditions. Conducting in loco observation, technical reports and semi infra-structured interviews with stakeholders, in particular community-dwellers, B 4H is developing social and technical surveys with the goal of doing a detailed report on the exposure to the risk of self-help constructed family houses. The activity includes the study and implementation at urban scale of measures aimed at reducing the impact of floods and their effects on buildings made with traditional local materials such as earth and wood. The project of a new school for a local community and the reinforcement of the existing private houses will serve as a particular laboratory to essay construction techniques that might improve resilience to the effects of rains at the building and street level. First results indicate that the many works and enlargement of family houses, to accommodate more family members, ends contributing to increasing vulnerability. Work within communities, educating to risk and involving the population in the mapping of vulnerabilities and resilient practices, seem to be useful tools to raise awareness of exposure to risk as well as mitigate impacts of urban disasters.

Key words: Guinea-Bissau, community resilience, informal settlements, risk reduction, urban disaster

INTRODUCTION

The current research is based on fieldwork carried out by the NGO Building 4Humanity (B 4H) within communities of the informal settlements of Bissau, the capital city of Guinea, where the large majority of the city's population lives in precarious conditions.

Conducting in loco observation, technical reports and semi infra-structured interviews with stakeholders, in particular community-dwellers, B 4H is developing social and technical surveys with the goal of doing a detailed report on the exposure to the risk of the family houses made in self-help construction with earth, wood, and zinc. The activity includes the study and implementation at urban scale of measures aimed at reducing the impact of floods and their effects on buildings. The project of a new school and the reinforcement of the existing private houses will serve as a particular laboratory to essay construction techniques that might improve resilience to the effects of rains at the building and street level.

The first results obtained indicate that the many works and enlargement of family houses, to accommodate more family members, ends contributing to increasing vulnerability.

Work within communities, educating to risk and involving the population in the mapping of vulnerabilities and resilient local practices, seem to be useful tools to raise awareness of exposure to risk as well as mitigate impacts of urban disasters (Hamdi, 1997, 2014; Sanderson, 2004)

CURRENT HOUSING AND OVERALL LIVING CONDITIONS IN GUINEA-BISSAU:

lack of basic services

Broadly speaking, the surveys found some tendencies among the population and characterization of the neighborhoods, which feature neither sewage nor water supply systems, and the water is still collected from traditional wells. Also, there is no public lighting except in very few main streets, and domestic electricity connection remains an exception. Several environmental problems are reported: numerous dumping areas, trash infrequently collected and consequently accumulating near houses, and, even more dangerous, shaky dry pit latrines, usually shared by several houses, becoming saturated. The Bairro Militar, the most populous of Bissau, with several tens of thousand inhabitants, has no health centre, with the result that people take between half an hour and one hour to arrive at a public hospital, and no community services are provided. Some thirty years ago it was estimated that almost 80 % of the population of Bissau lived in informal settlements known locally as "bairros", meaning popular neighborhoods (Davila,1989; Acioly 1992, 1993). These settlements grew in an informal way, without urban plans or observation of building regulations. Roads are rarely paved, and the space between the omnipresent one-storey houses is barely identifiable as a street, in spite of the frequent occurrence of local commerce. The few communal water taps in existence are insufficient to meet the actual demand for potable water.

local traditional building techniques

Dwellings are usually constructed with adobe bricks (fig. 1) according to a local building type of one-storey house with a rectangular, sometimes square shape (10-15 meters side) surrounded by a wide balcony (around 1,80m deep) and with four to six rooms. The balcony, 'veranda', works as a place for preparing the meals, socializing and resting. These houses usually have a roof that is four-sided and covered by cheap corrugated zinc sheets (fig. 2), covering an area equal to 180 m2, and sometimes even larger that includes the veranda so that the overhang protects the adobe walls from the rain. The bathroom is constructed outside, at a short distance from the home, since it is a traditional latrine, sometimes used by residents of several houses. Houses are grouped with more or less density depending on the location; for instance, on the main roads with local commerce they tend to be closer and more aligned, whereas in more residential areas they respect some distance, allowing some communal spaces in between and apparently following no clear order. These types of settlements seem to replicate the traditional rural 'tabancas' which the B 4H team visited, for instance, in the Pecixe island, in Cacheu region and nearby Quinhamel, in Biombo region (Correia Guedes et al, 2011). Remarkably, can happen that women and her children play a crucial role in the building process. As it was observed, sometimes handle the entire construction whereas men are elsewhere, supposedly doing business. (see fig. 1)

Householders pay the Municipality a yearly land occupation tax of around 7€. Land tenure is based on the customary rules ("traditional occupation"), except when the plot has been demarcated and regularized by a property title issued by the Municipality, which is the minority of cases. The population density is very high, usually above 200 inhabitants/ha and the multiple dwelling unit is often overcrowded, providing lodging for more than one family, or for extended families, with ten, sometimes up to twenty relatives. A household with up to four or five children commonly occupies two rooms of 16 m2. The B4H team interviewed a retired civil servant whose home sheltered a record of forty- three people; although the women ran an informal trade selling a few vegetables and mangos, all of them depended on his retirement pension of around 90€/month and vegetable garden production. Salaries of thirty- five or forty-five euros are standard, and many teachers reported having two or more jobs. Taxi drivers and people working on the privately- operated buses, the so-called 'toca-toca', which employ several thousands of individuals, work between twelve and fourteen hours per day in twenty or thirty-year-old vehicles in the midst of dense traffic and polluted air for a monthly income of seventy to one hundred euros. These numbers and housing features confirmed that Guine-Bissau ranks amongst the poorest less developed countries in the world. (UN-Habitat, 2014).

characterization of the country regarding disaster risk

According to unofficial numbers, Guinea passed the 1,700000 inhabitants, and nearly one-quarter of the population lives in Bissau, with a high percentage of families occupying squatter houses or sharing overcrowded unities as described above. Their neighbors have, in general, one single paved main street. In addition to several non-defined and claim roads subject to a long process of erosion, rain drainage gutters are in many cases obsolete, systematically blocked by solid waste or just inexistent. As a consequence, the rainfall forges its path and makes, what in the beginning, resembles grooves, rapidly passing to natural ditches until constituting authentic ravines, through which water flows dangerously, considering the proximity to walking paths, courtyards, and houses (see fig. 5). The houses are built without foundations and adequate care regarding flood-prone areas, thus facing rapid deterioration and collapse.

Bissau is located on the Geba River estuary and is a very flat conurbation, reaching a maximum of forty meters of altitude while the whole country never passes the three hundred meters of altitude with the vast majority of the territory situated under the sixty meters. The low altitude added to a uniform topography and a tropical climate with a pretty steady rain season lasting from June to November, and finally, to a significant level of poverty and vulnerability of peoples and houses, create conditions to disasters related to flood and storms, favoring the impact of natural hazards. This combination of factors places the country in a position of total dependence on its limited natural resources and increasingly low levels of official development assistance (Silva, 2010).

In the 2013, World Risk Index of 2013 (WRI 2013), calculated by the United Nations University for Environment and Human Security (UNU-EHS) a report that systematically considers a country's vulnerability, and its exposure to natural hazards to determine a ranking of countries around the world based on their disaster risk, positioned Guinea-Bissau as one of the fifteen countries more exposed to disasters in the world (WRR, 2013). According to the National Strategy for Management of Catastrophes' Risks (Silva, 2013) the recent crises that have affected Guinea-Bissau comprises: the military-political conflict of 1998-1999 that destroyed nearly 30% of national infrastructures; the floods, which affected 1,750 people; tropical cyclones that caused 2712 victims; epidemics, with particular incidence of cholera, affected 105 380 people causing 3032 dead. Summing up, the anthropic accidents caused 7,000 victims while the rains destroyed more than 829 homes and 25 schools nationwide. As stated in the same report, the State of Guinea-Bissau starts to recognize the integration of disaster risk reduction in the socio-economic development of the country as a prerequisite for achieving the millennium development goals (MDGs). As such, reduction of disaster risk stands as a priority in the National Strategy Document for Poverty Reduction (2011-2015) and is also part of the strategy and national policy on the Action and Adaptation of Climate Change national program (2006), as well as in the National Strategy for Protected Areas and Biodiversity (2009-2013). However, little work has been done in the past few decades in Guinea-Bissau to reduce disaster risk to houses and cities.

specific disaster risk issues, at the building and street level

At the urban scale of the neighborhood, some disaster risk measures applied by the residents were reported, for example, temporary barricades made with earthbags protecting entrances, surrounding houses or strategically aligned in crossroads (fig. 3). Other actions to protect from the rain include homemade mud plaster (fig. 4), executed in a very basic way by family members and the tying of the zinc sheets (fig.4). The reinforcement of the adobe or rammed walls with steel bars is almost unknown while the replacement of the veranda pillars and the roof frame, both made in Sibe, the traditional local wood, by reinforced concrete are increasing, although still too much expensive for the majority of the population. (Correia Guedes et al, 2011)

On one hand there are some urban and architectural endeavors to mitigate the impact of disasters; on the other hand, the enlargement of houses, to accommodate more family members and newcomers, become an issue. These extensions of the residential units are often made at the cost of the space of the verandas and somewhat would not constitute a problem since these has ample surfaces. Nevertheless, the new rooms are often built with their walls aligning with the edge of the roof and as such, these walls receive water from the gutter, are exposed to the rain and wind. When the enlargement surpasses that alignment, to gain some more space and achieve a more comfortable bedroom or kitchen, susceptible points appear, such as construction joints and leaks. These works are done without a permit and the participation of specialists, being entirely executed by members of the family, instead. As a result, rather than improving weakness, incremental housing ends contributing to increasing vulnerability (see fig 2). (Greene et al Rojas, 2008)

fig.1 traditional adobes bricks

fig.2 roof: corrugated zinc sheets

fig.3 earth bags against floods

fig.4 homemade mud plaster

fig.5 rainfall and flow water impacts

fig.6 enlargement processes

fig.7 mapping exercises

fig.8 modelling exercises

RESEARCH METHODS; FIELDWORK PRACTICES

local surveys; inquiries; identification of local responses to risk; exploring community-driven design through working with children

In 2015 an ad hoc interdisciplinary team of the NGO Building Humanity (B 4H) worked in Guinea-Bissau, within the community of the neighborhood of Plack 1, in the locally known as the Militar district. This area is an informal settlement without infrastructures and basic services where people live on the edge of poverty facing, on a daily basis, several challenges. With the precious the assistance of local teachers, the NGO team, a small group of architects and a psychologist, carried out a two-week program, previously discussed with the members of the school board, that comprised: three different workshops with students, including drawing, mapping, and models construction (see. fig. 7 and fig. 8); diverse meetings with teachers, parents, community representatives; interviews with key community actors; audiences with national authorities, including six state general-directors; architectural and social surveys. All activities intended to support the construction of a new school while raising awareness on urban disaster issues. Throughout the process, the teachers involved consulted with both civil and religious community leaders as well as the representatives of parents and guardians. The workshops, interviews, and inquiries registered high levels of participation. The fieldwork succeeded thanks to the involvement of some teachers who volunteered as all-purpose personal assistants and impromptu translators as despite Portuguese being the State's official language, the Guineans normally speak Creole, a common mother tongue among a population that belongs to more than twenty different ethnicities. The surveys addressed urban daily living conditions in a broad sense but mainly focused on housing and building issues, exposure to natural disasters, perception to the risk, construction skills and prevention measures to reduce the impact of rains, storms, winds, and floods.

ANALYSIS OF RESULTS AND OBSERVATIONS

identification of the local perception about the exposure to risk Poverty may explain, to some degree, why the locally called 'precarious constructions' remain for a long time, despite their fragility and lower resistance to natural agents. Householders seem to be aware of the risk that they are facing and despite the traditional African relaxed attitude they do fear that a great storm or flood would damage their homes and harm their relatives. In accordance to this concern, they corroborate the necessity of changing their situation, improve their houses, rebuild, perhaps, build a new one. Regarding their personal aspirations, it is frequently the reference to getting a better job or starting a business, namely exploring a container-shop. The lower wages, the country's long-lasting unstable political situation, the still incipient state of the economy, human rights and the rule of law, seem, however, to positively constrain peoples' ambitions, and no alternatives remain. Many of the interviewed revealed an interest in accessing the micro-credit, but so far they have not had contact with banks or other providers.

considering sustainable solutions with practical feasibility

Practical solutions to reduce the damages provoked by floods can be studied both on the urban and on the building scale.

On the urban scale, the main vulnerabilities include the lack of a drainage system and the shape of the roads, which is unsuitable to drain rainwater. The observations in the field show that people usually protect their houses placing rows of earthbags along the unpaved paths. A contribution to support this activity could come analyzing the digital maps, to get an overall idea on how the rainwater flows among the buildings. This analysis could allow for studying where to place and how to adjust the earthbags to achieve predetermined goals such as decreasing the water flow speed throughout the spaces between the buildings, preventing water from concentrating in proximity to the houses and, as a consequence, from damaging the building ground floor platform.

On the building scale, the vulnerabilities of the houses often include the inefficient connections between structural elements such as the main walls at the corners, the main walls at the top (absence of the bond beam) and the veranda pillars with the roof. They also include the nonexistence of plaster on the external walls that were moved from the original position and aligned with the roof edge, due to housing needs, such as the addition of a new room or the extension of an existing one. When it rains and in the event of floods, these walls are subjected to dangerous surface runoffs.

Moreover, it is worth to refer the current habit of replacing the old thatched roofs with bad quality corrugate zinc sheets, which are cheap and easy to obtain in the market and considered by householders as a mark of modernity. Despite its seeming usability as a protection from the rainwater, the zinc roof is an omnipresent feature of the precarious family houses that can also be considered as an indicator of vulnerability as it makes the living conditions inside the buildings substantially worse. All these are bad building practices that do not come from the local architectural culture, which on the contrary includes careful attention to details such as the incorporation of local reeds, such as bamboo, to make the walls elastic and thatched roofs connected with the main walls. These good practices produced long-lasting buildings, indeed, with good energy performances (Correia Guedes et al, 2011).

FINAL CONSIDERATIONS

Instead of imposing solutions or providing recommendations the team of the NGO Building for Humanity preferred to act as facilitators and sought to involve the community by organizing meetings with adults and practical activities with children. The workshops and informal dialogues confirmed that the latter can learn the good building practices through play and that latter can be sensitized to architectural and raise awareness of the risk issues through the eyes and handmade work of their suns and daughters. Meeting and interviewing adults was aimed at gathering information about their skills, needs and expectations in relation to the (re) building processes. They also showed that the community is available to cooperate and how is willing to be involved at the design and building process. Sketches and drawings proved to be useful to study technical proposals within the research activity. They also demonstrated their potential for effectively communicating with the community, both with children and adults.

Cooperating with the local community in building and design process implies a mutual transfer of knowledge between the researchers and householders. In fact, on one hand the researchers might simply suggest solutions to increase resilience; on the other hand they are willing to take in consideration the feedback received by people who express their expectations. The experience on the field shows that a reasonable strategy to increase the resilience of the community is to propose strategies that people are really going to implement, according with their experience, traditions and current expectations. The challenge of the researchers doing action-research, whenever engaged in long-term humanitarian assistance, as the one pursued by low-profile NGOs is to provide suggestions about practical measures aimed at driving people to adopt the correct solutions from the technical point of view. A theoretical conception of improvement of local responses must, therefore, be grounded in local architectural culture and resources with consideration of the peoples' perception of the exposure to risk.

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WELLINGTON CORE SHELTERS: AN ANALYSIS OF NEED

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ABSTRACT

As a result of climate change, extreme weather events are becoming more common around the world. Coupled with the ever present threat of sea level rise that coastal cities face there is a potential for far more severe weather events to occur. This paper will seek to understand how an existing city can adapt to a more hostile environment, and how in the event of an extreme weather occurrence it maintains its function. There is an urgent need to understand how a city can respond when faced with these situations. Previous extreme weather events, Katrina, the Indian Ocean tsunami, and extreme flooding around the world, highlight the danger of a lack of preparedness and resilience found in most cities.
The purpose of this paper is to understand at how the concept of a core shelter, as a way to address the threats of extreme weather events, can be applied to a well-established urban context, Wellington NZ. A core shelter is a structure that in the event of a large scale disaster, protects its users, and post disaster still reaches permanent housing standards without being deemed to be a permanent dwelling. It will also look at whether it is possible to create areas in an existing city that can be considered "safe havens" in the event of an extreme natural incident.
This paper outlines the need for these shelters by identifying the potential threats of climate change in a Wellington context, and by understanding the vulnerability of Wellington's current building stock. It reaches a conclusion that through the implementation of core shelters in Wellington NZ, resilience will be improved, disaster response efforts will be aided, and destruction arising from extreme weather events will be reduced. In addition it determines that both a conceptual and a physical introduction of core shelters is a more effective way of building resilience than either one on its own, and identifies the areas of Wellington that are deemed to be of higher risk in a disaster, or extreme weather event.

Keywords: Climate change, adaptation, extreme weather, disaster risk, core shelter

INTRODUCTION

As demonstrated in Fischer & Knutti (2015), McBean (2004) and Solomon, et al, (2007), the number of extreme weather events around the world is increasing rapidly and non-linearly as a direct result of anthropogenic climate change, (See Figure 1, Figure 2). Severe heatwaves, windstorms and intense precipitation are a direct result of climate change and human impacts on the environment.

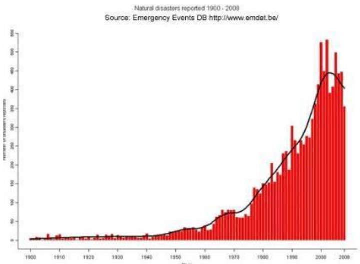


Figure 1: Natural disasters reported 1900-2008

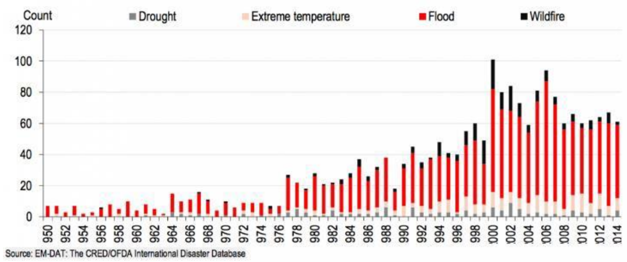


Figure 2: Extreme weather events 1950-2014

It is both the increasing frequency and the increasing severity of these events that pose a very real and serious threat to our cities and built environment. In order to effectively manage this increased risk, climate change adaptation (CCA) must happen throughout our environment, covering all aspects of population, assets and resources. With 66% of the world expected to reside within urban areas by 2050 (UN, 2014), it follows that addressing the issue of urban disaster management, and climate change adaptation is of the utmost importance, not just in the future, but also now. This paper will examine these issues within a Wellington context in order to establish the benefits of core shelter implementation, and whether disaster recovery efforts can be aided by these interventions.

RESPONSES TO CLIMATE CHANGE

The two main responses to climate change are those of mitigation and adaptation. Where mitigation looks at slowing or stopping the effects of climate change, adaptation understands that we have passed the point where we could stop global warming, and instead seeks to survive with the changing environment. This paper is predominantly interested in the adaptation of our built environment rather than the mitigation of climate change. Most research notes that adaptation should be implemented over time, and is made up of adjustments to our built environment and behaviours that will increase a community’s ability to survive an extreme weather event. Indeed, since we cannot stop extreme or anomalous weather events, our only option is to find ways to better survive them, to reduce our vulnerability and increase our ability to bounce back and recover. These studies, such as UNISDR (2005) (2011) and La Trobe & Davis (2005), assess the existing frameworks for disaster reduction, and propose new ways to integrate into the legislature of each country. While these studies are useful in order to gauge the current level of risk reduction efforts around the world, there are limited examples of physical implementation pre-disaster. Nonetheless, these examples are interesting in that they all advocate for active preparedness efforts to begin now, and all propose different ways of adapting, seemingly proving that each situation requires a different response. In the Netherlands, complex floating houses have been developed that allow for sea level rise to continue without threatening at risk housing stock (Tielen & Stam, 2013), while in Mexico (Pelling & Manual-Navarrete, 2011), and Canada (Henstra, 2012), a larger scale urban approach is advocated. The overarching idea that unites these studies is systematic diversity, in which there are a variety of ways that a city can be considered resilient, each one building upon the last (Bryant & Allan, 2011).

Wellington has a number of resilience based aspects to consider, including the strength of its sea walls, waterfront properties, seismic strength, and the reliability of infrastructure. The WCC has outlined a number of areas of resilience building that it will focus on over the coming years in the 2013 Climate change action plan, (Wellington City Council, 2013) with this document due to be updated in 2016. From 2010-2012 a sea level rise assessment was undertaken alongside resilience building, asset management and greater collaboration with local authorities. From 2013-2015, research on climate change impacts began, with adaptation integrated into resilience planning, greater public engagement, and water sensitive urban design implemented (Wellington City Council, 2013). While increasing the resilience of all aspects of Wellington is important, this paper suggests core shelters as a measure to accompany other resilience building efforts within the city.

Figure 3: Core shelter project, Philippines

Within the context of DRR and CCA lies the idea of a core shelter. A core shelter is a structure that in the event of a large scale disaster, protects its users, and post disaster still maintains permanent housing standards without being deemed to be a permanent dwelling (IFRC, 2013, p. 10), and thus is seen as a shelter that will be left once it is possible to do so. This process directly builds resilience into the city, in order to withstand any changing of its environment. Diacon (1992) details the Core Shelter Project of the Philippines, (Figure 3), and its ability to directly build resilience into a community. Since 1988, 41059 core shelter units have been completed, each one a simple and cost effective housing solution that has protected its inhabitants against typhoons with none being destroyed. This project demonstrated the success of this core shelter principle, allowing communities to withstand disasters and maintain a level of security and quality of life. This project is impressive given the extremely low budget of the areas it was implemented in, and demonstrates the effectiveness of community engagement, allowing members to upskill themselves and carry on work on core shelters long after the management had departed. This case study however is one that is specific in its execution but not in its goal. While a site specific response has been developed in the Philippines in order to combat the threat of Typhoons, its principle of creating spaces in a community which serve both as shelter in the event of a disaster, and in everyday use is one that should be applied to as many sections of the world as possible. The implementation of core shelters into an existing urban context, will reduce losses on all fronts and build resilience into communities from the ground up.

WELLINGTON RESPONSE

Figure 4 Wellington per household income levels

Wellington is a comparatively small capital city, with a population of around 470,000 in the greater Wellington region and 190,000 in Wellington City there are roughly 177,000 dwellings including 15,000 unoccupied dwellings. The average median income for the city is $37,900, which is slightly higher than the New Zealand average of $28,500 (Statistics New Zealand, 2013)(Figure 4). The majority of the population identifies as Pākehā, with small subsets of Maori, Pacific, and Asian people, (Figure 5). The Wellington region is typically a temperate climate, typically ranging between 7-21 degrees Celsius with the majority of the year spent in either cold or cool temperature bands.

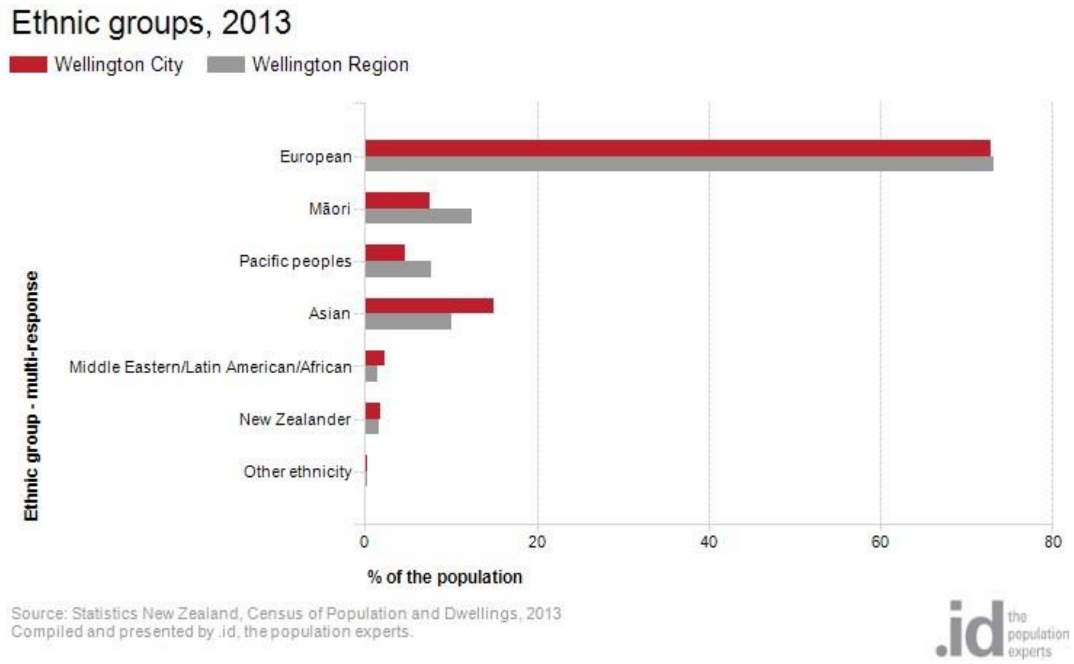
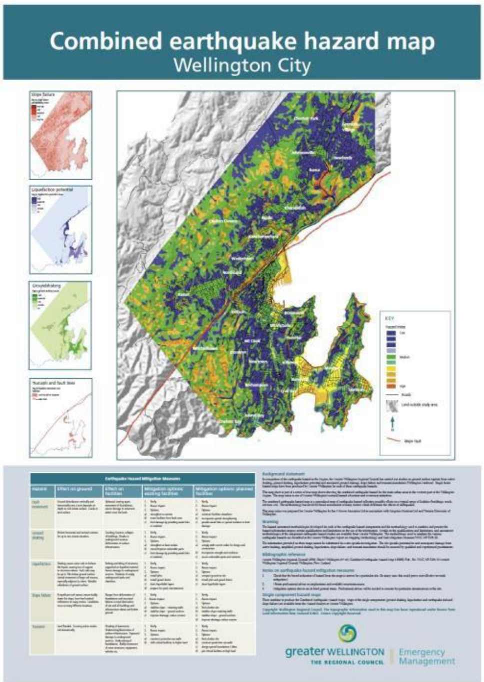


Figure 6: Topography of Wellington City

There is between a 40%-58% chance of precipitation during any day of the year, with moderate rain the most common type (Weather Spark, N.D). Wellington is a hilly city, (Figure 6), with a wide range of outdoor activities possible, and has 98.9km of coastline (Wellington City Council, n.d.). The city is expected to experience an increase in weather events due to global warming over the next century.

The Ministry for the Environment reports that Wellington should expect an increase in average temperature of .9C by 2040, and 2.1C by 2090, alongside this will be an increase in storms and high wind events throughout the region, and 0.8m of sea level rise by 2090 (Ministry for the Environment, 2014). However, this data was only reviewed in 2014, and will not take into account recent papers which demonstrate that we have underestimated the effects of climate change on our environment e.g. Fischer and Knutti (2015). As such we should expect the effects of climate change upon the Wellington environment to be more pronounced than previously estimated. In addition to the threats from extreme weather and climate change that Wellington faces, the city and its main transport route, also lies over a major fault line (Figure 7).



This fault line is one that has moved in the past, and while the risk is rated as relatively low, has the potential to produce a major seismic event in the future (Langridge, Leonard, Van Dissen, & Wright, n.d.). Bryant & Allan (2011) note that Wellington itself is of high risk due to the singular access in and out of the city, and the presence of earthquake faults under this route and major water supply networks. Understanding the threat to each of these systems is key in developing resilience. Adaptability therefore is not purely about how the built environment can change in response to an event, but also how it can predict the effects of one, and mitigate them beforehand, ensuring that cities are able to redistribute functions easily and effectively.

While Wellington currently enjoys a predominantly moderate and easily inhabitable climate, the potential for climate change to have an extreme effect on the local climate system is a real one. The 2014 breach of the Island Bay sea wall is now estimated to cost over $1.3 million dollars to repair for example (Forbes, 2015). Recent research has shown that the degree of sea level rise in Wellington may exceed past estimates, and as such we should begin to model these unexpected rises in ways other than simply flood and water level risk (Sharma, et al., 2016).

Wellington retains a level of urban grit in its building stock, and has a wide variety of building typologies that could be adapted in multiple ways. These typologies range from single unit households, to detached, semi-detached, high-density units, and medium density developments. In 2013, 59.7% of households were classified as separate, 28.1% as high density, 9.2% as medium density with 5.3% as other dwellings or not stated (Profile ID, n.d.). On a larger scale, Wellington has a number of suburbs and satellite towns that support the region, with 23.5% of dwellings as medium or high density compared with the 35.2% of Wellington City. This shows that the level of density in the main city is markedly higher, and is increasing each year, with 17,715 in 2006 and 20,124 high density houses in 2013 (Profile ID, n.d.). The level of difference between Wellington City and the Wellington region requires a different response to be developed for each area, but this opens up options that are able to support each other's individual weaknesses as a whole.

On an architectural level this paper is most interested in how a city can respond and function both during and after an extreme event, using core shelters as a key method of resilience. One of the easiest ways to measure this is to understand the vulnerability and fragility of our existing building stock. Using data produced by the Wellington City Council, Piers Chamberlain (2011)(Figure 8), mapped the buildings deemed to be at risk in a seismic event in Wellington. This data will form the preliminary analysis of risk undertaken in this paper. It assumes that these buildings will be uninhabitable in a seismic event, and so sets the baseline of vulnerability in order to build urban resilience. These building are at risk of earthquake damage, and are typically unreinforced masonry buildings that are vulnerable to lateral loading and in severe windstorms and are clustered around the CBD. This data suggests a need for core shelters that will provide shelter in both seismic and extreme weather events to the inhabitants of these at risk buildings, with

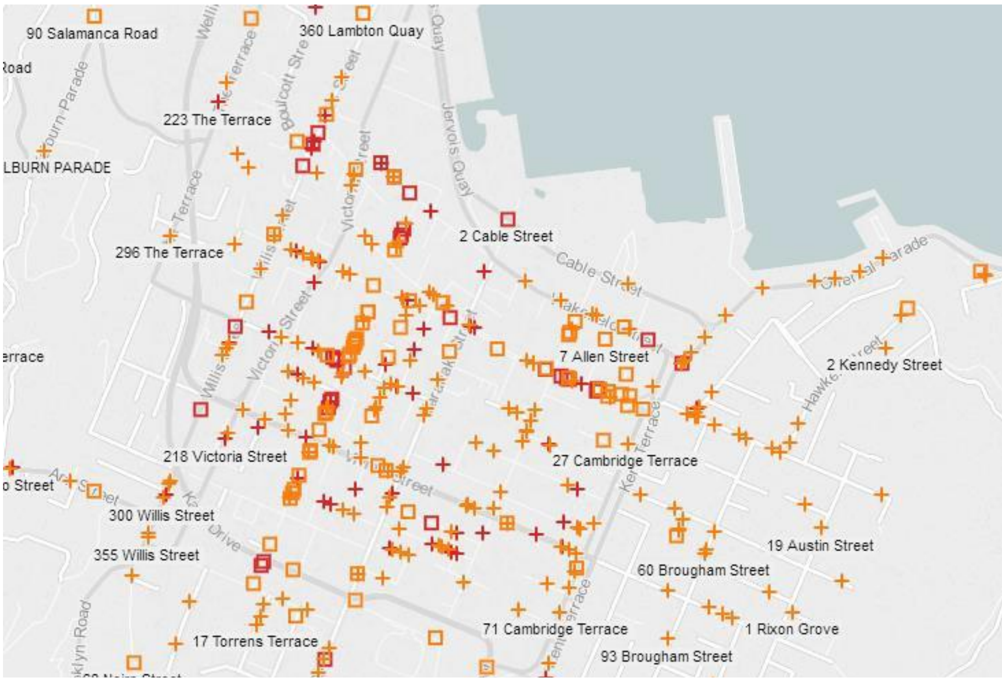


Figure 8: Seismically at risk buildings, Wellington CBD

shelters located in the vicinity of at risk clusters. Creating these interventions will require a multi stakeholder approach, will need to provide a benefit to the area when not in use as a disaster shelter and must be able to transition from their non-disaster use to their shelter function quickly. By creating a multitude of mixed use developments, (Bryant & Allan, 2011), it is possible to build resilience into a community at the same time as enhancing everyday capacity. In addition, being able to prove the economic viability of a development in terms other than disaster resilience will encourage greater private sector interest in DRR and CCA (Alam, Alam, & Rahman, 2015).

In order to respond to this need, we must understand the effectiveness of a core shelter, and whether they are the most appropriate solution for Wellington. Core shelters are effective for a number of reasons; they are focused on strength over aesthetics, they are built with issues of resilience and disaster response in mind, and are seen within the community as places to go in the event of a disaster thus creating a highly visible focal point for recovery. In a Wellington context, these shelters will have to provide for the people of the city who are made homeless in the event of a disaster, and provide certain forms of infrastructure service to the city. The services provided could range from electricity generation, to water sanitation, and telecommunication facilities. These shelters will directly mitigate the effects of a disaster on both the city's services, but also its population through relief accommodation and shelter. This paper proposes that there are two main ways of applying core shelters to an existing urban environment; direct physical implementation, and a conceptual one.

Physical implementation would see a series of structures located in areas deemed to be of high risk, and would provide immediate shelter during an event, and prolonged shelter after one as recovery effects are undertaken. These shelters would not be seen as permanent dwellings for the users, instead offering a secure and safe place to stay whilst other forms of accommodation or shelter are provided. The ability to reduce the strain on aid organisations and facilities through these pre-existing structures is also useful, and was mentioned in a recent memorandum from the Kumamoto International Foundation (2016).

Conceptual implementation would take the underlying principle of a core shelter, that of a centralised core that is protected at all costs, demonstrated in the New Zealand parliament building's National crisis management centre (New Zealand Government, 2006), and apply this to a larger area. This treatment of the system is one that is focused entirely on protecting the city's central area, and would provide shelter to the outer areas of the city through resilient design and upgrading of existing building stock in the city centre. The population of the outer suburbs would move to their nearest shelter, with shelters located in areas with clusters of high risk buildings.

High risk areas are identified by their proximity to the coast, the wind loading that they experience, the quality of the existing housing stock nearby, the availability of multiple transport routes, the density of population, the age and economic stability of the population, and the vulnerability of the areas in a seismic event. These factors have led to the following areas being identified as of higher vulnerability in a disaster event: Willis Street- Cambridge Terrace, Mt. Victoria West, Adelaide, Haitaitai North, Kilbernie West- Haitaitai South, Newtown East, Lambton, and Thorndon- Tinakori Road (Table 1).

Table 1

Suburb	*Population*	*Median age*	*Median personal income*	*Number of households*	*Person per household*	*Risk factors*
Thorndon- Tinakori Road	4,125	32.3	48,200	1,857	2.2	Coastal proximity, high numbers of seismically vulnerable buildings, close to fault line
Lambton	5,625	25.1	21,300	1,908	2.9	Coastal proximity, high numbers of seismically vulnerable buildings, lower income level, younger population, close to fault line
Willis Street-Cambridge Terrace	7,329	26.8	36,800	3,117	2.3	Coastal proximity, , high numbers of seismically vulnerable buildings, medium level of personal income, younger population,
Mt. Victoria West	5,400	30.7	44,000	2,202	2.4	Steep terrain, high numbers of seismically vulnerable buildings
Adelaide	1,020	27.2	22,300	300	3.4	Lower level of personal income, high population density, high numbers of seismically vulnerable buildings
Newtown East	4,878	30.4	28,700	1,797	2.7	high numbers of seismically vulnerable buildings, medium income level, higher levels of density
Kilbernie West- Haitaitai South	3,207	33.9	38,200	1,320	2.4	high numbers of seismically vulnerable buildings, costal proximity
Haitaitai North	4,563	33.4	45,500	1,725	2.6	high numbers of seismically vulnerable buildings, coastal proximity

These areas are all ones with high concentrations of vulnerable buildings and higher concentrations of dwellings, and demonstrate a need for core shelter intervention. Shelters will be sized dependant on the amount of population expected to be displaced in a disaster event, and will provide services that each community is likely to have restricted access to. There will be two typologies of shelter, with the sizes determined in future research, and they may be larger buildings that can house multiple people rather than individual units. Each building will follow a set of design guidelines so that they are able to be adapted to a variety of sites and situations, but will differentiate themselves from each other based on each community’s needs. A combined approach is the most appropriate for an existing built environment, because by building resilience at a large systematic level, and at a small local scale, it is possible to reduce a city’s’ vulnerability overall, and provide direct and specific shelters to those who will need it. Research has shown that lower income communities, (Figure 6), are typically more vulnerable in the event of a disaster (Wamsler, 2007) (The World Bank, 2012) (UNFCCC, 2007). Within this resilience building effort also lies a wish to protect sections of communities that are unable to flee in the event of a disaster as easily as those with financial means.

CONCLUSION

In conclusion, it is likely that our existing built environment will not be able to support rapid or extreme changes to our climate without intervention. Should this climate change bring along an increase in extreme weather events or disasters we will have to drastically alter how a city withstands and adapts to these new threats. Urban core shelters provide a means to do this, and allow the inhabitants of an area to remain safe during and after an extreme event, and also provide a benefit to the community beforehand. Wellington is at high risk of a disaster inhibiting the city’s ability to function, and as such resilience building efforts should be undertaken at once, & should also acknowledge that current efforts to strengthen communities and buildings are not progressing at the same rate as climate change and its effects. As such, a series of urban core shelters could be introduced alongside traditional resilience building efforts so that should part of a city fail in protecting its citizens, there are still areas for them to seek shelter and begin recovery. With the introduction of these multi use core shelters into Wellington, it is proposed that resilience will be improved not just for the immediate areas around them, but also for the city as a whole.

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A LOW COST RESILIENT CITY: JAKARTA

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ABSTRACT

Jakarta, the capital city of Indonesia, is potentially wounded from many sides. Geographically it is located within the range of 40-70 km from the nearest three active volcanoes; Mt. Salak, Mt. Cagak, and Mt. Gede. Meanwhile within the range of 170-200 km lies one of the most active volcanoes on earth, the Son of Krakatoa. The history recorded that in 1699 Jakarta was severely destroyed by a powerful earthquake (M 7.5) that was followed by the eruption of Mt. Salak. In 1780, an earthquake (M 8.5) caused buildings to collapse in Jakarta (Musson, 2012). In 1883, the blast of the Mighty Krakatoa generated a tsunami wave that reached Jakarta within 2.5 hours (Badan Geologi ESDM, 2011).

In addition, Jakarta is sinking due to the rapid land subsidence. Some areas in North Jakarta are predicted to be 5m below sea level in 2050. The solution that the government is working on, is a project to build an expensive giant sea wall to protect residents from the sea level rising (NCICD, 2015).

This paper simulates the event of the 1883 to the current condition. The simulation reveals that a 3m tsunami could reach the National Monument as well as the president palace areas. Thus to evacuate residents, this paper proposes a grid evacuation system that maps all possible areas for evacuation centres. In addition, colour coding the surrounding buildings is proposed for a fool-proof mitigation purpose.

Key words: Low-cost, Resilience, Grid Evacuation System, Colour Coding.

INTRODUCTION

Indonesia & Volcanoes

Obviously, Indonesia is an archipelago country that has a lot of volcanoes ranging from Sabang to Merauke (Figure 1). In the book Volcanoes of the world, The Smithsonian Institution documented that Indonesia has more volcanoes than any other country in the world. What makes the situation even worse is the fact that most of Indonesians live within 30-100 km from Holocene Volcanoes (Siebert *et al*, 2010). Located in the ring of fire region, Indonesia sits in between two continental plates; the Eurasian Plate (Sunda Plate) and the Australian Plate (Sahul Shelf) and two oceanic plates; the

Philippine Sea Plate and the Pacific Plate. Through the subduction process of the Indian Oceanic Plate beneath the Eurasian Plate, the landscape of the country was created in the form of islands and chain of volcanoes throughout the region. Currently there are 76 major active volcanoes that are under constant surveillance in the country (Badan Geologi ESDM, 2015).

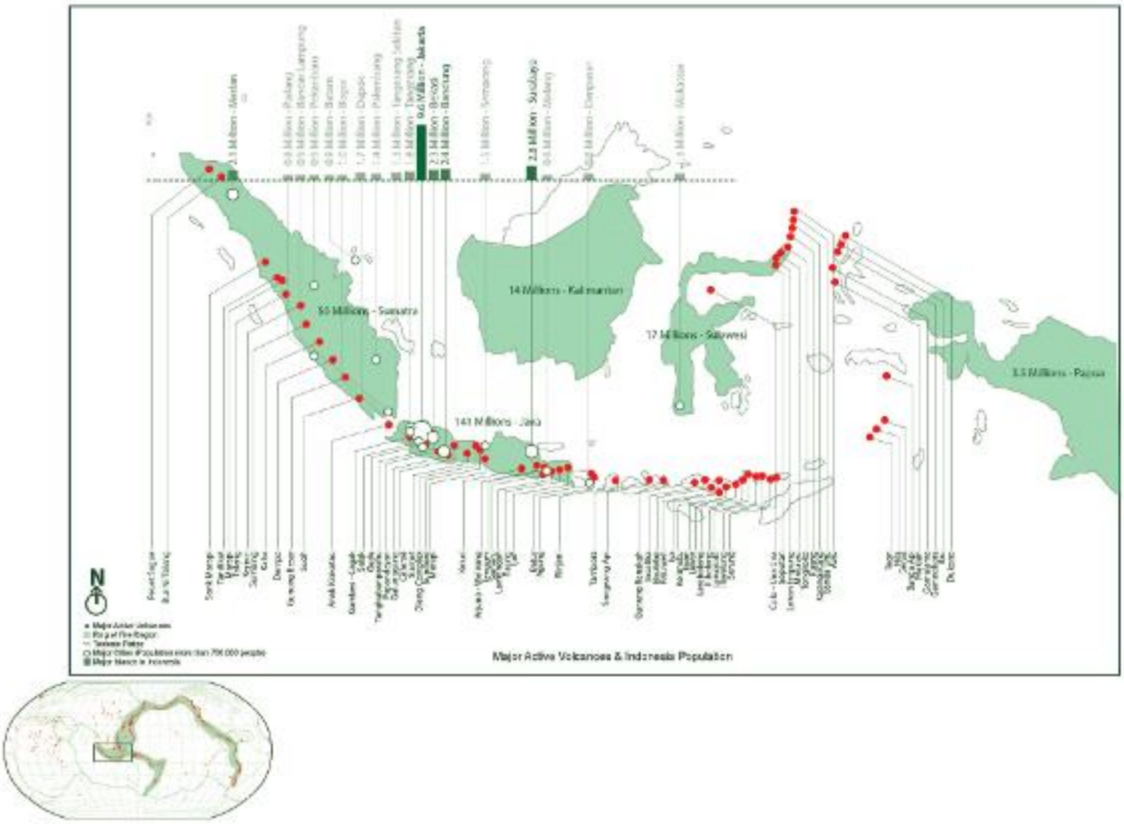

Figure 1. Volcanoes Distribution & Number of Population in 2011 in Indonesia
Source: (Author Graphic & Analysis, 2015).

The history has recorded that a single blast of a volcanic eruption in Indonesia could be fatal and have a global long-lasting impact. For example, the eruption of Mt. Tambora in April 1815, that was known to be the most destructive in the past 10,000 years. During the blast, there were 12 cubic miles of gases, dust and rocks that had been spewed into the atmosphere. With the eruption column that reached 13,000 feet above sea level, the eruption killed almost 10,000 inhabitants instantly. During the event, ash rained down the region for weeks causing houses to collapse, killing trees, crops and herds. It was estimated that almost 90,000 people in Sumbawa and Lombok died from starvation. In the mean time, a massive quantity of Sulfurous gases that mixed with water was released into the stratosphere. Together with ash and dust, this Sulfuric Acid Aerosol circled the planet blocking the sunlight causing weather disruption all over the world. In China and Tibet, cold weather killed trees, crops and animals. In the USA, crops failed and prices rose in 1815-1816. Meanwhile in Europe and Great Britain, an unusual amount of rainwater fell in the summer of 1816. In Ireland, rain fell nonstop for eight weeks causing crops failure and famine. Moreover, in the next couple years, hunger was followed by typhus in British Isles that killed thousands. The year of 1816 was known to be a year without a summer in the Northern Hemisphere (Evans, R., 2002).

Jakarta: Volcanoes, Earthquakes & Tsunamis

Jakarta is located in the West-Northern part of Java Island. It is the biggest, the most complex and the most populated city in the country. The census in 2011 revealed that Jakarta was inhabited by 9.6 million people (BPS DKI Jakarta, 2014), meanwhile the Greater Jakarta that is known as "Jabodetabek" was inhabited by 28 million people (World Population Review, 2015). The rapid development of the city attracts more people towards the city looking for jobs, better education, entertainment and better living. Many lands and beaches have been converted into apartments, housings and condos (Abidin *et al*, 2009). Yet many people are unaware of the danger surrounding the city that they could face at anytime.

Geographically speaking, Jakarta is surrounded by many active volcanoes (Figure 2). Within the range of 40-70 km, there lie three main active volcanoes; Mt. Salak, Mt. Cagak and Mt. Gede. Within the range of 85-110 km sits Mt. Pulosari. Within 140-165 km stands Mt. Rajabasa and Within 170-200 km lays the youngest and one of the most active volcanoes on earth, The Son of Krakatoa. Some of these volcanoes had caused tremors and destructions in the city and some has a global catastrophic impact. Badan Geologi ESDM (2006) and Musson (2012) recorded that in 1699, a massive earthquake with magnitude bigger than M 7.5 hit West Java and South East Part of Sumatra causing a massive destruction to Batavia (Old Jakarta) and Lampung Province, it was then followed by the eruption of Mt. Salak that sent ash and rocks to the atmosphere. The eruption also sent mudflows to rivers blocking the river flow causing environmental and health problems as well as massive destruction to the city at that time. In 1780, an earthquake with Magnitude of at least M 8.5 hit Java, a lot of houses collapsed in Bogor, Banten and Jakarta. This trend continued in 1903 and 2004. The Earthquake Track (2015), reported that the most recent earthquake that hit Jakarta was in 2014 with Magnitude of M 5.2 from West Java.

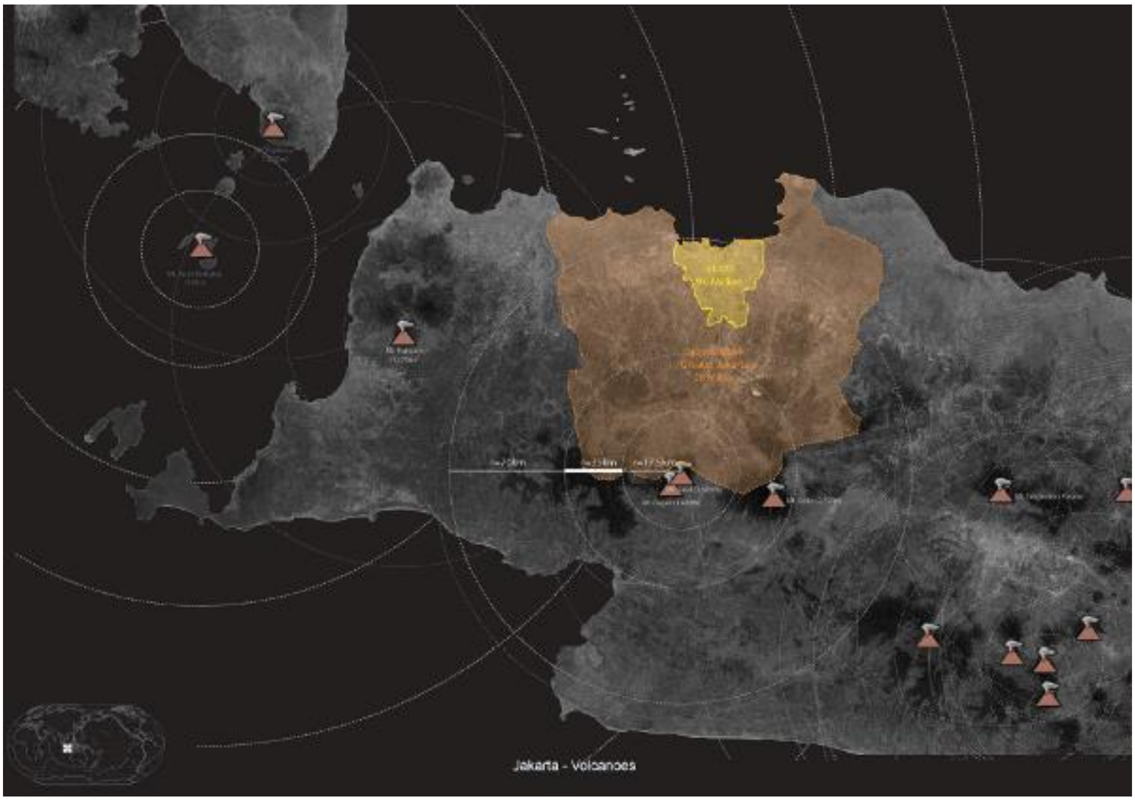

Figure 2. The Nearest Active Volcanoes Surrounding The Capital City of Indonesia
Source: (Author Graphic & Analysis, 2015).

Figure 2 indicates that Mt. Son of Krakatoa is not far away from the capital city. The history has recorded that this particular volcano is deadly and could cause a massive disaster globally. Dating back in 16 centuries ago, in around 416 AD. The Javanese book of Kings recorded that Java and Sumatra was once a merged island. Until one day there were a huge eruption that was accompanied by violent thunder tremendously bursting apart the island into pieces and sank them into the deep ocean. It was then gave birth to Sunda Strait, some small islands and a new island called Krakatoa with its three mountain ranges (Pustaka Raja-Raja, 2003). Later on in 1883, this particular mountain showed its true immense power by exploding itself causing a global impact at the time. The August 1883 was known to be the benchmark of Vulcanology. Through the telegraph the event was reported globally. The eruption was so powerful that it was known to be the most powerful thermonuclear weapon ever detonated in the history both manmade and natural. It has the loudest sound ever recorded and the eruption column reached 80 km above sea level. The eruption affected weather pattern for five years around the globe. It was estimated that there were 18-25 cubic kilometers of rocks spewed into the atmosphere. Moreover, what made the eruption so deadly was that it generated tsunamis with the height of 30-40 m in Banten. This huge wave travelled along the west coast of Java and hit Tanjung Priok Area (Jakarta) in 2,5 hours. The reported 3 m wave washed away a whole china town and killed 300 fishermen. The wave continued to travel through the sea to Cape Town, Panama and English Channel (Badan Geologi ESDM, 2011).

Jakarta: Land Subsidence, Tidal Floods & Inland Floods

Rimbaman and Suparan (1999) and Sampurno (2001), stated that Jakarta is located in a lowland area that has five major landforms; 1) volcanic alluvial fans that are located in the southern part of the city, 2) marine-origin landforms that are found in the northern part close to the coastline, 3) beach ridge landforms that are discovered in the northeast and northwest, 4) mangrove & swamp landforms that are located in coastal fringe, and 5) former channels. In addition, there are 13 rivers that flow through the city; Ciliwung, Citarum, Cisadane, Sunter, Krukut, Angke, Karawang, Cakung, Bekasi, Ciranjang, Cikarang, Cidurian and Cimancuri.

Several studies (Harsolumakso, 2001; Hutasoit, 2001) indicates that there are four major factors that cause land to subside in Jakarta: 1) load of buildings and constructions within the city, 2) excessive groundwater extraction, 3) natural consolidation of alluvium soils, and 4) tectonic activities. Abidin *et al* (2009) pointed out that land subsidence mostly occurs in the coastal area of the city that coincides with the rapid development of the coastal area. The study indicates that some areas in northern Jakarta subsides about 12 cm/year. The study also predicts that in 2020 about 5,146 ha of the city will be inundated by seawater, while in 2050 almost 16,237 ha of the city will be claimed by seawater.

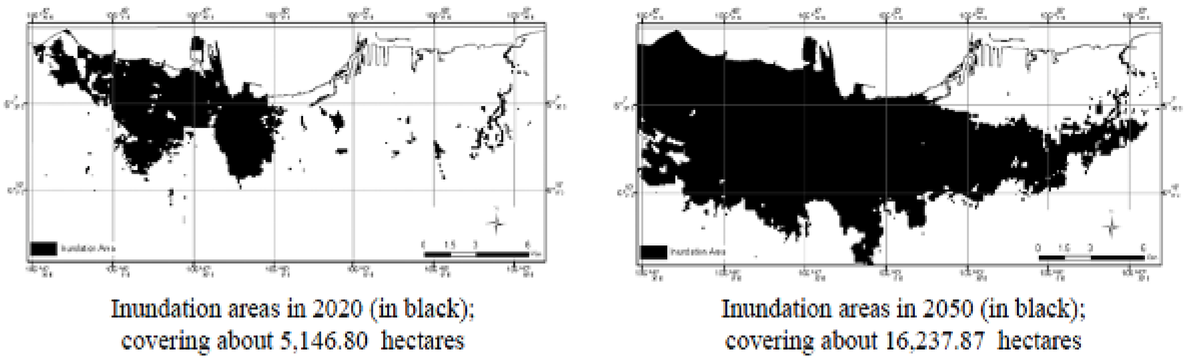

Figure 3. Predicted Inundation Areas in Jakarta
with the assumption of land subsidence rate 2mm/year.
Source: (Abidin *et al*, 2009).

Apparently, Jakarta is not only threatened by tidal floods but also inland floods that inundate the city during rainy season. UNISDR (2013) reported that one of the most severe floods that hit Jakarta was in 2013. During the event, almost 40% of the city was inundated including the president palace and many government buildings (Figure 4). As water overflew the city, it was estimated that the flood caused a major loss up to 32 Trillion Rupiahs (Jakarta Globe, 2013).

Figure 4. Floods inundating Hotel Indonesia Roundabout
& Rasuna Said Street in 2013
Source: (Naranabil, 2013; AntaraNews, 2013).

In order to save the city from rapid sinking as well as tidal floods and inland floods, the government is currently working on a project called The National Capital Integrated Coastal Development Program (NCICD). It is a project of multi trillion Rupiahs to build a massive giant sea wall around Jakarta coastline. It is expected to be the biggest giant sea wall in the world once completed. The project will use an integrated approach to protect the city: flood protection, improved sanitation and water supply, improved connectivity and sustainable community development in coastal area. This coastal defense system is developed by consortium of industries from Indonesia and Holland (NCICD, 2015).

Figure 5. NCICD Project
(Left: Diagram & Analysis; Right: Rendering Image)
Source: (NCICD, 2015).

RESEARCH QUESTIONS

This paper questions the preparedness of the city towards the real nightmare. Although the government is currently working on something big to solve the problem of the rapid land subsidence & floods, there are several things to be questioned:

What is the potential catastrophe that might hit Jakarta in the future? How big will it be? and how many people will be affected?
What is the evacuation system plan that the city has?
What is the easiest, cheapest and fool-proofed method for mitigation purpose?

SIMULATIONS

To answer those questions, this paper runs two simulations indicating how many people need to be evacuated at once and which location will mostly be the death zone area:
The eruption of Mt. Salak & Mt. Cagak with radius of 70 km was used to determine the number of people to be evacuated at once.
The data of the 3m-tsunami wave that was generated from the eruption of Mt. Krakatoa in 1883 was overlaid with the data of the current contour height affected by land subsidence.

Volcanic Eruption

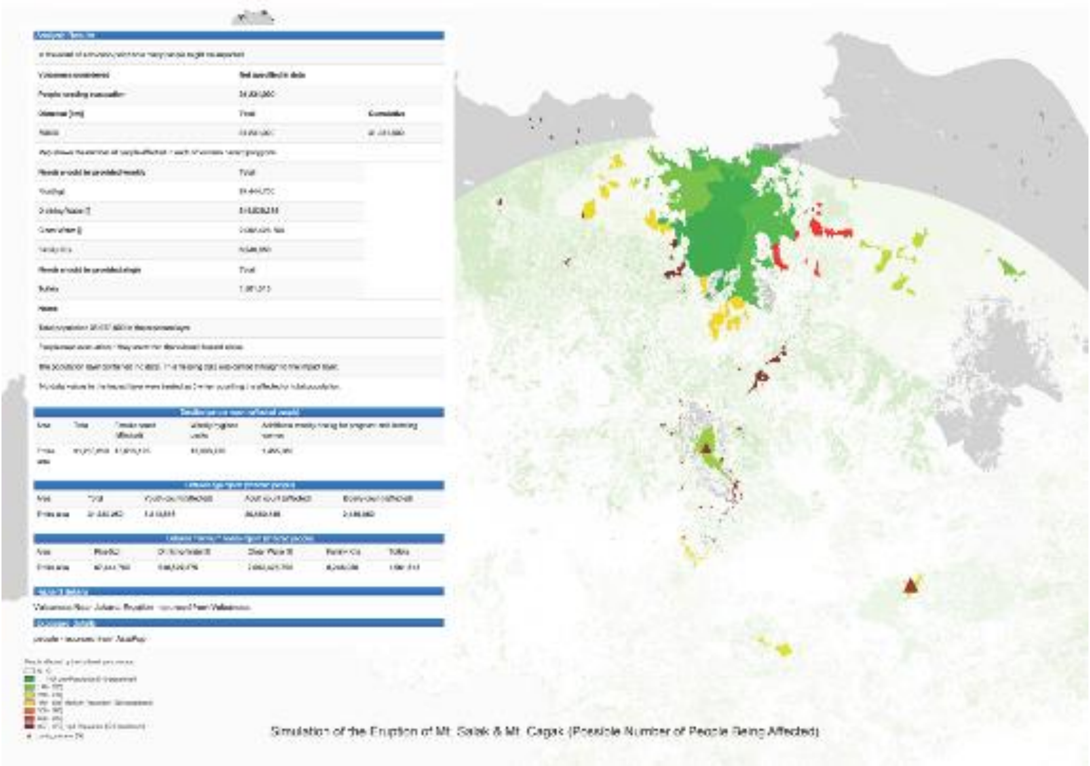

Figure 6. The Simulation of the Eruption of Mt. Calak & Mt. Cagak
Source: (Author Analysis, 2015).

By using the database from the World Population Asia Data set, that was combined with the coordinate of the active volcanoes from the Smithsonian Institution and the Inasafe plugin that was run in QGIS. The radius of the eruption was set at 70 km. In this scenario there were two volcanoes that are erupting. The simulation reveals that by using the current database, there should be around 31 million people need to be evacuated at a time as shown in Figure 6. Understanding this number could be useful in the future when dealing with a disaster in a massive scale. It is important to predict what kind of movement plan does the city need in order to avoid clashes during the movement of a large number of people quickly into a safer zone area. This is significant especially when dealing with a city like Jakarta that is too crowded in a daily life. Thus the city needs to make a better way of moving people especially in a worse-case scenario.

Krakatoa Eruption & Tsunami

The second simulation uses the data from the 1883 event. The 3m-tsunami wave is overlaid with contour data that was extracted from GMTED 2010. The result was shocking that a single blast of the future Mt. Son of Krakatoa might wipe almost half area of Jakarta including the National Monument (Figure 7). To be underlined that this data is the current condition of Jakarta. If the land subsidence trend continues and the sea level continues to rise. Once completed, even the new NCICD structure might not cope with the scale of the future disaster that renders the city into a chaotic condition.

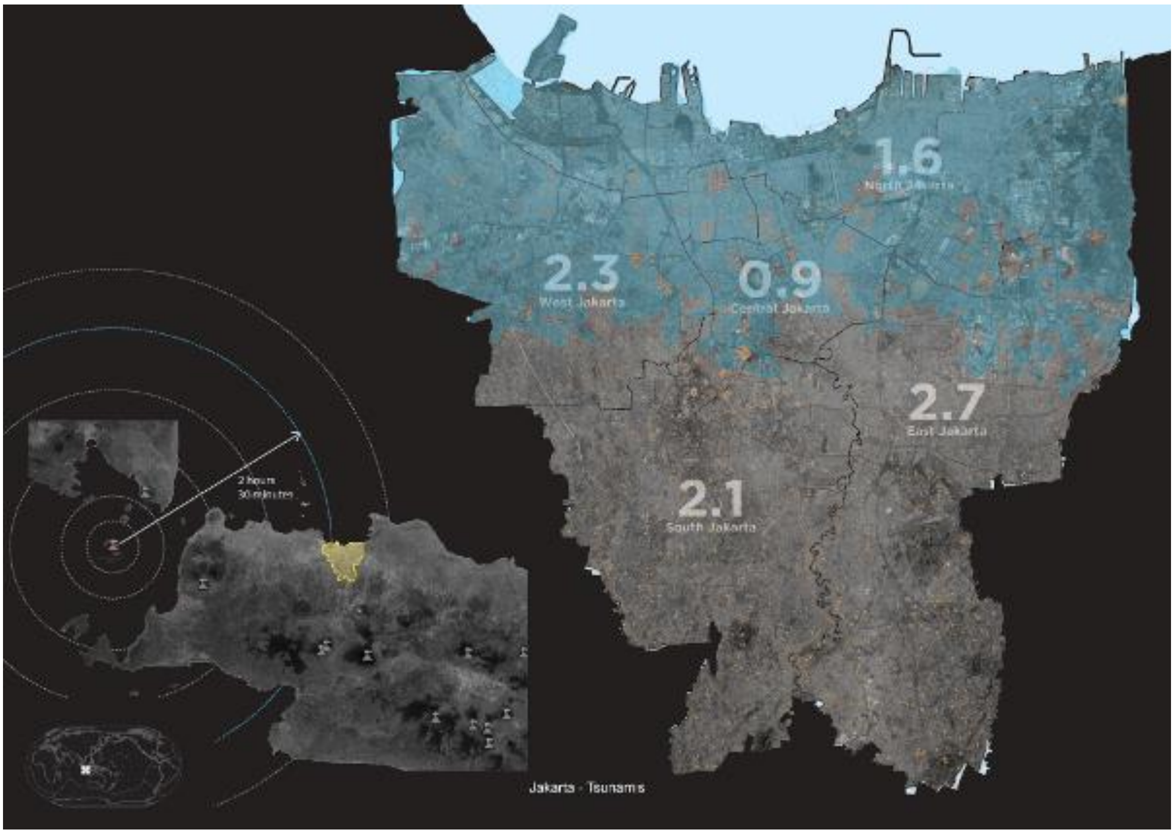

Figure 7. Jakarta Current Topographic Data in Comparison with a 3m Tsunami Generated from the Blast of 1883
Source: (Author Graphic & Analysis, 2015).

THE GRID EVACUATION SYSTEM

This paper proposes an integrated contingency plan that consists of two general ideas that can be applied anywhere: *Macro Plan and Micro Plan*. The Macro Plan consists of a holistic approach in the city that requires planning and managing the disaster risk level. It consists the overall city evacuation plan that maps all possible safety areas and makes it available for people nearby. The idea is to avoid clashes during the evacuation process and make the evacuation centers as close as possible to the people. Thus the proposed idea of this macro plan is making *"The Grid Evacuation System"*.

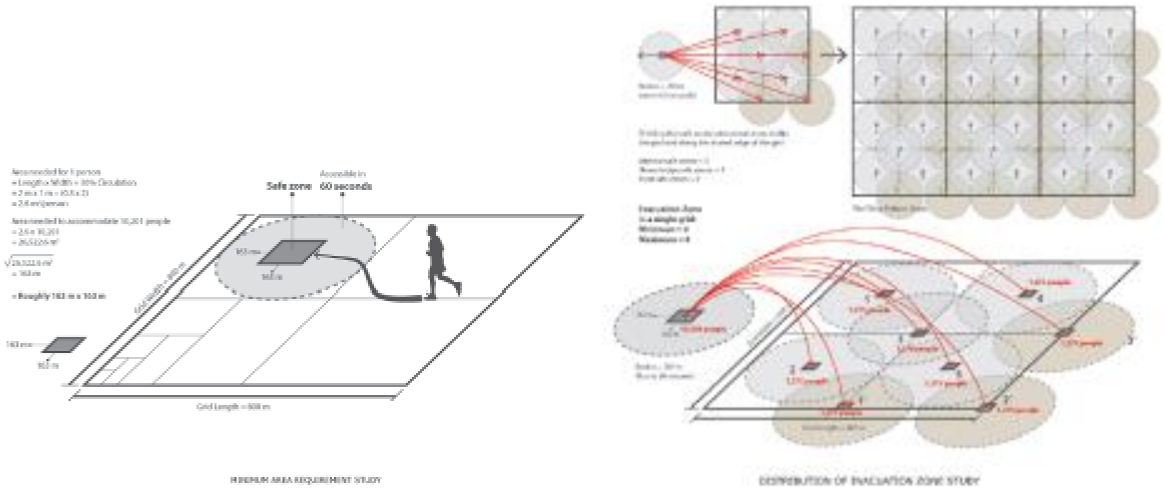

Figure 8. Grid Evacuation System Concept
Source: (Author Graphic & Analysis, 2015).

This system is not just limited to a grid shape but any network that divides a big city into smaller scales that can be access by people nearby. The idea is to create the block-chain of evacuation centers within a city by using radius system. In this scenario, each evacuation zone has to be accessible within 60 seconds. Thus the big area of the city is divided into this micro scale evacuation centers. After that, rather than focusing on a big single block of a building, the evacuation centers are divided incrementally to make it more available for public, it is to make the distance closer. By having a wide spread centers, a community has a better chance of surviving rather than fighting to get into a single safety zone. The more overlaps of evacuation centers offer people more choices of safety zones (Figure 8).

Figure 9. Grid Evacuation System & Possible Evacuation Areas in Pink Color Based on Public Access
Source: (Author Analysis, 2015).

The Micro plan consists of a fool-proofed system to identify and distinguish hazard areas and safety zones throughout the city by utilizing *"color-coding".* Red indicates dangerous area while green indicates safety zones. With this method, the system is supposed to be easy for crowds to follow. Figure 10 indicates how somebody in a red zone tries to follow the guideline passing through the orange area and finally makes it through the green zone area for shelter.

Figure 10. Color-Coding the Whole City to Make Easier Evacuation Process
Source: (Author Analysis, 2015).

SUMMARY & CONCLUSION

Geographically speaking, Jakarta is located in a volcanic hazard prone area. Thus Jakarta is threatened by earthquakes, volcanic eruptions as well as tsunamis from the Krakatoa blast in 1883.

The study indicates that Jakarta is sinking due to the rapid land subsidence. Some areas in northern Jakarta subsides 12 cm/year. In 2050, almost half of Jakarta is predicted to be below sea level. On the other hand, inland floods have always become the major problem during rainy season. Thus, this combination could be catastrophic for the city.

However, the contingency plan seems to be absent from the city. Instead of building an inexpensive integrated mitigation plan, the government is working on something big and expensive to save the city. As a result, most of Jakartans are unaware of the danger that they could face any time, and the worst is that most people do not know where to go when a disaster occurs.

This paper offers the *"grid evacuation system"* as a contingency plan. It has two main ideas that can be applied anywhere at any time: *Macro Plan and Micro Plan*. *The Macro Plan* consists of a holistic approach in the city that requires planning and managing the disaster risk level. It consists the overall city evacuation plan that maps all possible safety areas and makes it available for people nearby. While *the Micro Plan* consists of a fool-proofed system to identify and distinguish hazard areas and safety zones throughout the city by utilizing *"color-codes".* With this method, crowds could go to the nearest safe zones as quick as possible.

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SYSTEMATIC IDENTIFICATION OF BARRIERS TO PPP SUCCESS IN DEVELOPING COUNTRIES: APPLICATION OF SLEEPT FRAMEWORK

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ABSTRACT

The UN's 2030 Development Agenda recognises the necessity of mobilising private sector resources in innovative ways, in order to help developing countries develop critical social and economic infrastructure. This will enable them to generate the wealth necessary to eradicate poverty, and provide decent basic living standards for their citizens. These approaches are broadly characterised as being public private partnerships (PPPs), which allow off-balance sheet infrastructure development for governments whilst providing stable, long-term income streams for private sector investors. Such approaches are a familiar part of the infrastructure development landscape in developed countries such as the UK (through its private finance initiative), Australia (through its privately financed projects program), and others including France and the United States. Developing countries have also experimented with PPP approaches e.g. Sri Lanka embarked upon various PPPs during the 1990s, though these were subsequently felt to be unsuccessful. Various studies of these projects identified contextual and systemic barriers to their adoption, whilst other studies in different jurisdictions extended generic understanding of the barriers and enablers to PPP use in developing nations. Consolidation of these bodies of work would be desirable. Accordingly, the outcomes from a systematic review of the latest literature reveals social, legal, economic, environmental, political and technological issues that must be addressed in order to maximise the likelihood of success for PPPs in developing countries; tentative recommendations for further research are presented.

Keywords: PPPs, developing nations, barriers, UN-SDGs, SLEEPT approach

INTRODUCTION

Public-private partnerships as understood in the Anglophone world are contractual arrangements between a government body and one or more private sector entities to provide infrastructure, quite often in the form of provision of a service, over the long term. They can be variously thought of as risk transfer mechanisms, opportunities to harness private sector innovation and efficiencies, or a mechanism by which to reduce public sector borrowing requirements (RICS, 2012). They are generally employed by experienced client side entities with sufficient understanding of the specialised nature of the risks involved, and are bid for by equally experienced consortia or "special purpose vehicles", these being one-off joint venture organisations assembled specifically for a particular project (CCPPP, 2007).

The use of PPPs in developing countries, as a primary means by which critical infrastructure can be obtained is one of the core strategies embodied in the United Nations Sustainable Development Goals (Jomo et al, 2016). This is because the current rate of economic expansion typically experienced by these nations, and the low base from which they are rising, dictates that the required capital to procure critical infrastructure and will take a prohibitively long period of time to accrete. Mobilising international capital and know-how is viewed by many as an inevitable step in infrastructure provision across the developing world (OECD, 2014).

The 1990s saw Sri Lanka experiment with the use of PPPs (Central Bank Report of Sri Lanka, 2011), albeit with disappointing results (Shanika, 2012). Inadequate legal and regulatory frameworks were identified as negative influences on project success (Kelegama, 1999), however this is to oversimplify the situation (Gunnigan & Rajput, 2010). Review of the latest literature reveals social, legal, economic, environmental, political and technological issues that must be addressed in order to maximise the likelihood of success for PPPs in the context of developing nations into the future. This paper presents an overview of a systematic literature review in pursuit of a conceptual framework to underpin further research into the issue.

LITERATURE REVIEW

Public Private Partnerships in Sri Lanka

Although a number of developed nations have long-term experience with the concept of PPP (Howes & Robinson, 2005; Yescombe, 2007; Inderst, 2016) many developing countries have concerned themselves with PPPs only in the recent past (Burger & Hawkesworth, 2011). The arrangement of PPP is structured in a way that it is intended to provide greater flexibility (Shen, Tam, Gan, Ye, Zhao, 2016) to achieve the provision on public infrastructure objectives by altering traditional public and private sector roles with a view to taking better advantage of the skills and resources that private sector firms can provide (Vadali, Tiwari, & Rajan, 2014).

Poor social and economic infrastructure, coupled with inadequate budgetary capacity, largely prevent developing nations from achieving their desired levels of economic growth (Jomo et al, 2016).

By way of example; in an attempt to overcome these challenges Sri Lanka embarked on various PPP projects during 1990s, yet the outcomes were far from optimal. Since then investment in PPP projects has comprised a modest US $1651.9 Million across just 15 projects. When compared with others in the region Sri Lanka is placed behind India & Pakistan in terms of Investment & behind India, Pakistan & Bangladesh in terms of number of projects implemented (Wijewardena, 2014). In its Annual Report for 2012 the Central Bank emphasised the need for bringing in private sector to deliver public projects efficiently. It stated that the initial capital outlay could be made by the government but the operation of the projects could be handed to private sector through PPPs (Central Bank, 2012). Even though many have identified the importance of proper implementation still there are number of challenges to overcome prior to achieving the core objectives of PPP in Sri Lanka.

Shrybman and Sinclair (2015) note that the World Bank group PPP guidelines, and the PPP project checklist jointly developed by the Organisation for economic co-operation and development and the World Bank group both fail to take into account the lessons learned from the sale PPPs, especially with risk allocation between public and private sectors. They further observe that the default position is to assign the burden for all difficult or unforeseeable risks to the private sector: implicit in this are any additional costs incurred to ensure compliance with future regulations such as achieving UN-SDGs. Such underwriting of the unforeseeable – which even extends to underwriting the senior debt of private sector partners in PPP projects in the event that default (Jomo et al, 2016) – would appear to be a questionable interpretation of "best value" and "innovation". Under the circumstances a comprehensive evaluation of barriers for implementing PPPs in developing countries would appear to be timely.

BARRIERS FOR IMPLEMENTING PPP

SLEEPT Framework

Given the foregoing, and the increasingly desired usage of PPPs in infrastructure development for developing nations, the experience of both the public and private sector with PPP has not been globally positive (Kwak et al. 2009). In this context many PPP projects have either been delayed or terminated, triggering researchers to conduct studies on barriers to PPPs implementation. This research provides a rigourous basis for further research in the context of developing nations. As such it is describes a robust framework of barriers, which is particularly useful as it is structured in accordance with Zhang's SLEEPT framework (Zhang, 2005). The following sections present state of the art in relation to each of the characteristics represented in the framework acronym.

Social barriers

A considerable number of social barriers have been identified, indicating public opposition as the most critical issue to consider (El-Gohary et al, 2006; Zhang & AbouRisk, 2006; Grimsey & Lewis, 2004). Gunnigan & Rajput (2010) revealed that both cultural impediments and societal discontent against the private sector contributed to a lack of confidence in them, deterring private sector investment in PPP projects.

Distrust of private sector investors is not the only reason for rejecting PPPs but also the demonstrably higher user charges associated with public services and facilities once private investments are used to underpin the supply of services (Blanc-Brude et al, 2006).

By way of contrast: though living standards might be improved through these projects, society might still pull back from supporting PPP processes and project implementation. This is because of the nature of the procurement, which is non-traditional and the doubt that the future generations will inherit crippling levels of debt if the PPPs continue, since private sector interests will recover their investments over the long term (Hamilton, 2015). Moreover misallocation of risks of PPP projects (Abd Karim, 2011) is also emphasized as another drawback by the society where the private sector owns the whole income though the risk is shared with public sector.

Legal barriers

Research demonstrates that there is often an inadequate PPP legal regime, underpinned by a poor regulatory framework. Even if these are infrequently present the potent combination of weakness in enforcement of policy and a desire to engage in grass-roots review, frequently reveal a lack of institutional capacity and PPPs strategy absence of PPP disputes resolving legal institute among others as legal constraints for proper implementation of PPPs in most developing economies (Babatunde, Perera, Udeaja, & Zhou, 2015). This indicates that some developing countries governments with less matured economies execute PPPs even when overall PPP policies are absent, which drives towards improperly established goals and objectives ultimately creating greater possibility of issues with projects implementation. PPP generates exceptional pressure on the legal regime affecting economic maturity, renaissance, and mechanism for developing infrastructure. Although in PPP projects a large number of agreements and conditions are involved in documentary lack of a proper package has become a barrier to proper implementation of PPP. PPP involves a great deal of disputes among parties involved due to different interests of stakeholders, for protection of public interests and legitimate rights of private sector. According to Grimsey and Lewis (2004) and Satpathy and Das (2007) lack of well-established legal framework, has given rise to number of disputes which are inevitable in PPP.

Economic barriers

PPP project preparations are considered complex in nature due to variety of interests and objectives of involved parties which has higher possibility of conflicts compared to a traditional procurement contract. This nature creates the necessity of extensive expertise input and comparatively high costs in PPP projects and requires lengthy time in negotiation stage. Hence the financial requirement to be achieved has become a barrier in proper implementation of PPP in less mature economies (Chan, Lam, Chan, Cheung, & Ke, 2010). Difficulties in obtaining long-term finance, lack of capacity of the private sector to fully meet the challenge of investing in a very large number of projects, and unfavourable economic and commercial conditions have been identified as common constraints in achieving financial goals of PPP. Moreover with the bidding procedure for PPP being expensive private sector confronts issues in seeking financial partners also due to lack of confidence of investment banks and financial institutions in new procurement methods. Corbett and Smith (2006) and Carrillo et al.(2008) mentioned that the potential high transaction costs create a negative impact on proper implementation of PPP. Additionally, lack of transparency in deals and corruption in both public and private sector has become a major threat for PPP projects security. Even though many have identified high transaction cost as the most affecting barrier Babatunde, Perera, Udeaja, and Zhou (2015) had discovered that perceptions of developing countries as high risk economies by foreign investors and inadequate domestic capital markets among others were identified as economic barriers to PPPs implementation in developing countries.

Environmental barriers

The prior studies have revealed that land acquisition problems, lack of coordination between national and regional governments, lack of transparency and accountability, and acquisition of land for project from third parties as environmental barriers to PPP projects. PPP projects require the transfer of rights of public assets to the private sector in order to fulfill their operations effectively and efficiently. But according to the legal systems transferring of property has many restrictions regarding the level of environmental liabilities and occupiers liabilities to be transferred with the property. Hence it has become a major constraint in PPP implementation in many countries as land acquisition has not been easy due to public distrust in private sector and many other social issues. Moreover obtaining planning permission with an error free EIA (Environmental Impact Assessment) report also require a considerable time and costs of getting approvals from the relevant authorities is high. Thus these have prevented private sector interests in investing in PPP projects.

Political barriers

Lack of awareness about PPPs by politicians and decision makers, lack of political willingness and commitment to develop PPPs have been stated by the researchers as the constraints for PPP in developing countries. Moreover, political reneging, politicization of the concessions and lengthy delays due to political debate also have affected as barriers in implementing PPP in a more stabilized platform. According to Kwak et al. (2009) insufficient contribution and lack of maturity of governments to administer PPP projects has led to project failure in developing nations. But Gibson and Davies, (2008) mentioned a contrast fact stating where in mature economies local political opposition has become a barrier to PPPs. Hence it is significant that political influence is a more crucial factor for proper implementation of PPP in both matured and less mature economies. Moreover absence of provision by governments of incentives, subsidies or viability gap funding to overcome the financial issues in the private sector in investing in PPP also creates an obstacle. In PPP only a fewer employment opportunities are available compared to traditional method which would create an excessive floating workforce in construction industry being a threat to any government in a developing economy. Therefore lack of political willingness to develop PPPs on such grounds has become a critical issue.

Technological barriers

The literature review has identified non-availability of model concession agreements, Lack of suitable skills and experience, inconsistent risk assessment and management, and shortage of expertise as technological barriers to PPPs. Li et al., (2005) and Mahalingam (2010) stated absence of an enabling institutional environment for PPPs. Thus it is significant that less mature economies are seeking knowledge and resources from developed nations in structuring a proper PPP procedure where PPP process not clearly being defined has become a barrier to proper implementation. Absence of a well-established institution has also being identified as a barrier to PPP by Hamilton (2015). Uncertainty and lack of a clear project pipeline, delayed communication of decisions and protracted procurement processes together with complexity and relatively inflexible structures are also issues in implementing a proper PPP in the real world scenario. Poorly designed and structured projects would also pull back private sector investors from engaging in PPP projects in the future.

DISCUSSION AND IMPLICATIONS FOR FUTURE RESEARCH

The paper has revealed constraints for proper implementation of PPP around the globe according to the SLEEPT approach proposed by Zhang (2005). According to the literature during past decade developing countries have successfully implemented a number of PPP projects providing economic infrastructure such as highways, ports, power, and telecom sectors. Attempts at providing social infrastructure have been less successful, certainly in terms of improving service provision, equity of access, and affordability.

The growth of PPP usage in developing nations has likely stalled due to many constraints. The most significant of these have been the social barriers –public opposition, lack of confidence and distrust in the private sector and the higher charges to the end user. The situation is compounded where the general public lacks a proper understanding of the PPP concept, using the term to define what is traditionally been called privatization. Absence of proper PPP legal and institutional frameworks together with weak policy and regulatory frameworks are becoming a critical issue.

Lack of public sector project development funds, difficulties in obtaining long-term finance, conflicts of interest, corruption, unfavourable economic and commercial conditions and constraints of local finance markets have been identified as the economic barriers restricting the proper implementation of PPPs.

Among the identified environmental barriers in the global context, difficulty in land acquisition, limitation of environmental liabilities and lengthy time period in obtaining approvals from the authorities have been encountered.

Weakening of political commitment, lack of awareness, poor understanding about PPPs by politicians or decision makers, no provision by governments of incentives, and governments losing political willingness to develop and promote PPP have been identified as the most critical political barriers.

Lack of expertise in structuring transactions, management inefficiencies, labour resistance, lack of entrepreneurial awareness of PPP opportunities have been mentioned as technological barriers to implement PPP, though the extent to which these are in reality less technological and more educational is a matter of debate.

Ultimately these barriers represent a significant impediment to the performance of existing PPPs in developing countries and the future potential of PPPs to help achieve the 2030 Agenda for Sustainable Development. Despite increasing rhetorical popularity of PPPs in the search for solutions to the development gap between rich and poor nations there remains a number of question marks over their ability to deliver increased value for money (beyond mere economic efficiency and increased financial gains for the concessionaires) in terms of improved GDP, consequent reductions in poverty and increased sustainability of development, and effectiveness when applied to social infrastructure (as opposed to economic infrastructure).

It is clear that a combination of a lack of clarity as to what constitutes a PPP (as opposed to other privatisations and joint ventures) combined with a lack of the in-country institutional capacity to create, manage and evaluate PPPs is likely to be a severe impediment to their adoption in developing countries: application of the SLEEPT framework of analysis has provided fine-grained detail of the areas that require further investigation and subsequent attention/capacity building.

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SETTING THE PRIORITY OF RISK AND IMPACTS TO COMMUNITY BASED

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ABSTRACT

The ability to assess the risk and its impact in urban infrastructure context is of great importance supporting the preparedness, response and further fostering the recovery period of the infrastructure in the pre and post extreme event period, as well as significantly improves the building of both society well-being and community resilience. Nonetheless, current risk analysis methods are commonly worked in an isolated manner and focused solely on the technical matter. A missing point on the current risk analysis methodologies is the lack of assessing, determining and prioritizing the impact of risks to different community groups in the face of various specific risk events which is received very little attention among the academia in the field. This study develops and validates a novel risk analysis method for assessing, setting and prioritizing the risks and its impact level on each of a number of community groups facing multi-hazard events in the context of urban infrastructure systems. The method developed in this study has been validated using a real case study in the Surabaya water supply infrastructure context. The data analysis and simulation results demonstrate the advantage of the proposed method in determining and screening both the associated the most endangers risks to several community groups. The proposed method will potentially assist the decision making in regards to the infrastructure risks governance and increasing both the infrastructure and community resilience.

Key words: Community resilience; social network; risk management; urban infrastructure; vulnerability; decision support system

INTRODUCTION

The urban infrastructure systems fundamentally underpin the ceaseless and mobile process of city life in a myriad of ways. The continuous reliance of urban dwellers on huge and complex systems of urban infrastructure stretched across geography creates its inevitable vulnerabilities. On the practical side of the issue, the matter of fact urban infrastructure are witnessing more and more system-level breakdowns, which emerge from small perturbations that cascade to large-scale consequences. Then, it is not surprising that infrastructure protection and resilience have become a national and international priority which calls for the analysis of infrastructure vulnerability and the evaluation of their resilient properties, for ensuring their protection and resilience (Rinaldi, 2004; Rinaldi, Peerenboom, & Kelly, 2001).

Consider the inherent risk within the complexity characteristic of urban infrastructure system which are various by nature; e.g., physical-engineering, cybernetic or organizational, and by environment (geographical, natural), and operational context (political/ legal/ institutional and economic) (Zio, 2016), thus the discussion towards a disturbance on, and resilience of urban infrastructure serviceability may lead to the investigation of significant risk issues. The ability to assess the risk and its impact in urban infrastructure context is of great importance supporting the preparedness, response and further fostering the recovery period of the infrastructure in the pre and post extreme event period, as well as significantly improves the building of both society well-being and community resilience. Nonetheless, current risk analysis methods are commonly worked in an isolated manner and focused solely on the technical matter.

A missing point on the current risk analysis methodologies is the lack of assessing, determining and prioritizing the impact of risks to different community groups in the face of various specific risk events which is received very little portion of attention in the academia field. The overarching question for this study is; *'how to objectively model and analyse the; correlation between hazard event and the stakeholders including with the dissimilar effects of multi-risks on the community can be defined, and assessed?'.* This study thus develops and validates a novel risk analysis method for assessing, setting and prioritizing the risks and its impact level on each of a number of community groups facing multi-hazard events in the context of urban infrastructure systems.

SOCIAL AMPLIFICATION OF RISK

The social amplification of risk (SAR) denotes the phenomenon by which information processes, institutional structures, social group behavior and individual responses shape the social experience of risk, thereby contributing to risk consequences (R. E. Kasperson et al., 1988). The information system and characteristics of the public responses that compose social amplification are essential elements in determining the nature and magnitude of risk. Figure 1 depicts the conceptual framework of SAR.

The SAR was one of the most perplexing issues and problems in risk analysis is why some relatively minor risks or risk events, as assessed by technical experts, often elicit strong public concerns and result in substantial impacts upon society and economy (R. E. Kasperson et al., 1988). The main thesis is that risk events interact with psychological, social, institutional and cultural processes in ways that can heighten or attenuate public perceptions of risk and related risk behavior. The social structures and processes of risk experience, the resulting repercussions on individual and group perceptions, and the effects of these responses on community, society and economy compose a general phenomenon that we term the social amplification of risk.

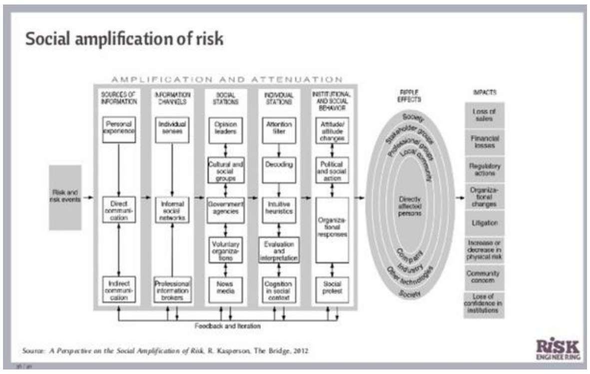

Figure 1. The conceptual framework of social amplification of risk (J. X. Kasperson, Kasperson, Pidgeon, & Slovic, 2003; R. E. Kasperson et al., 1988).

The graphic representation demonstrates the possibility that social amplification may, quantitatively and qualitatively, increase the direct impact. The analogy of dropping a stone into a pond is apt here, as it illustrates the spread of these higher-order impacts associated with the social amplification of risk. The ripples spread outward, first encompassing the directly affected victims of the first group to be notified, then touching the next higher institutional level and, in more extreme cases, reaching other parts of the industry or other social arenas with similar problems.

Following the SAR framework, the information system may amplify risk events in two major stages (or amplifiers); (i) the transfer of information about risk or risk event by intensifying or weakening signals that are part of the information that individuals and social groups received, (ii) the response mechanisms of society by filtering the multitude of signals with respect to the attributes of the risk and their importance. Signal arises through direct personal experience with a risk object or through the receipt of information about the risk object. These signals are processed by social, as well as individual, amplification 'station' (for instances; individuals, social groups, and institutions, for example, scientists or scientific institutions, reporters and the mass media, politicians and government agencies, or other social groups and their members).

The SAR will spawn behavioral responses, which, in turn, will result in secondary impacts. Secondary impacts are, in turn, perceived by social groups and individuals so that another stage of amplification may occur to produce third-order impact. The impacts thereby may spread, or 'ripple', to other parties, distant locations or future generations. Each order of impact will not only disseminate social and political impacts but may also trigger (in risk amplification) or hinder (in risk attenuation) positive changes for risk reduction. The concept of the SAR is, therefore, dynamic, taking into account the learning and social interactions resulting from experience with risk.

This rippling of impacts is an important element of risk amplification, since it suggests that the processes can extend (in risk amplification) or constrain (in risk attenuation) the temporal, sectoral and geographical scales of impacts. It also points up that each order of impact or ripple, may not only allocate social and political effects but may also trigger (in risk amplification) or hinder (in risk attenuation) managerial interventions for risk reduction. The example study within risk amplification in society concept has been studied well by Yang, R.J. and P.X.W. Zou, S. (2014) (Yang & Zou, 2014). By comparing the research paradigms in the previous studies, the study proposed a theoretically innovative and practically applicable stakeholder-associated risk analysis model for green building projects from a social network perspective.

Given the inherent complexity of risk communication and social processes, it is clear that the assessment of risk processes cannot be expected to yield simple or direct predictions regarding which issues are likely to experience amplification/attenuation effect in advance. One clear robust and comprehensive risk assessment contribution could be to draw upon social amplification to improve society's capability to anticipate new or emerging risks. Therefore, understanding the interaction of different risks with every individual, and how stakeholder groups (in which influenced by different social experiences and different culture) get affected by respective risk is an important research need.

RISK IMPACT ANALYSIS ON STAKEHOLDER GROUPS

The proposed method is based on gathering and assembling the exchanging perception-based information towards (or experts-associated risk event. To explore the risk-stakeholder interactions-based properties, the step-by-step processes explained below.

Identify and determined both the hazard events and the stakeholder(in a group manner) in the respective urban infrastructure sector. The design-based questionnaire built in order to obtain the perception of risk from the participant. Participant need to specify what hazard vents are associated with them (S1Rn). Then, each of the participant asked about 'what stakeholder groups (S⊗) do you think impacted and, or affected by each of the risk which related to you?" The next step involves defining the links within the respective network, by building the associated matrix in order to further develop the network structure (Danilovic & Browning, 2007; Fang, Marle, Zio, & Bocquet, 2012). The associated matrix present the relation between two entities as the existence of a possible precedence relationship between two entities (S1Rn) and (S⊗).

	S_{G1}	S_{P2}	S_{M1}	S_{M3}	$S_{\otimes}$
S_1R_3	(O,S)		(O,S)		
S_1R_7				(O,S)	
S_2R_4		(O,S)			
S_2R_6			(O,S)		
S_3R_9					(O,S)
....	.....	.....	.....	.....	.....
S_iR_n	(O,S)			(O,S)	

Figure 1. Associated matrix

Direct assessment is made for each potential interaction between entities by participants according to their experience and/or expertise. A qualitative Likert scale from 0 to 10 used to describe both the likelihood and severity (O,S) issued for assessing the interactions. The risk impact can be calculated using equation 1 below. Importantly, the way to calculate both Risk Priority Value (RPV) and CritR⊕ (which formed based on both conventional risk assessment method and network analysis) are beyond of this study and will not explored further in this paper. However, reader are suggested to explore more in the published paper (Ongkowijoyo & Doloi).

$$
\begin{aligned}
R_{\oplus} \rightarrow S_{\otimes} &= \sum_{*=1}^{\#}\left[\left(\prod_{n=\oplus, n\in m}\left\{\left|\mathrm{Occ}_{S_* R_n \rightarrow S_{\otimes};\otimes\in *}\right|,\left|\mathrm{Sev}_{S_* R_n \rightarrow S_{\otimes};\otimes\in *}\right|\right\}\right)_{\mathrm{RSM}} \times \underset{\max}{\mathrm{Norm}}\left(\mathrm{Crit}_{R_{\oplus}}\right)_{\mathrm{S\text{-}R}}\right] \\
&= \sum_{*=1}^{\#}\left[\left(\mathrm{RPV}_{S_* R_{\oplus} \rightarrow S_{\otimes};\otimes\in *}\right)_{\mathrm{RSM}} \times \mathrm{Coeff}\left(\mathrm{Crit}_{R_{\oplus}}\right)_{\mathrm{S\text{-}R}}\right]
\end{aligned}
\qquad (1)
$$

The outcome result then normalized using standard equation (which fall between 0 and 1) in order to be comparable between one stakeholder groups with the other one.

METHOD VALIDATION AND DISCUSSION

This study applies and validates the proposed Bi-NA method in the case of in Surabaya city water supply infrastructure system. A number of past studies explored and discussed the problem and challenged that Surabaya water supply system faced either in environmental, technical, economic and social aspects (Ostojic, Bose, Krambeck, Lim, & Zhang, 2013; Setiono, 2013; W.Dick, 2002). As many as 30 hazard events were identified based on the vast literature review (including interviewing the experts) based on the studies published in the mainstream risks and resilience literatures (Grafton, Pittock, Tait, & White, 2013; Roozbahani, Zahraie, & Tabesh, 2013) (Table 2).

Table 2. The identified 30 hazard events.

Hazard category	Hazard events
Nature	R1. Climate change, R2. Natural disasters, R3. Water scarcity (shortage), R4. Idle land exploitation, R5. Pollution and contamination.
Social	R6. Uncertain water demands (and trends) R7. Water misuse, R8. Limited access to clean water, R9. Payment problem, R10. Community rejection, R11. Population growth and urbanization problem, R12. Sabotage to physical infrastructure.
Political	R13. Uncertain political behavior, R14. Limited public participation, R15. Changes in government policy, R16. Obscurity on government legal and regulatory.
Technical and Operational	R17. Insufficient non-technical service provision, R18. Water quality defective, R19. Trouble in water transmission and distribution network, R20. Mechanical (physical) component failure, R21. Under rate maintenance, R22. Physical infrastructure decay (aging), R23. Lack of technical service provision, R24. Water loss (NRW), R25. Disturbance from another supporting infrastructure.
Economic	R26. Interest rate instability, R27. Foreign exchange rates instability, R28. Poor infrastructure investment, R29. Inflation hazard, R30. Uncertain water price.

Table 3. The respondents from eight different groups of stakeholders.

Respondent Group	Group Code	Total Respondent
National river basin management agency (BBWS)	G_1	7
Province Government public works department	G_2	13
Public corporation (PJT-1)	P_1	5
Surabaya city government	G_4	8
Regional water supply company (PDAM)	P_2	10
Industry	M_1	24
Commercial and, or public facilities	M_2	27

Domestic end user (household/ individuals)	M_3	32
	Total respondent	**126**

A total of 126 respondents from eight different stakeholder groups, which are; national river basin management agency (G_1); state government public works department (G_2); public corporation PJT-I (P_1); Surabaya city government (G_4); regional water supply company (P_2); industry (M_1); commercial and, or public facilities (M_2) and; domestic end user (household/individual-M_3) participated in this study. Responses were collected using a design-based questionnaire which was used as the preliminary input data within the proposed method (see table 3 below).

DATA ANALYSIS, OUTPUT AND DISCUSSIONS

The raw data has been initially input, modelled and simulated using Spreadsheet and NetMiner 4.0. The SRM is a big matrix which consists of 30 x 126 matrix size (i.e., based on the 30 hazard events and 126 participant). Once the SRM developed, both the network visualization and topology decipherment can be obtained and analyzed by following the network topology measurement. This study focuses on the bipartite (2-mode) network analysis and output discussion in the risk events node side only in terms of affecting to various stakeholders. Figure 2 depicts the interrelationship between stakeholder and the risk event based on divergent perceptions towards risk.

The urban infrastructure system is a complex and crucial assets which regulated, controlled, supported and exploited by various stakeholders (who dependent and affected by the infrastructure system as well). Departing from the understanding of the SAR framework aforementioned, the analysis output shows true value that different individual or groups within the urban community will be affected to each of risk event differently as depicted in Figure 2 and Table 3 below.

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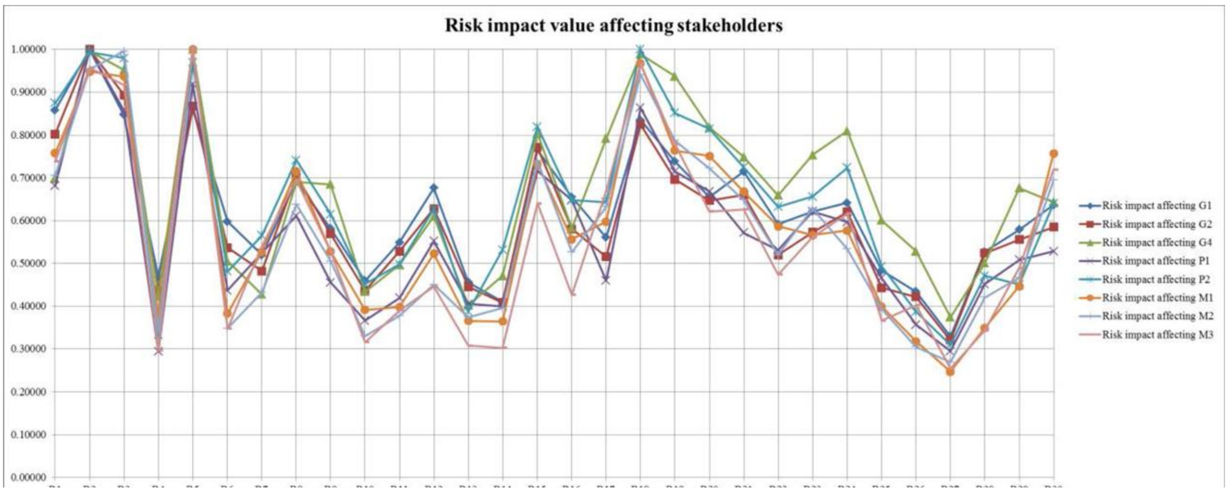

Figure 2. Risk impact value affecting each stakeholder groups

This study reveals that risk affected higher related to the risk issues that were highly correlated with the main product of "Clean Water" such as R2, R3, R5, R18 as these risk events perceived the most risk affecting community (critical risk). Therefore, decision makers should comprehensively consider these risk events and give more resources towards making risk mitigation and plan strategy in the context of community impact. Further, figure 2 shown the risk impacts value to different stakeholder groups relatively same. However, it is not fully true as different stakeholder groups affected differently towards various risk events. For instance, eight different stakeholder groups are affected differently by the R6, as well as by R7, R8, R9, R10, (and so on). Contrary, R4 and R27, considered not so or unimportant in terms of affecting public.

Risk ID	G1	G2	G4	P1	P1	M1	M2	M3
R1	0.858	0.803	0.698	0.681	0.875	0.758	0.706	0.739
R2	1.000	1.000	0.996	1.000	0.993	0.949	0.954	0.957
R3	0.847	0.893	0.953	0.857	0.980	0.937	0.996	0.917
R4	0.469	0.438	0.423	0.294	0.334	0.379	0.343	0.297
R5	0.861	0.868	1.000	0.919	0.970	1.000	1.000	1.000
R6	0.598	0.537	0.505	0.437	0.481	0.383	0.349	0.348
R7	0.520	0.482	0.428	0.525	0.566	0.527	0.433	0.541
R8	0.693	0.705	0.691	0.611	0.741	0.716	0.638	0.695
R9	0.581	0.569	0.685	0.456	0.615	0.528	0.505	0.528
R10	0.460	0.437	0.434	0.367	0.453	0.391	0.331	0.316
R11	0.549	0.528	0.497	0.419	0.498	0.398	0.378	0.391
R12	0.676	0.628	0.610	0.552	0.628	0.523	0.450	0.446
R13	0.456	0.446	0.403	0.406	0.387	0.366	0.375	0.308
R14	0.410	0.408	0.471	0.400	0.532	0.365	0.396	0.303
R15	0.765	0.771	0.804	0.717	0.820	0.733	0.739	0.641
R16	0.655	0.581	0.583	0.648	0.648	0.556	0.526	0.427
R17	0.561	0.515	0.792	0.460	0.643	0.598	0.633	0.670
R18	0.835	0.825	0.989	0.864	1.000	0.967	0.941	0.967
R19	0.738	0.696	0.937	0.715	0.852	0.764	0.787	0.779
R20	0.655	0.647	0.818	0.668	0.815	0.751	0.723	0.622
R21	0.715	0.660	0.749	0.571	0.725	0.668	0.648	0.626
R22	0.592	0.520	0.660	0.532	0.633	0.587	0.520	0.475
R23	0.621	0.573	0.753	0.622	0.656	0.566	0.628	0.562
R24	0.641	0.620	0.810	0.597	0.724	0.577	0.534	0.617
R25	0.483	0.443	0.601	0.466	0.493	0.399	0.394	0.366
R26	0.434	0.422	0.529	0.357	0.387	0.318	0.305	0.403
R27	0.330	0.321	0.375	0.295	0.310	0.248	0.269	0.255
R28	0.527	0.524	0.501	0.452	0.472	0.350	0.421	0.344
R29	0.579	0.556	0.676	0.508	0.451	0.447	0.467	0.489
R30	0.637	0.585	0.644	0.528	0.640	0.758	0.695	0.719

Although the risk impact value (Figure 2) is somehow similar trend affected mainly by the divergent people perceptions towards risks, R17, R17, R19, and R21 shows a disparate impact value data for different groups. Although a number of risk events ranking are always stand both in the same level of risk as aforementioned, however, there an risk events which its ranking order is slightly different from each other. The discussions above further reveals another findings; people were giving their attention higher to the risks issue in which correlated high to the main product delivering by the Surabaya water supply infrastructure system (i.e., "clean water"). Moreover, people perception toward risk events is the product of individual intuition which reflects their self-vulnerability point of view both in the pre and post disturbance period.

Rather than, assessing the urban infrastructure risk by mainly follow the classical and isolated paradigm of risk management in the context of technical calculation (i.e., magnitude, severity or probability), a risk impact affecting various stakeholder groups assessment as discussed aforementioned will bring another perspective towards comprehensive risk assessment in the manner of society impact. The ability of each of the risk event giving its impact and affecting community based on multi-stakeholder perceptions toward each of risk events has been discovered and discussed deeper. This analysis is significant to be another supportive document in order to support decision maker making crucial final decision for developing community resilience as well as respective urban infrastructure system in the further time.

CONCLUSION

This study proposes a method in which is capable to capture, model and simulate the phenomena of the complexity of risk impact towards different stakeholders groups. The application of the proposed method tailored to urban infrastructure risk analysis, in an effort to complement the classical risk assessment paradigm and approach. A real application on an urban water supply infrastructure is performed with the involvement of the 126 individual within the determined eight groups of stakeholder and the identified 30 risk events. The results obtained show that different stakeholder groups affected differently towards different risk events.

This study adds value to the classical risk assessment, in identifying the critical and important risks towards different groups. The advantages of the proposed method can be seen in the analysis and discussion shown in previous section as the risk not assessed by its impact, instead the association between individual and how the risk affecting another groups (risk amplification). Even though the analysis has been done in the period when there was no any infrastructure system disruption, however the analysis output reveals that public perception towards specific risk is dissimilar and in some hazard events perceived and assessed by the stakeholders higher (and lower) than the other.

Further, the proposed method is a general risk method which repeatable and can be applied to other urban infrastructure system case. This gives additional information for the further step of decision making, since risks may be considered important for criticality of their impact. The method is expected to be applicable to a wideer urban infrastructure sectors for decision support, including allocating resources for risk mitigation and reassigning risk owners. Finally, this study contributes to the urban infrastructure risk-based decision making theory acknowledgement which can support the governance of urban communities facing the respective urban infrastructure disturbances, thus develop both the respective urban infrastructure system and the community resiliency.

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SAFETY AND SECURITY IN SLUM UPGRADING INITIATIVES: THE CASE OF LPUPAP, BANGLADESH

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ABSTRACT

This paper is derived from an assessment of a safety and security initiative of UN-Habitat within the Local Partnerships for Urban Poverty Alleviation Project (LPUPAP) in Bangladesh. It examines the achievements and challenges of the initiative and identifies ways of building upon them. LPUPAP initially focused on infrastructure upgrading and community development in urban slums and then UN-Habitat's global Safer Cities Programme assisted LPUPAP to formulate a work plan and pilot project for community safety and security. These were eventually not implemented, but LPUPAP continued promoting the initiative's ideas for prevention of gender-based violence, empowering its women committee members, reducing domestic violence and initiating local crime prevention responses. However, challenges remained, particularly dealing with wider crime in the community, and to structure a strategic project component focused specifically on community crime and violence prevention. Thus the way forward would be to review the Safer Cities work plan and use it as a foundation to address community safety and security.

INTRODUCTION

Figure 1: A large number of people in Bangladesh's cities live in such slums.

Bangladesh is one of the most densely populated countries in the world with more than 150 million people; a third of its population live in extreme poverty (UNDP, 2011; UNFPA, 2011). A rapidly urbanizing country, it is expected to have more than 50% urban population by 2050 (UN, 2012). In a context of widespread poverty, political instability and frequent natural disasters, the urban poor have to fend for themselves against the persistent fear of eviction, living in slums rife with crime, violence and anarchy controlled by ganglords locally known as "*mastans*" (Banks, 2008; World Bank, 2007) (see Figure 1). Inadequate safety and security adds to an array of shocks and stresses on the urban poor acting as a barrier to building resilience.

A notable urban poor community development initiative was the Local Partnerships for Urban Poverty Alleviation Project (LPUPAP) (2000-07) supported by UN-Habitat. This paper is based on an assessment by the author of LPUPAP's 'Safer Cities' programme aimed at improving safety and security in the project's slum communities (UN-Habitat, 2011).

METHODOLOGY

The following activities comprise the methodology of the assessment:

Review of institutional literature detailing the chronological events and conceptual framework of the programme.

Interviews of LPUPAP staff and project consultants at various levels in the cities of Dhaka, Mymensingh, Narayanganj and Tongi.

Interviews/focus group discussions in Mymensingh and Narayanganj with Ward Commissioners and beneficiary communities including LPUPAP's Community Development Committee (CDC) leaders.

Thematic analysis of the literature and fieldwork data. Recurrent issues and themes, as well as unique and outstanding ones, were grouped for analysis and reflection.

SCOPE OF LPUPAP

LPUPAP targeted about 360,000 people in 75,000 households in 338 slum communities and was implemented in three metropolitan and eight smaller cities. It worked with local government authorities to improve their services to the urban poor. The basic scope of LPUPAP when it started in 2000 was upgrading of slum infrastructure - paving of walkways and constructing drainage channels, and provision of water-and-sanitation services – pumped water, community latrines and washrooms (see Figure 2). A social component - community development through microfinancing and capacity building - was later integrated with the physical intervention, focusing on women's empowerment through CDC leadership development, local institution building and economic activities.[9]

Figure 2: Paved walkways and drains built by LPUPAP in a slum in

CRIME AND SECURITY CONTEXT

[9] A large number of project documents were consulted, which are not listed in this paper. The list is available from the report in UN-Habitat, 2011, pp. 65-77.

LPUPAP operated in a context of widespread crime and insecurity; the large extent of slums and corruption at all layers of society has resulted in crime and insecurity becoming "'routinized' or 'normalized' into the functional reality of life" (World Bank, 2007; also see Shafi, 2006; UNESCAP and UN-Habitat, 2009). The lack of policing in slums, not considered legal because of tenure insecurity, and even police collusion in criminal activities, has led to slums serving as a safe refuge for criminals (Ahmed, 2010). Other poor slum residents are vulnerable to such crime as they do not have any legal recourse and cannot expect police help (Ahmed and Johnson, 2014). Along with a range of disasters affecting the urban poor (Ahmed, 2014), inadequate safety and security add to the shocks and stresses that diminish opportunities for building resilient communities.

Three main types of crime were consistently highlighted in project documents and by LPUPAP staff and community members. Firstly, the all-permeating control over slums by mastans, who run the collection and extortion of illegal 'toll' from businesses, transport stations, construction sites and even small informal traders and workers. They also control housing rents and supply of basic services (water, electricity, etc) and charge extortionate rates from poor slum dwellers (see for example, Ahmed, 2014; Ahmed and Johnson, 2014; Banks, 2008; UNESCAP and UN-Habitat, 2009). Various criminal activities - snatching, mugging, forgery, small arms and weapons, etc - operate under the patronage of mastans, who usually have political links. Secondly, linked to the first but assuming a proportion to be significant on its own, is crime linked to consumption and dealing of illicit drugs. Slums dwellers are often caught in territorial battles among dealers over turf for drug peddling and are also victims of theft and mugging by addicts. In general, as found in several studies (Ahmed, 2010; DIG, 2008) and also the LPUPAP assessment (Ahmed, 2011), particularly in the evenings a tense and uneasy atmosphere prevailed in slums where drug use and dealing were common; many slum dwellers reported the detrimental effect on their lives, especially on young men or boys (drug users are almost all male in Bangladesh).

Often linked to the above crimes, the third type – crime against women - is less visible, but more deeply entrenched and more pervasive, and often as lethal (Ahmed and Johnson, 2014). Women in slums are generally burdened with more poverty than men, especially women-led households, and more vulnerable to gender-based domestic violence. In Bangladesh, as in other countries of the region, many forms of gender-based violence exist, often linked to cultural practices such as dowry demand, early marriage and illegal divorce, reported widely (see for example Ahmed 2010; Rau, 2015; UNESCAP and UN-Habitat, 2009). Reported in these studies, women are subject to a range of criminal and other offences including sexual abuse and exploitation, prostitution, trafficking, battering, assault, revenge crimes, illegal divorce and abandonment, harassment and eve-teasing.

SAFER CITIES WORK PLAN

LPUPAP's original project design of did not take safety and security issues into consideration. However, LPUPAP's organisational structure consisting of the CDCs was women-based in cognizance of the vital role women play in family and community development. Extensive gender-based violence was a barrier in achieving the project's objectives and in response LPUPAP requested UN-Habitat's global Safer Cities Programme to assist in the development of a project component to address community safety, gender-based violence and access to justice. UN-Habitat's programme was built on work in Asia, Africa and Latin America (UN-Habitat, 2007a; UN-Habitat, 2007b), hence the benefit of this experience was sought by LPUPAP.

In response, a broad outline of safety concerns and ideas for action to eventually develop a work plan for community safety and security was formulated through several external UN-Habitat missions and contextualised by local consultants through community consultations. The activities and findings were eventually consolidated into a 1-year work plan or Community Safety component for LPUPAP. However, the component's objectives were implicitly long-term as they aspired to address deeply entrenched structural issues, requiring action over a long period to achieve results, usually difficult to achieve within a short project timeline.

KEY FINDINGS

Although during the UN-Habitat missions, communities participated with interest, subsequently there was not much direct uptake by LPUPAP or CDCs. The Safer Cities concept was interpreted mainly as an awareness-raising campaign. It became evident that it required a substantial commitment of institutional support, specialist staff, training, reporting, monitoring, etc. Adding socio-economic components to an infrastructure upgrading project had already stretched the capacity of LPUPAP. Thus, the Safer Cities initiative, at least as outlined in the work plan (UN-Habitat, 2007b), was not implemented. Despite a detailed strategic plan and pilot project proposal developed through extensive consultations, not much happened after the UN-Habitat missions.

Although there were serious existing crime elements such as *mastans* and drugs, it was beyond the scope of LPUPAP to address them; they required national level intervention. The Safer Cities campaign thus began to focus on gender-based violence which could be addressed within LPUPAP's capacity. Empowerment of women through involvement in the CDCs was a focus area for LPUPAP under a 'gender' component, where issues relating to gender-based violence were addressed, and the Safer Cities initiative became subsumed within it. The workshops during the Safer Cities missions provided scope to LPUPAP managers and other staff members to gain knowledge and exposure on safety and security issues and this was subsequently applied to activities under the gender component. Thus, although a full-fledged Safer Cities component was not implemented, its concerns helped strengthening an existing component.

Capacity Building

The gender component relating to safety and security of women addressed the prevention of culturally-rooted practices of dowry, early marriage and domestic violence, and raising awareness of women's rights and entitlements. Training programmes on legal rights for female LPUPAP members and for provision of legal aid in cases of battery, assault, rape, etc were initiated through a non-profit partner, the Bangladesh Legal Aid Services and Training (BLAST). BLAST had already been cooperating with LPUPAP on legal matters, for example, securing land tenure for project communities and also in some gender-based violence cases. Other training programmes included capacity building of CDCs on leadership, economic skills and women's rights as well as management of project activities. Some CDC members had been taken on exposure visits to LPUPAP projects in other cities and also to Thailand and Cambodia. It was reported that women had benefited from personal development and learning through LPUPAP, becoming more capable and confident.

However, in the Safer Cities work plan there was no indication of structured training provision. The adaptation of the principles and approaches of UN-Habitat's global Safer Cities Programme from the international level to the local slum community required training at different levels, but in the work plan there was hardly any recognition of that. The assumption seemed that once the Safer Cities component became integrated into the framework of LPUPAP, it would benefit from the wide range of capacity building opportunities existing within the project.

Key Achievements

Although the Safer Cities initiative was not continued as planned, LPUPAP's work addressed some important community safety and security issues. It was successful in developing a strategic work plan for community safety and security through intensive community consultations, having potential for wider adaptation and replication to the national context of urban poor community development.

The UN-Habitat missions brought focus to the serious issue of gender-based violence and raised awareness among LPUPAP staff and communities and it became a key focus area. Already marriage registration (to prevent early marriage) and divorce notice (to prevent illegal divorce) were enforced in LPUPAP communities, generally uncommon in the urban poor context. Wider support to women through a range of services – economic empowerment, skills development, education and health support, day care centres for children of working women, etc – all contributed towards empowerment of women with eventual benefits for the family and community, as well as reduction of domestic violence.

Empowerment of women in LPUPAP communities was widely reported, for example formerly poor CDC members rising to the position of local government Ward Commissioners. Women begun having much more negotiating power with local authorities and even placed demands to the Mayor's office. One of the CDCs had created a 'Crime Welfare Fund' by setting aside money from project funds, using it for emergency domestic violence management. The LPUPAP strategy of enlisting the support of local influential persons was also useful; although the police seldom responded to calls from slum dwellers, because of links with Ward Commissioners, in some cases community members were able to access police help. Thus with minimal institutional support, slum communities were able to address important safety and security issues.

In Bangladesh, it was common local *mastans* to demand 'fees' for building/infrastructure work to proceed in their area. However, in the case of LPUPAP's infrastructure work, they had been able to avoid such extortion. Often *mastans* belonged to the same communities and because the work benefited the whole community and due to the engagement of community members, *mastans* were unable to make demands as they would at a private construction site. There was a case reported where community members had to seek police help to prevent *mastans'* demands. Initially the police were reluctant, but women from the communities demanded filing a police report, generally uncommon for women from slums to make such demands; because the women were empowered, they gained respect and eventually help from the police. This shows that empowerment of women not only helps address domestic violence issues, but also wider crime.

A project such as LPUPAP provides opportunity for community policing in the face of inefficacy of the national police system. For example, in Mymensingh about 20 men had banded together and raided drug dens and confronted addicts and dealers. This was supported by the Ward Commissioner and local LPUPAP administration, and drug use and dealing became reduced. Some funds were raised from the community by CDC members for expenses for this team. Given an institutional support framework, the communities were able to develop locally appropriate strategies for preventing crime and violence.

Challenges

Originally, LPUPAP requested UN-Habitat's Safer Cities Programme to assist in developing a project component that addressed: 1) community safety, 2) violence against women and 3) access to justice. Emphasis was eventually given mainly to the second issue. Safety and security of the entire community extended beyond this, as indicated by the drugs and *mastans* problems repeatedly highlighted as the critical crime and violence issues, which were beyond the capacity of communities to address on their own. As one community member mentioned, "There might be possible solutions, but we don't know them. These things [crime] are too big for us to deal with." Also, poor men were often in need of access to legal aid, not only women; access to justice as a fundamental human right needed to be considered. Building on the work initiated on domestic violence prevention, the challenge remained in extending it to the broader sphere of overall community safety and security. Perhaps the key issue was that crime and violence prevention actions had been undertaken within an ongoing regular programme, not as part of a key strategic component. Whatever was done was not documented or evaluated adequately, did not follow a work plan or institutional strategy instrument, or link to wider local influences active in promoting gender-based violence prevention, such as the work of NGOs or the media.

The Safer Cities initiative was largely unknown to the communities, except for those that participated in the UN-Habitat and consultants' workshops. CDC members in Mymensingh when asked about Safer Cities did not know it, although they were aware about the LPUPAP's gender-based violence prevention efforts. Abuse of women continued to prevail in the community: There were men with multiple wives and even within the group in Mymensingh, there was a woman abandoned by her husband.

The problem of measurably assessing the impact of crime and violence prevention initiatives, particularly gender-based violence reduction, made it difficult to mainstream initiatives such as the Safer Cities, particularly within the framework of an infrastructure upgrading project. Infrastructure projects result in concrete quantifiable outputs, therefore use of donor funds can be easily justified and the development efforts are visible. What is often not understood is that if local conditions are safe and secure, infrastructure projects have the opportunity to be implemented more effectively. On the other hand, improved infrastructure, such as better street lighting, roads and communal spaces, has the potential for assisting in crime and violence prevention. Even though LPUPAP was a community-based infrastructure-and-services project, there was hardly any effort at linking the physical work to crime and violence prevention.

DISCUSSION AND CONCLUSION

Although LPUPAP's work made some progress on preventing gender-based violence, challenges remained, particularly in addressing overall crime and violence in slum communities. The Safer Cities initiative offers lessons on how a project component on community safety and security can be designed through community consultation. Crime and violence persist in urban slums and to begin addressing it systematically, beginning with a strategic plan that is already available and building upon it offers a useful option. If the idea of a focused crime and violence prevention initiative or program component is taken on board, it should begin with a consultative review of the outputs of the Safer Cities initiative with a view towards adapting them to the current context.

Together with a review of the work plan, it is necessary to develop and incorporate within it a set of urban safety indicators that are contextual and relevant to the concerns of the work plan and to measure its long-term impact. Such indicators are available from a range of sources such as UN-Habitat's global Safer Cities Programme (UN-Habitat, 2011), which can contextualised through a consultative process with local experts and stakeholders. There would be a need to clarify focus: at present crime and violence prevention measures and general development activities tend to overlap. Although such measures need to be integrated within the overall project, they should be understood and applied as distinct from delivery of other development services because of the high risks involved and the need for greater sensitivity and psycho-emotional support.

An important concept that should be considered is community policing, especially because of the lack of a police force responsive to the safety and security needs of the urban poor. However, this has to be developed in coordination with the existing legal system, not as an alternative, because that might lead to gang formation and extra-judicial action. There were some examples of informal community policing in the LPUPAP communities, which could be built upon to develop a system that functions appropriately at the community level.

Policing and law enforcement alone are not sufficient to address the complexity of the crime and violence situation, especially due to its linkage with the drugs trade and domestic violence. It has to work within a system of counselling, psychological support, employment and education opportunity creation and community-wide awareness-raising. Drug rehabilitation clinics exist in larger cities, but drug addicts often resume their habits after undergoing treatment because of the lack of adequate community and family follow-up support. Although such clinics are important and should be considered for slum communities, they have to be backed by a community and family support structure, requiring capacity building down to the family level, and programme development and management at the organisational level within a broad-spectrum community crime and violence prevention agenda.

Structured training on crime and violence prevention had not been undertaken under LPUPAP, nor suggested in the Safer Cities work plan. There is an important need for that at all levels, institutional to household. Efforts at linking with legal aid agencies (e.g. BLAST) for training on domestic violence prevention is a form of capacity building that should be undertaken on a wide range of community crime and violence prevention measures. Some of the achievements of LPUPAP's domestic violence prevention activities were possible due to the presence of an extensive NGO network active in human rights issues. There was a need to strengthen links with this network.

A key disadvantage communities face is the lack of adequate information on crime and violence prevention. There are many successful examples from other countries (see for example UNESCAP and UN-Habitat, 2009; UN-Habitat, 2011), and even within Bangladesh, which offer useful lessons and scope for adaptation, but slum communities do not have access to such information, nor are they directed towards it. LPUPAP had provisions for information sharing on various issues including women's and human rights, and also for cross-learning visits within the country and Asia. This idea should be extended to the field of crime and safety prevention so that community members can visit and learn from examples of good practice elsewhere. A concrete way forward would be the development of documentation and mapping of existing initiatives on violence and crime prevention within Bangladesh and similar contexts for the benefit of communities, and also for the government and local authorities, for use when designing and planning projects and interventions.

An important possibility not considered so far is to link infrastructure and services upgrading to crime and violence prevention. Better street lighting at key spots, clean paved roads and community open spaces designed for safety are among some ideas that can contribute towards community safety and security. Through community-based consultations such physical planning options can be developed that are context-specific and can be implemented and monitored by the communities.

Perhaps, most importantly, it is necessary to commit funding and human resources to such an initiative for community crime and violence prevention. It may not have to be a separate project component; even within the regular functioning of a project, attention can be given to budget allocation, staffing and training for activities that specifically relate to safety and security issues. This would allow better performance, accountability and monitoring of impact. The LPUPAP project is unique in many ways, with potential for replicable good practice to make a strong impact on crime and violence prevention for the urban poor in Bangladesh.

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FISHERMEN COMMUNITY AND GOVERNMENT INTEGRATION IN STRENGTHENING THE RESILIENT CITY – SURABAYA

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The fisherman settlements at the northern and eastern coast of Surabaya spreading about 40 km along the coast. Some are in good conditions and some are still inadequate, in terms of physical and economic conditions. To increase the resilience of the community, which in turned contribute to the resilient of the city, some key factors should be addressed. These are : hazards and stresses, fragile livelihoods, future uncertainty and governance. The objective of the study was to find the answer of how the fisherman community and the government strive to increase the resilience of the city. Resilience refers to the ability of a system to resist, absorb, cope with and recover from the effects of hazards and to adapt to changes in a timely and efficient manner.

The method used in the study was surveying the physical conditions and livelihood at the fisherman settlements case study and the government action in the development of the settlement environment. The framework of analysis based on resilience framework, which includes hazard and stresses, future uncertainty, livelihoods and governance. The result of the study shown that the fisherman community has the ability to manage risk, and adapt to change. While the government promoting integrated approaches to livelihood and climate change.

KEYWORDS: fishermen community, government, resilient city.

ENHANCING RESILIENCE OF CRITICAL ROAD STRUCTURES UNDER NATURAL HAZARDS

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Critical road structures play a significant role before during and after a disaster by providing evacuation, rescue access and recovery respectively. Failure of these lifeline structures therefore has a direct influence on the resilience of the community. A current major research project conducted in collaboration of four research institutions and funded by the bush fire and natural hazards CRC in Australia is focussed on enhancing resilience of road structures: bridges, culverts and floodways, under flood, bush fire and earthquakes.

The paper presents the conceptual framework for vulnerability modelling of critical road structures under natural hazards and the methodology adopted to quantify the damages. Vulnerability modelling methods adopted under different hazard types are described and the major contributing factors are identified. A case study of a bridge failure under flood is presented to demonstrate the application of the methodology. Vulnerability of a structure can be quantified using a cost based approach or a structural capacity based approach. Outcome of vulnerability can be integrated with the community impact to determine the required measures for enhancing resilience. A decision making framework for enhancing resilience of infrastructure is presented.

KEY WORDS: natural hazards; resilience; road structures; vulnerability

EXOGENOUS AND ENDOGENOUS DRIVERS IN CLIMATE CHANGE ADAPTATION POLICY MAKING IN DEVELOPING COUNTRIES

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ABSTRACT

Global initiatives such as 100 Resilient Cities, UN-Habitat's Cities and Climate Change Initiative, and Making cities resilient movement by UNISDR have recently seek to enhance preparedness and risk reduction around the world especially in developing countries. These global initiatives have triggered local actions in some cities across South Asia and Southeast Asia to adopt adaptation policy and practices. This research aims to understand the role of such exogenous forces namely Asian Cities Climate Change Resilience Network (ACCCRN) that seeks to foster endogenous adaptation in Indonesia. This paper focuses on understanding the impacts of exogenous force for triggering knowledge-policy interactions, exploration of new ways for climate risk governance and the sustainability of adaptation planning. The question is under what condition endogenous adaptation planning and practice not only takes place but also can be performed as a routine urban development in developing world?

Keywords: climate change adaptation, exogenous forces, endogenous adaptation, risk governance, ACCCRN, mainstreaming adaptation

INTRODUCTION

The 100 Resilient Cities Project seek to "Helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century".[10] The UN-Habitat's Cities and Climate Change Initiative (CCCI) "seeks to enhance the preparedness and mitigation activities of cities in developing countries." Similar projects at regional level such as Asian Cities Climate Change Resilience Network (ACCCRN) have seek to "catalyze attention, funding, and action on building climate change resilience for poor and vulnerable people" (The Rockefeller Foundation, 2009).
These exogenous factors originally derive from outside the cities.It is critical to understand the buy in from actors in Bandar Lampung City in term of leadership, process for mainstreaming adaptation planning and social

[10] See http://www.100resilientcities.org

learning. This will determine the likelihood of sustainability for adaptation planning and actions. The main question of this research is "How exogenous forces (e.g. international supports) in fostering adaptation to climate change at local level in developing world can trigger sustainable endogenous responses". This paper highlights practices and experiences from Bandar Lampung city[11] for initiating and testing adaptation planning facilitated by ACCCRN. This paper also evaluates the processes of institutionalization of adaptation planning and the potential buy-in from local actors.

The paper draws on a fieldwork in Bandar Lampung (from June to October 2012 and recent research 2015 (First author) and followed up by a field work during May 17th to June 28th 2014 9 (Second Author). Data collection methods include participant observation, unstructured interviews with city stakeholders and project managers, semi-structured interviews with local communities and literature reviews (including a review of official minutes of meetings, project reports and other official documents). During May-June 2014, at least 30 key stakeholders in Bandar Lampung and project manager and experts in Jakarta have been interviews. This research has used ethnographic field research, document collections and focus group discussions. The field interview findings are presented in Chatham House format – i.e. no personal attribution - throughout the sections (Chatham House 2014).

EXOGENOUS AND ENDOGENOUS FACTORS IN URBAN ADAPTATION POLICY MAKING

The origin of adaptation planning policy can either be from within or outside the cities. This research uses the terms endogenous forces and exogenous forces. The definitions and characteristics of endogenous and exogenous driving forces are derived from Anguelovski and Carmin (2011), Carmin et al (2012) and Carmin et al (2013**). Endogenous factors** underpinning urban adaptation usually come as a response to existing city vulnerability or trigger by recent disasters that have severely damaged the city. The initiative was taken by either local champion, who sits as manager or staff at city department, or civil society actors. The goal is mostly for reducing risks from future hazards and current vulnerabilities, and as an advancement of local development agenda. The process involved multi-actors for conducting assessment and planning for adaptation plans, and maintained with locally generated resources such as: local staffs, budget and office.

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[11] *Bandar Lampung is a coastal city located in southern tip of Sumatra Island in west of Indonesia. Its topography comprised of plains, seashores, hilly to mountainous area (Bandar Lampung City Government, 2008). Its current population in 2014 is about 960 thousand people with annual growth rate 1.5% (Statistic Bureau of Bandar Lampung, 2014). The number of poor people is about 27-30 per cent of its total residents.*

Exogenous forces usually aim to linking with international funding or enhance environmental leadership of the city. The driver is being pursued as consequences from national policies, international agreements or transnational network. Some of these international programs include: ICLEI-Local Government for Sustainability, UN-Habitat's Cities and Climate Change Initiative (CCCI), the World Bank, Asian Development Bank, The Rockefeller Foundation's Asian Cities Climate Change Resilience Network (ACCCRN) and The Rockefeller Foundation's 100 Resilient Cities (Carmin et al, 2013). The goal is to advance local development agenda and foster for adaptation planning. It was undertaken with incentives and provision of monetary and technical assistance to the cities. The separation between driving forces is not to ignore that both can simultaneously happened within a city.

ACCCRN IN BANDAR LAMPUNG CITY

ACCCRN cities followed typical design for planning and managing adaptation planning. Even though a general freedom was offers to adapt with local institutional framework within each city. ACCCRN cities followed cyclical adaptation planning where the process starts with stakeholder engagement, followed by undertaking assessment and sector studies, planning for city resilience strategy, implementing multi-actors collaborative interventions and end-up with learning, synthesis and evaluation. This process is iterative to understand both city vulnerability and response for building urban resilience, and depicts a channel for inclusive decision-making and participation of broader stakeholders (Tyler and Moench, 2012).

The first interaction of multi-actors within this experimental adaptation planning happened during vulnerability assessment. The dominant actor in this phase is the scientists or university academics as outsiders that have been facilitated by the external actors funded by ACCCRN Project. The scientists had attempted to involve other actors, including city team, local authority and the public, during the process. Even though city team represented as a concerned group, but in vulnerability assessment phase they only functions as "informants" to the study draft results and as "facilitator" for coordinating the general processes.

Multi-stakeholder engagement and public participation

City Team is established since the beginning of the project in Bandar Lampung. This is an ad hoc body of multi-stakeholders groups that is responsible for managing, planning and supervising adaptation planning (and actions) in the city. The team is chaired by City Manager and consists of multi-sectors stakeholders, including local university academics, professional association, non-government organization (NGO) and government officials, such as Planning Agency, Environment Agency and Disaster Management Agency. The City Team meeting in frequent basis and Planning Agency is become its secretariat for daily coordination. The most active agencies within the City Team that sits at planning and environment desk are: Planning Agency (BAPPEDA), Disaster Management Agency (BPBD) and Environment Agency (BPPLH).

During the experimental adaptation planning, poor and vulnerable groups is also being involved to give their voice heard and recognized by other city stakeholders (Nugraha, 2013). In the early stage of the cyclical adaptation planning, they only become a confirmation hub, but then moved to have greater role as a facilitator and controller. The City Team has able to build trust across diverse stakeholders and having neutral position to knowledge production.

Vulnerability Assessment and City Resilience Strategy

Vulnerability assessment as both process and a product serve as the basis for taking decision for adaptation actions that going to be outlined in city resilience strategy. The vulnerability assessment study predicted that the probability to have rainfall that will lead to flooding or inundation might increase slightly in Bandar Lampung. Moreover, the study reported that 16.73% of local residents has affected by flooding in one of the study area in Bandar Lampung (ACCCRN, 2010). Identified existing vulnerability includes poverty, lack of basic infrastructure and compounding effects from urbanisation and climate risks, poor and vulnerable communities will suffers most of the impacts.

After conducting vulnerability assessment, the experimental city of Bandar Lampung outlined adaptation strategies in **city resilience strategy**. The resilience strategy is "a city-level strategy that equipped the local government to adapt to climate change and outline adaptation actions" (Nugraha, 2013). The document also functions as a roadmap for the city to prepare for the worst-case scenario if climate change severely impacted to the city (Lassa and Nugraha 2015). The strategy consists of 17 prioritized adaptation strategies in 6 different sectors: water, environment, infrastructure, coastal, human resource and institutional capacity. The top five prioritized strategies for the city to be taking as adaptation actions are: community empowerment in climate change adaptation, implementation of an artificial groundwater recharge of biopore and infiltration well, maintenance and construction of an integrated drainage system, rehabilitation of forest and degraded land rehabilitation, and development of integrated waste management (Mukhlis et al, 2011).

Modes for undertaking public participation

There are different modes for undertaking public participation in experimental adaptation planning, including focus group discussions, meetings, shared learning dialogues (SLD), community based mapping, etc. The last two modes are among the most potential to have more inclusive public participation. First, *shared learning dialogues (SLDs)*; it is a technique for discussion, communicating ideas and negotiating future scenarios of planning that invites multi-stakeholders within a moderated forum. The SLDs has provided "a space for informed deliberation on the meaning and value of systems, and co-production of new, cross-disciplinary knowledge…and avoiding dominance of technical knowledge" (Reed et al, 2013). Second, *community-based mapping*; it was used for mapping local vulnerability by local communities themselves and used for future risk mitigation planning.

Adaptation planning

In adaptation planning, the city has initiated and explored using normalization approach for managing risk from climate change. Risk mapping is widely used to illustratively provide categorical spatial-based information of risk level at identified area. It exhibits climate risk maps for Bandar Lampung in year 2005, 2025 and 2050. These maps were developed based on SRESB1 emission scenario, which depicts a convergent world with stabilized population growth, reduction in material intensity and introduction of clean and resource-efficient technology (ACCCRN, 2010). The map is composite result from different type of hazards: flood, drought, landslide, and sea level rise, and combined with calculation from city vulnerability indices. In baseline year of 2005, there are 5 sub-district classified at medium risk (M), 36 sub-district at low-to-medium risk (L-M), 22 sub-district at low risk (L), 21 sub-district at very-low risk (VL), but in the future years, 2025 and 2050, more sub-districts will be exposed to higher climatic risk (ACCCRN, 2010).

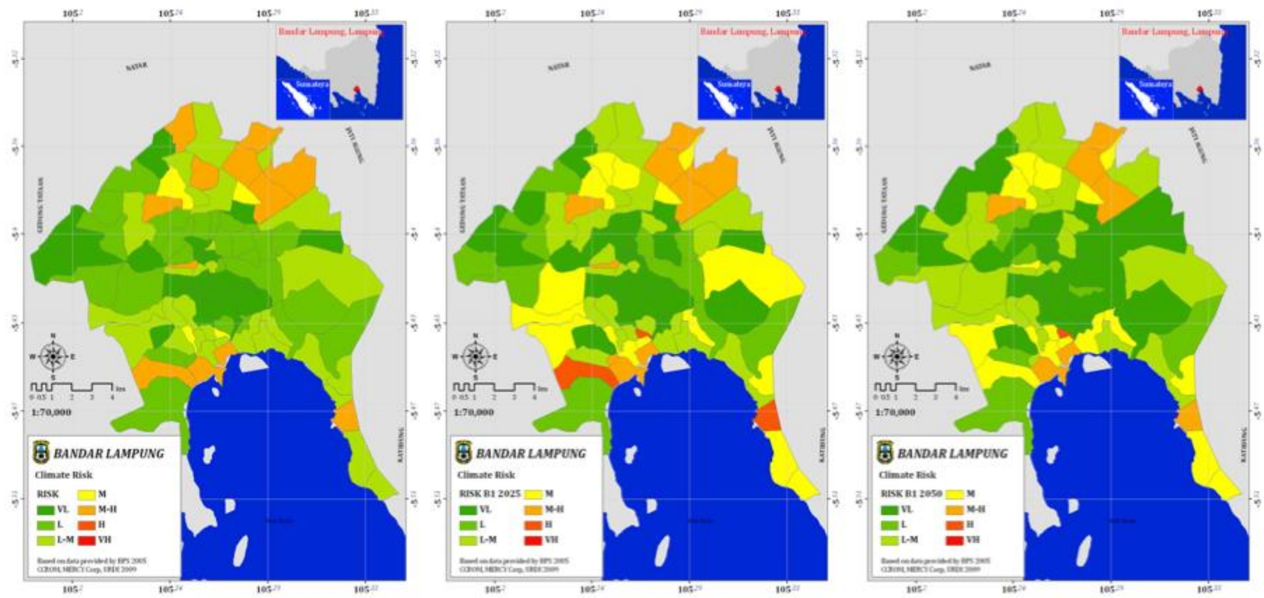

Figure 1 Climate risk maps for Bandar Lampung in year 2005, 2025 and 2050

- under SRESB1 emission scenario (Source: ACCCRN, 2010)

INSTITUTIONALIZING RESILIENCE: EMERGENCE OF ENDOGENOUS FORCES

Emerging practices and lessons has evolved from experimental adaptation planning in Bandar Lampung. All measures that were being planned and implemented are to anticipate extreme weather or climate variability and impacts from climate change and aims to build local institutionalization and long-term sustainability. Exogenous forces have fostered adaptation planning, but what can make this process become sustain in long-term and institutionalize within current governmental context, will be discussed here.

Leadership

Leadership plays significant role for fostering local process for adaptation planning. Wamsler (2014, p.156) point out that the successful of adaptation planning is "highly dependent on the level of commitment and leadership of local authorities." At city level, it's depend on City mayor and city executive understanding and support for policies and regulations that enable the process for adaptation planning. In Bandar Lampung, the City mayor has enabled the adaptation planning process by: approving to establish City Team, agreed to sign new regulation on groundwater conservation and city budgets for adaptation. There is also increasing role from city manager and his assistant to experimental adaptation planning process. They developed more understanding, commitment and support that the process can align with city development and concurrently reduce climate change impacts.

City team: structure, functions and authority

City Team is ad hoc body that initially responsible for managing, planning and supervising adaptation planning in Bandar Lampung. The team is chaired by City Manager and consists of multi-sectors stakeholders, including local university academics, professional association, non-government organisation (NGO) and government officials. The mandate for City Team has been extended not only for adaptation, but also climate change mitigation. This was undertaken for two reasons: implementing climate change adaptation requires concurrent efforts on climate change mitigation and to seek other opportunities from mitigation sector.

FINAL REMARKS ON MAINSTREAMING ADAPTATION PLANNING INTO FORMAL DEVELOPMENT PLANNING

Exogenous factors have temporarily fostered climate change adaptation at the city level, but the question is how this really effectively create meaningful interactions between stakeholders, facilitate knowledge and policy interactions, useful for undertaking climate governance and adequately provide sufficient foundations for sustainability of experimental adaptation planning. The exogenous forces can play roles as a catalyst for urban adaptation planning, including undertaking vulnerability assessment and city resilience strategy and implementing adaptation actions, and facilitates risk management. Further processes are still necessary to arrive at endogenous climate adaptation routines. This including the need to mainstreaming adaptation into local planning routines and systems which required complex interactions of multi-stakeholders and local political processes.

Bandar Lampung took different strategies for mainstreaming climate change adaptation. This was undertaken looking at the current institutional arrangement and opportunity for creating more sustainable mainstreaming. *Implicit policy mainstreaming*; since there is no mandate at national level for mainstreaming climate change adaptation, the city implicitly mainstreaming adaptation policies into city formal plans such as: City Medium Term Development Plan 2010 – 2015. Second, *multi-policies mainstreaming*; the experimental city has explored that working in adaptation needs to be integrated with climate change mitigation.

Current endogenous strengths include the establishment of City Team, commitment from the City mayor, city budget and support from NGO communities. In fact, there is a substantial increase in local government income in Bandar Lampung during the last five years (Lassa and Nugaraha 2015) which allowed the local government to co-create and co-finance adaptation planning and implementation in Bandar Lampung. However, the existing institutional constraints remain such as limited city budgets for adaptation, lack of priority for environmental protection agenda, absence of national or provincial regulations on climate change adaptation and lack of commitment from neighboring county and local communities. The current mainstreaming adaptation planning still has to face more challenges, including: (i) *multi-policies integration*, which mean different formal development plans are require to integrate with climate change adaptation strategies; (ii) *deliberative process*, which mean to build a process that evoke full understanding of the process and motivations; (iii) *implementation gap*, that inclusion of adaptation strategies into governmental plans will not automatically turn into actions, because it's requires commitment and resources; and (iv) *national-driven mainstreaming*, where the city still demand national support or an umbrella regulations for mainstreaming climate adaptation.

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SPATIO-TEMPORAL VARIATION IN CHRISTCHURCH'S EARTHQUAKE RECOVERY: INTERACTIONS BETWEEN BUILT, ECONOMIC AND SOCIAL ENVIRONMENTS

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In the post-disaster setting, change to the built environment can be viewed both as a consequence of disaster and as a means to recovery. As the Canterbury region in New Zealand moves towards long-term recovery from its 2010/11 earthquakes, information is needed by decision-makers and communities to guide recovery efforts so negative impacts over the recovery are minimised and opportunities to thrive are enhanced. Valuable lessons about recovery and effective ways of reducing risk of harm from damaged built environments also need to be shared across New Zealand and internationally to increase our ability to prepare for recovery. Funded through the Natural Hazards Research Platform, the objective of this longitudinal research is to understand the interaction between recovery of the built environment and social and economic recovery of communities, cities and regions. Using multiple formal and informal secondary datasets, area indicators of the physical, social and economic neighbourhood environments are developed, including damage to land and buildings, number of businesses, population change, to identify variations in the level of recovery within the city. Analyses compared changes over time (yearly) and across neighbourhoods (census area units). To date, findings have shown recovery to be uneven across neighbourhoods, with some doing unexpectedly better or worse, given the level of damage and other factors. Cases of recovery trajectories will explored in depth using the build back better framework to identify where and how rebuilding can facilitate good recovery outcomes. Early findings in what will be a prolonged recovery emphasise the importance of location for the recovery of business, neighbourhoods, and the city.

KEY WORDS: Recovery trajectory, Community resilience, neighbourhood indicators,Canterbury earthquakes Build back better, Longitudinal study

DISASTER ETHICS AND THE MANAGEMENT OF VULNERABILITIES: AN ASIAN PERSPECTIVE

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ABSTRACT

Natural disasters and disaster created by human activities have been on the rise in the last several decades. It has been estimated that some 50 million people are living in conflict areas and another 100 million are affected by natural disasters annually. In Asia, extended droughts, trans-boundary haze, earthquakes, floods, hurricanes, tsunamis, landslides, volcanic activities and severe weathers have created havoc and displaced populations in many parts of this continent. The 2004 Asian tsunami alone caused 230,000 deaths and 15 billion dollars in damages. These events have given rise to the realisation that a more concerted disaster management strategy is needed to manage disasters more effectively. In disasters, often the victims, their families and friends, and the care givers are confronted with undesirable situations and difficult decisions. In such context, decisions made on an ethical basis may have significant and lasting impacts on the communities served. This paper will provide an analysis on how Asian communities perceive disaster and the ethical reasoning in dealing with calamities. By drawing from experiences in several Asian countries, the paper will discuss, firstly how worldviews and faith systems help to reconcile extreme difficulty resulting from disasters, and secondly it will address the ethical issues and dilemmas faced by the humanitarian first responders, care givers and disaster related agencies as they seeks to respond to situation of extreme vulnerabilities.

Key words: Asian, Communities, Disaster, Ethics, Vulnerabilities.

INTRODUCTION

Risks and vulnerabilities go beyond national boundaries. Disasters whether natural or man-made have affected millions of human lives with significant social and economic consequences throughout the world. However, experiences have shown that developing countries suffer more when disasters occur. For instance, according to World Bank"s disaster risk management report, 89% of fatalities arising from storms were from lower-income countries. This is despite the fact that these countries experienced just 26% of the storms between the periods of 1995-2014(The Human Cost of Weather-Related Disasters 1995-2015). In addition, financial losses from such disasters have 20 times impact on the Gross Domestic Product (GDP) of lower income countries than those of developed ones. For example, post-disaster needs assessment estimates that the total value of the damages and losses caused by the earthquakes in Nepal in April and May 2015 is around one-third of the country"s GDP. In the last two decades, extended droughts, trans-boundary haze, earthquakes, floods, hurricanes, tsunamis, landslides, volcanic activities and severe weathers have created havoc and displaced populations in many parts of the Asian continent. The scale of devastation in the affected countries is alarming.

These include the Indian Ocean Tsunami (2004) which caused some 230,000 deaths and 15 billion dollars in damages; Cyclone Haiyan (2013) in the Philippines caused 7,354 deaths; Cyclone Nargis (2008) in Sri Lanka registered some 138,366 casualty; in the 2008 Indonesian earthquake some 5,778 people lost their lives; Japan"s earthquake and tsunami in 2011 claimed some 19,846 lives; the recent 2015 Nepal earthquake also caused the death of some 8,000 people and the figure goes on (ADB 2015). These figures represent only the death toll, the number of people affected by these calamities run into hundreds of millions, not to mention the billions of dollars in damages. In addition, whenever there is a disaster, lives are shattered, livelihoods are ruined and mass numbers of people are displaced, with many not able to return to normalcy for good. Therefore, mainstreaming disaster ethics in the management of vulnerabilities can help to reduce the impact of disasters on lives and property.

The continuous occurrence of these disasters coupled with the colossal losses and the challenges that accompany them, have given rise to the realisation that a more effective disaster management strategy is needed. In disasters, often the victims, their families and friends, and the care givers are confronted with undesirable situations and difficult decisions. In such context, decisions made by relief agencies on an ethical basis may have significant and lasting impacts on the communities that are affected. Arising from this understanding, this paper attempts to analyse how Asian communities perceive disaster and the ethical reasoning in dealing with calamities. By drawing from experiences in several Asian countries, the paper also discusses how worldviews and faith systems help to reconcile extreme difficulties resulting from disasters. In addition, ethical dilemmas faced by international relief agencies as they seeks to respond to situation of extreme vulnerabilities is also discussed in the paper. Therefore, for the purpose of clarity and understating, the paper is structured into three main themes.

CONCEPTUAL DISCOURSE

The conceptual discourse of disaster ethics and management of its attendant vulnerabilities is imperative to provide insights on what constitute a disaster. It also provide insights on what motivates people and organizations to act or respond in an ethically manner to these situations. The question of what is Disaster? May sound simple but yet very complicated. As Cutter (2005) explains, *"seeking or proposing definitions of disaster can be a complex task that brings out the pedantic in scholars and may create considerable frustrations"*. Although there is no general consensus on a single definition of disaster, Quarantelli (1998) contends that most of the definitions, whether it is made based on the mandated, classical period or hazard related perspectives share some similarities.

Despite the lack of unified definition, in contemporary academia, disasters are viewed as the consequence of risk that is not managed properly. These risks can be the product of mixture of both hazards and vulnerability (Quarantelli 1998). Hazard is viewed as an extreme event which can be natural or man-made and can cause destruction to social, economic and human assets. While vulnerability is the degree to which a group of people, ecosystems, food supplies, and livelihoods are in danger of injury, damage, or harm (Smit & Pilifosova, 2001). As a result of this, the World Health Organization (WHO) defines disaster as "any occurrence that causes damage, ecological disruption, loss of human life, deterioration of health and health services, on a scale sufficient to warrant an extraordinary response from outside the affected community or area" (WHO/EHA, 2002).

Conversely, Jenson (1997) defines ethics as the study of standards of conduct and moral judgments, as well as the study of what is considered to be right or acceptable behaviour and what is considered wrong by the society. As such, navigating the process of social change in human society is largely dependent on the understanding of ethics and how it affects the society. Disaster ethics therefore, can be viewed as accepted principles or moral codes that are applied in the management of vulnerabilities resulting from such incidents. Thus, Zack (2009) concludes that the development of disaster code of ethics is necessary for managing disaster related vulnerabilities since ethics generally involves human life and well-being; the same values that are threatened by disaster. These codes, according to her, include general moral obligations, adequacy and fairness, individual obligation, social contract obligations, safety and security, dignity, and needs (Zack 2009).

ASIAN FRAMEWORK

There are several regional frameworks set up in Asia to address trans-boundary issues around disaster prevention and preparedness. The primary aim for such initiative is to provide leadership, address vulnerabilities and build resilience in communities and countries. Based on the Hyogo Framework for Action (HFA 2005-2015), these regional frameworks aim to achieve a robust regional mechanism to implement the Sendai Framework, in order to reduce disaster risk by creating and sustaining the shared political obligation. These regional frameworks consist of the Asian Ministerial Conferences on Disaster Risk Reduction (AMCDRR) and the ISDR Asia Partnership (IAP) forum, which provide the avenue for consultation and technical support. Starting from 2005, the AMCDRR is a two-yearly conference jointly organised by Asian countries and the United Nations Office for Disaster Risk Reduction (UNISDR).

The AMCDRR provides an avenue for stakeholders to exchange experiences, assume a shared responsibility and commitments towards implementation of disaster risk reduction in the region. To date, some six AMCDRR conferences have been organised in different parts of Asia, starting with China (Beijing, 2005); India (New Delhi, 2007); Malaysia (Kuala Lumpur, 2008); Republic of Korea (Incheon, 2010); Indonesia (Yogyakarta, 2012); and Thailand (Bangkok, 2014). Through these conferences, the AMCDRR has been influential in increasing political commitment and strengthening the disaster risk reduction agenda among the countries. AMCDRR is largely effective due to the role played by UNISDR and the host countries.

In the ASEAN framework, there has been unequivocal commitment by its member countries to step up to the reduction of disaster vulnerabilities. For instance, at the 4th East Asia Summit (EAS) in Cha-am Hua Hin, Thailand, held on 25 October 2009, the Fifth EAS on 30 October 2010 in Hanoi, Viet Nam, the Sixth EAS in Bali, Indonesia, on November, 2011, and the Seventh EAS in Phnom Penh, Cambodia, on November 2012, the leaders continuously reiterated the need to enhance disaster management cooperation for the region.

Apart from the regional organizational frameworks for disaster management, each of the Asian country has its separate disaster management strategy. These strategies are formulated and built based on the particular historical, political, socio-economic backgrounds of each country. For instance, in Malaysia, disaster management is coordinated by the National Security Council (NSC) in accordance with Directive No. 20, which deals with the "Policy and Mechanism on National Disaster Relief and Management". The Council is tasked to facilitate activities that are implemented by the Disaster Management and Relief Committee, which includes numerous agencies that are based at the federal, state and local government levels.

Therefore, the committee is given the mandate of coordinating flood relief operations at national, state and district levels with the combined aim of reducing the associated vulnerabilities. Disaster management has constantly featured in Malaysia"s development policy. For example, the 2013 Malaysian National Platform for disaster risk reduction incorporates many stakeholders from the whole of government agencies and the related private sector. The large amount of resources allocated by the government to minimize risk factors and facilitate sustainable development is testament to the commitment of the government. This is also evident in the 11^{th} Malaysia Plan (2016-2020), which is directed on strengthening disaster risk management across five phases that include prevention, mitigation, preparedness, response and recovery.

Asian Worldviews and Faiths in Managing Disasters

Natural disasters pose different forms of threat to communities around the world. As a result of this, communities perceive, understand, anticipate, and make meaning of disaster risks through the lens of their worldviews. Originating from the works of Immanuel Kant, worldview has been utilized in philosophy, psychology, religious studies, cultural anthropology, and sociology (Call 2012). In Asia, like many other regions of the world, religious beliefs and cultural practices contribute to the shaping of peoples" worldview. These subsequently affect their attitudes, decisions and behaviours in reconciling with extreme difficulties posed by disasters. Apart from being the most populous continent in the world, Asia is also home to different ethnic groups with different cultural and religious affiliations.

Majority of Asians practice Islam, Hinduism, Buddhism, Taoism, Confucianism, Jainism, Sikhism, Christianity, Judaism, Shinto, Shamanism and Animism. Therefore, considering the significant influence of religion in human lives, to understand how communities" response to disaster vulnerabilities, entails looking at their cultural and belief systems. Thus, despite the lack of attention given to the role of religion, disaster management scholars such as Chester et al (2008) argued that there is a strong link between a community"s particular religious beliefs and their worldviews. Religion plays an important part in shaping the communities" perception of vulnerabilities by providing spiritual and moral guidance. In Asia, religious beliefs also form an important part of the worldviews.

For instance, during the 2004 Tsunami in, communities in Indonesia were reported to have interpreted and responded to the disaster and disaster vulnerability through their particular worldview. This worldview was derived from their national and religious ideologies (Call 2012). Both Muslims and Christians, were said to have perceived the disaster vulnerability as a punishment of God. In the case of the Muslims, Chester (2005) explained that Islam is often associated with an instrumentalist theodicy. This implies that disaster related vulnerabilities are viewed as a means whereby Allah uses pain to discipline human beings and bring them back to the right path or the teachings of Prophet Muhammad. Thus, the Muslims of Aceh, including the whole of Indonesia, and those of the neighbouring Malaysia believed that the Aceh Tsunami was an act of Allah due to his displeasure (Wieringa 2010).

Particularly, the women were blamed for causing the calamity by not conforming to the Islamic tenets. To justify their conviction, the Muslims pointed to the female immorality and the fact that more women were killed by the disaster than men (Felten-Biermann 2006; Campbell-Nelson 2008). In contrast to the Muslims, the Indonesian Christians, who also interpreted the disaster as an act of God, believed that God used the incident to punish the Muslims of Aceh for their mistreatment of the Christians. In particular, many of the Indonesian Christians were of the view that the Tsunami was a divine punishment against the Muslims for burning and killing their pastors (Campbell-Nelson 2008; Paul and Nadiruzzaman 2013).Similarly, when the Kashmir earthquake (2005) and the 2010 Pakistan"s worst floods disaster occurred, the Muslims of those areas interpreted these disasters as punishment from Allah (Reale 2010; Shamsie 2010).

However, in the case of the Indian Ocean Tsunami, Hindu and Buddhist survivors in India, Thailand and Sri Lanka, interpreted the disaster based on the principle of *Karma* which holds that one"s present misfortunes are due to his or her past actions (Levy et al 2009 and Falk 2010). Karma stipulates that there are no innocent victims. Thus, any person or group that is befallen by disaster calamity is considered as a sign of retribution from God (Kapur 2010). In order to support these religious interpretations, the Muslims, Buddhists, and Hindus resorted to the display of miracles as a sign of God"s favour to them. For instance, the Christians of Nagapattinam in Tamil Nadu, India claimed that most of the residential houses were destroyed by the Tsunami but the Velangani shrine was spared miraculously. Hindus of coastal Tamil Nadu also claimed that their shrines were not washed-off. While the Buddhist of Phi Phi resort in Thailand claimed that a statue of Buddha equally survived the disaster due to the miracle of God. Similar scenario was attributed to an undamaged mosque during the Aceh Tsunami by the Muslims in Indonesia and Malaysia (Sugimoto et al 2011).

ETHICAL DILEMMAS IN DISASTER MANAGEMENT IN ASIA

In the Asian context, disaster relief operations are often confronted with several ethical issues. These dilemmas can be classified in the following categories, which are (i) determining religiously permissible food offered to victims, (ii) cultural sensitivity with regards to social stratifications, (iii) research ethics in disaster situations, and (iv) issues of distribution of resources. These ethical issues are the result of cultural, religious and language plurality of the Asian societies. For example, during the 2004 Aceh Tsunami, the distribution of food items and health related services to the Muslims became a serious ethical dilemma. The relief providers were confronted with the dilemma of serving non-*Halal* food (forbidden food in Islam), in the absence of availability of *Halal* food. In addition, physical contact while handling female survivors by male relief workers became a concern too – for fear of offending Islamic sensitivities. Similar concerns were also raised by non-beef eating Hindus and Buddhists survivors in India and Sri Lanka in the post-Asian tsunami period (Telford et al 2006).

The second ethical dilemma faced by relief workers is the issue of inadequate cultural knowledge with regard to social stratification of the Asian societies; particularly, when it comes to selecting local people as relief workers from the affected communities. For instance, in places like India and Sri Lanka where the practice of *caste* system is still prevalent, international relief agencies often run into difficulties in deciding who to employ as relief workers. As some disaster victims in these countries have shown hesitation in receiving assistance from or cooperating with persons of different or lower caste than them. Thus, international relief agencies are confronted with the problem of choosing someone that is accepted by the affected community, in order not to jeopardize their operations (Hussein 2010; Karadag and Hakan 2012; Athukorala 2012).

The third area of ethical concern is the question of conducting research in disaster zones. In disasters, communities face extreme vulnerabilities and are largely dependent on the assistance of relief workers. While it is important to conduct post-disaster research, experiences have shown that some researchers, in the frenzy of collecting data, have not been conscious of the contextual and cultural sensitivities of the survivors. For example, in the aftermath of the 2004 tsunami in Sri Lanka, the survivors were made to serve as research respondents to post-graduate students affiliated to international relief agencies. The survivors were compelled to answer many surveys, and were asked to give blood samples to investigate neurobiological stress markers. In addition, some relief agencies emphasized mandatory counselling for the survivors, which is contrary to the recommendations of the WHO (Sumathipala 2008).

Another area of ethical concern is the distribution of resources to disaster survivors. Relief agencies, due to inadequate knowledge of local customs, processes and survivors" needs, sometimes are confronted with the dilemma of deciding on the suitability and distribution of limited resources to the victims. For example, in Aceh, some of the donated clothing were not appropriate to the Muslim belief, thus the victims were reluctant to wear them. Similarly, the fishing boats that were donated by the international agencies were too small and unsuitable for use (Donnan and Hidayat 2005). The same scenario happened in both Sri Lanka and Indonesia, where expired drugs and unsuitable medical supplies were donated. (de Ville de Goyet et al 2006).

CONCLUSION

The foregoing suggests that Asian continent has a history of persistent occurrence of disaster. Although, collectively and individually Asian states have developed different frameworks for mitigating these disaster incidents, global experiences have shown that irrespective of the capacity of a state, it cannot handle disaster issues without the involvement of relief agencies. However, due to the multi-ethnic nature of the Asian continent, vulnerabilities arising from these disasters are often interpreted along the cultural and religious perspectives. These different worldviews of disasters by the Asians have often created some ethical dilemmas for relief agencies as shown in the Aceh Tsunami and the Indian Ocean disasters.

Therefore, relief agencies can significantly lessen or even overcome many of the inherent ethical dilemmas and vulnerabilities through the following approaches. Firstly, to address ethical issues relating to food and clothing, international relief agencies should consult local or national religious bodies on permissible food and clothing for victims. These consultations should come in the pre-disaster stage, where relief agencies will have adequate time for preparation and planning. Secondly, to reduce vulnerabilities, the most affected groups in disasters, such as the poor, children, women, the elderly and the sick should be given priority in relief assistance. This is because poverty makes the community more vulnerable due to lack of education in risk awareness, and disparity in access to medical facilities and safe environments. In some cases, women are exposed to sexual abuses and violence during disasters. The lack of physical fitness among the elderly and children make them highly vulnerable in disasters. Lastly, in disaster situations, the dignity of the victims must be respected with regard to cultural sensitivities, especially access to clothing, food, hygiene, shelter, and medical assistance.

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CHALLENGES IN MANAGING RESIDENTIAL EARTHQUAKE INSURANCE: A POST-DISASTER REVIEW

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This paper examined the challenges associated with the management of the dual EQC-private insurance model offered in New Zealand after the Canterbury earthquake disasters. A mixed-methods approach comprising survey and semi-structured interviews were adopted in the study. The research findings highlighted key challenges associated with the dual insurance model that impeded post-disaster residential reconstruction. These challenges include policy holder's lack of knowledge of insurance policy underwritings and entitlements, high cost of insurance premiums and deductibles, and a complicated claim management process. Main recommendations proposed from this study to improve the post-disaster claims management processes, should another earthquake occur include ensuring property owners' due diligence, adopting a simplified and streamlined insurance claim management approach, good communication approach and providing clarity and consistency in policy underwritings and legislative provisions governing the dual insurance scheme. The findings highlight the significance of a streamlined approach to insurance claims evaluation and management in pre-disaster planning and post-disaster reconstruction.

KEYWORDS: Residential earthquake insurance, Earthquake Commission (EQC), Canterbury, Post-disaster rebuild

PRIVATE SECTOR COMPETENCY NEEDS FOR BUILT ENVIRONMENT RESILIENCE

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ABSTRACT

There have been numerous calls for increasing the engagement of the construction industry in disaster resilience efforts. These have included recommendations for the greater integration of resilience concepts into the general education of built environment professionals as well as for the incorporation of additional, specific competencies which fall beyond the scope of the normal property cycle as they arise only in the event of disasters. These should be taken into account in the education and training of construction professionals in order to achieve a resilient built environment.

The Collaborative Action towards Disaster Resilience Education (CADRE) project is an EU funded research initiative intended to develop an innovative professional doctoral programme that upgrades the knowledge and skills of practising built environment professionals who are working to improve disaster resilience to address their career demands.

The research carried out under this project has included capturing construction professionals' competency requirements from the perspective of the different stakeholder groups associated with disaster resilience and management through a series of semi-structured interviews conducted in four countries. This paper reports the analysis of and findings from 20 semi-structured interviews with private sector stakeholders. The analysis resulted in the identification of a list of 66 competencies which should be incorporated into the proposed professional doctoral programme.

Key words: built environment, competencies, disaster resilience, private sector, professional education

INTRODUCTION

The built environment is central to societal disaster resilience. Its failures often determine the number of casualties and damage to it accounts for most of the economic losses associated with disasters (Witt et al., 2014a). Numerous calls for increasing the engagement of the construction industry in disaster resilience efforts have been made (Hecker et al. 2000; Prieto, 2002; Godschalk, 2003; Liso et al. 2003; Lorch, 2005; Aldunate et al.

2006; Rees, 2009; Haigh & Amaratunga, 2010 and Bosher & Dainty, 2011). These have indicated the need for integrating concepts of disaster resilience into the general education of construction professionals as well as expanding construction education and research further into disaster resilience-related areas.

Specific disaster resilience competency requirements for construction industry professionals have also been suggested. Following the September 2001 terrorist attacks on the World Trade Center, Prieto (2002) suggested that a new '3Rs' - resist, respond and recover - be the cornerstone for the future education of engineers. Haigh et al (2006) proposed the adoption of a more expansive view of the construction life cycle to encompass the need to anticipate, assess, prevent, prepare, respond to and recover from disruptive challenges. Peña-Mora et al (2008) identified specific disaster response roles for civil engineers and recommended their inclusion in emergency response teams (as an addition to the police, fire and ambulance services). Bosher and Chmutina have emphasized the actual versus ideal inputs of key construction industry stakeholders with respect to 'built-in' resilience, i.e. the preventative /mitigation-oriented, pre-disaster interventions (Bosher, 2013; Chmutina & Bosher, 2014). Additionally, the World Economic Forum's Engineering & Construction Disaster Resource Partnership has highlighted the various ways in which the firms of the construction industry can deploy their expertise, labour forces, materials, equipment, supply chains, etc. in support of disaster response and relief efforts (WEF, 2010).

There is, however, relatively little available in the literature regarding overall, comprehensive frameworks for defining the scope of construction professionals' roles in disaster resilience and thus providing a basis for educational programmes to support disaster resilience in the built environment (Witt et al., 2014b).

The Collaborative Action towards Disaster Resilience Education (CADRE) project is a European Commission funded initiative under its Lifelong Learning programme. It aims to develop a disaster resilience-focused Professional Doctorate (DProf) programme for construction industry professionals. In order to develop the proposed DProf programme it was first necessary to identify the appropriate current and future competency requirements. To this end a three dimensional framework for identifying competency requirements was developed and refined during the first year of the project through a review of literature and an extensive consultation process with project partners. The framework (shown in Figure 1) consists of the following parameters:

5 categories of built environment stakeholders: National and local government organisations; Community; NGOs, INGOs and other international agencies; Academia and research organisations; and the Private Sector.

5 dimensions of resilience: Economic Resilience; Environmental Resilience; Institutional Resilience; Social Resilience and Technological Resilience
5 stages of the property lifecycle: Preparation Stage; Design Stage; Pre-Construction Stage; Construction Stage and Use Stage. Malalgoda et al. (2016)

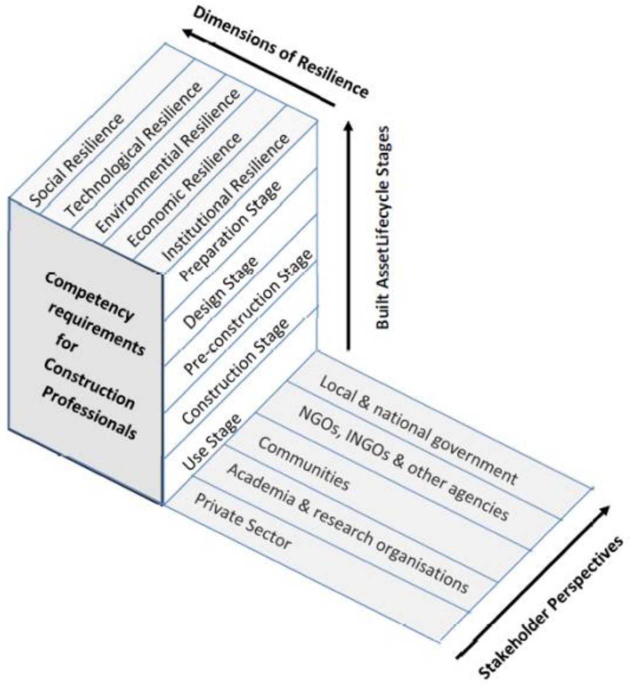

Figure 1: CADRE Framework for the Identification of Competency Requirements for Construction Professionals

The framework emphasizes that a comprehensive identification of competency requirements must consider the whole lifecycle of built assets, all dimensions of resilience and the full spectrum of stakeholders.

To determine current and emerging competency requirements, interviews of representatives of all the stakeholder groups were carried out in all four CADRE partner countries (the United Kingdom, Sri Lanka, Lithuania and Estonia). This paper reports the data collection, analysis and findings from interviews of representatives of the Private Sector stakeholder group. It is one of a series of publications which have reported the findings of the research carried out under the CADRE project. Already published reports include: Malalgoda et al. (2016) which reported the findings for Local and National Government stakeholders; and Perera et al. (2015) for Community stakeholders.

RESEARCH METHODOLOGY

A qualitative data collection exercise was carried out through a series of semi-structured interviews of private sector stakeholders in the four survey countries (United Kingdom, Sri Lanka, Lithuania and Estonia). Interview guidelines based on the analytical framework described above were created to guide the discussions and ensure adequate coverage of the complete property life cycle and a basic level of compatibility between the interviews.

The focus of the interviews in all cases was to capture the private sector stakeholders' perspectives on current and emerging *needs* for the built environment vis-à-vis disasters as well as the *skills* that they considered necessary for construction industry professionals to possess in order to satisfy these needs.

Audio recordings of the interviews were made with the permission of the respondents and these recordings were then transcribed. The interview transcripts were then subjected to a qualitative content analysis using an interpretive approach in which evidence (in the form of transcribed interviewees' statements) was thematically coded according to an emerging list of needs and skills. The analysis was facilitated by the use of NVivo (version 10) software.

Following the analytical framework, the identified needs and skills were classified according to the five dimensions of resilience (Social, Economic, Institutional, Environmental, Technological) and the five stages of the property lifecycle (Preparation, Design, Pre-construction, Construction and Use).

In all cases, the thematic coding of data from the interview transcripts was first carried out by the researchers responsible for conducting the interviews in the four different countries. This was considered the most appropriate approach to accurately interpret and code the interviewees' statements according to the emerging list of needs and skills. These 'country' analyses were then combined into a single ('global') NVivo analysis project. Through the matching and combining of similar thematic nodes, a single, overall list of needs and skills was developed.

Finally, all the identified needs and skills were summarized into a set of current and emerging resilience-related competency requirements for construction professionals.

RESULTS

A total of 20 semi-structured interviews were carried out between November 2014 and January 2015: 5 in the United Kingdom, 10 in Sri Lanka, 2 in Lithuania and 3 in Estonia. The interview respondents represented private sector businesses including engineering, construction, architectural design, quantity surveying, consultancy, insurance, manufacturing and utilities. The interviewees represented numerous built environment professions including architecture, various types of engineering, quantity surveying and others (e.g. insurance, environmental services managers) and varying levels of management from site engineers to managing directors.

Table 1: Number of Needs and Skills identified for each Dimension of Resilience and for each Built Asset Lifecycle Stage

LIFECYCLE STAGE	Preparation		Design		Pre-construction		Construction		Use	
RESILIENCE DIMENSION	**Needs**	**Skills**	**Needs**	**Skills**	**Needs**	**Skills**	**Needs**	**Skills**	**Needs**	**Skills**
Economic resilience	25	36	18	30	11	21	16	26	17	18
Environmental resilience	20	40	16	40	11	21	17	46	14	40
Institutional resilience	38	30	24	29	27	18	36	29	30	29
Social resilience	37	40	31	43	20	15	35	35	34	30
Technological resilience	23	51	32	76	19	39	51	81	35	42

Table 2a: Generic Competency Requirements and the Resilience Dimensions (Economic, ER; Environmental, EvR; Institutional, IR; Social, SR; Technological, TR) and Lifecycle Stages (Preparation, PS; Design, DS; Pre-construction, PCS; Construction, CS; Use, US) that their component needs and skills were associated with

#	COMPETENCY REQUIREMENTS - GENERIC	DIMENSIONS OF RESILIENCE					BUILT ASSET LIFECYCLE STAGES				
		ER	EvR	IR	SR	TR	PS	DS	PCS	CS	US
1	Analytical skills	X	X	X	X	X	X	X		X	
2	Auditing skills	X		X					X	X	
3	Awareness raising and educating	X		X	X		X	X	X	X	X
4	Communication skills			X	X		X	X	X	X	X
5	Dealing with complaints				X		X		X	X	
6	Decision-making skills	X	X	X	X		X	X	X	X	X
7	Dispute resolution			X			X	X	X	X	
8	First aid				X				X	X	X
9	Identifying and conforming with requirements		X	X	X		X	X	X	X	X
10	Leadership skills			X	X		X	X		X	X
11	Learning skills			X	X			X		X	
12	Lesson learning	X	X	X	X	X	X	X	X	X	X
13	Lifelong learning and continuous professional development					X		X		X	
14	Managing consultants, expertise and knowledge				X	X	X	X	X	X	
15	Modeling and simulation skills	X	X		X	X	X	X			X
16	Negotiation skills	X			X		X		X	X	
17	Planning				X		X		X	X	X
18	Project and process design				X		X				
19	Stakeholder management	X		X	X		X	X	X	X	X
20	Strategic and proactive thinking	X	X	X	X		X	X	X	X	X
21	Teamworking, collaboration and cooperation			X	X	X	X	X	X	X	X
22	Writing skills		X	X			X		X	X	X

Table 2b: Specific Competency Requirements and the Resilience Dimensions and Lifecycle Stages that their component needs and skills were associated with

#	COMPETENCY REQUIREMENTS - SPECIFIC	DIMENSIONS OF RESILIENCE					BUILT ASSET LIFECYCLE STAGES				
		ER	EvR	IR	SR	TR	PS	DS	PCS	CS	US
23	Building and infrastructure design for disaster resilience	X	X	X	X	X		X	X	X	X

24	Business continuity	X		X			X	X			X
25	Codes and standards			X		X	X			X	
26	Codes and standards evaluation and formulation			X					X	X	
27	Community engagement	X		X	X		X	X	X	X	X
28	Construction management for disaster resilience	X	X	X	X	X	X	X	X	X	X
29	Construction materials and technologies for disaster resilience					X		X	X	X	X
30	Damage assessment	X	X	X	X	X	X	X	X	X	X
31	Debris management		X			X	X	X			X
32	Decommissioning	X				X					X
33	Different hazards - their identification, assessment, mitigation measures and management	X	X	X	X	X	X	X	X	X	X
34	Disaster management		X	X	X		X		X	X	X
35	Disaster mitigation	X	X	X	X	X	X	X	X	X	X
36	Disaster preparation	X	X	X	X	X	X	X	X	X	X
37	Disaster recovery			X	X	X	X	X	X	X	X
38	Disaster resilience considerations for BE professionals	X	X	X	X	X	X	X	X	X	X
39	Disaster resilience research			X	X	X	X	X	X	X	
40	Disaster resilient development				X		X				X
41	Disaster response		X	X	X	X	X	X	X	X	X
42	Environmental protection		X	X	X	X	X	X	X	X	X
43	Ethics and human rights				X					X	
44	Financial management and investment appraisal	X	X	X	X	X	X	X	X	X	X
45	Geotechnical engineering for disaster resilience		X			X	X	X	X	X	
46	Health and safety		X	X	X	X		X	X	X	X
47	Human resource management			X	X	X	X	X		X	
48	Information systems					X	X				
49	Institutional arrangements for disaster resilience			X			X		X	X	X
50	Insurance	X		X	X	X	X	X	X	X	X
51	Legislation and regulations for disaster resilience		X	X	X	X	X	X	X	X	X
52	Logistics		X							X	
53	MEP engineering for disaster resilience				X	X		X		X	X
54	Organisation of disaster resilience education			X	X		X	X	X	X	X
55	Post-disaster reconstruction	X	X	X	X	X	X	X	X	X	X
56	Procurement, tenders and contract management	X	X	X	X	X	X	X	X	X	
57	Project management	X	X	X	X	X	X	X	X	X	X
58	Resource management	X		X	X	X	X	X		X	X
59	Risk management	X	X				X				
60	Structural engineering for disaster resilience		X		X	X	X	X	X	X	X
61	Technical competence of BE professionals		X				X				
62	Understanding and taking account of the local context	X	X	X	X	X	X	X	X	X	X
63	Urban and land-use planning and zoning	X	X	X	X	X	X	X	X	X	X
64	Water and sanitation engineering for disaster resilience		X	X		X	X	X	X	X	X
65	Watershed and river basin management		X				X				
66	Vulnerability assessment	X	X	X	X	X	X	X	X	X	X

After compiling the country analyses and matching similar node descriptions used by the various researchers during their coding of the interview transcripts, a total of 408 different needs and skills were identified. Table 1 (above) shows the distribution of these needs and skills with respect to the various dimensions of resilience and built asset lifecycle stages.

The list of needs and skills were then aggregated into a summary list of 66 competency requirements which reflected both generic competencies (in

Table 2a) and competencies specific to the built environment professions (Table 2b).

DISCUSSION

The description of each need and skill identified (and represented by an individual 'node' in the NVivo analysis) was left to the discretion of the individual researcher in each case. No master list of needs and skill descriptions was used so as to keep the process as flexible as possible. In addition, no attempt was made to coordinate the relative level of detail (or breadth of scope) of the initially identified needs and skills. The effects of this approach included that there was a low level of correspondence between need and skill descriptions from different researchers and considerable differences in terms of the relative 'breadth' of each description. For example, 'fire system installation' and 'land use planning' were both identified as needs. This tended to result in similar but not precisely the same and overlapping descriptions (e.g. 'designing and building flood defenses', 'flood risk management and protection', 'assessing flood risk') and had the effect of driving up the numbers of identified needs and skills.

In addition, and with a similar effect on the number of emerging needs and skills was the dual classification system of aspects of resilience and stages of the property life-cycle together with the understanding that the identified needs and skills would relate to more than one type of resilience or stage of the property life-cycle. In the case of the private sector analysis, the combined total of all needs and skills (with considerable duplication) for all aspects of resilience and all stages of the property life-cycle was in the region of 1600.

Although these numbers of needs and skills appear impressively large, it does not necessarily bear a direct relationship with the range of needs and skills required as identified from the interviews and it is very sensitive to the needs and skills description choices of the various researchers.

However, in analysing the data captured, a relatively wide spectrum of needs and skills does indeed seem to have been identified. By combining and aggregating the identified needs and skills into competencies, the data becomes easier to interpret as the classification system of competencies is rather more uniform as it reflects the view of a single analyst only and there is greater consistency in terms of the relative scope of each competency description (see Tables 2a and 2b). However, with only a single analyst determining the competencies on the basis of the identified needs and skills and also their own experience and interpretation, the emerging list of competencies would not necessarily be precisely the same one that would emerge for a different analyst. This particular issue has been dealt with at the next stage of analysis (which is not covered in this paper) where the competency requirements findings with respect to each stakeholder group have been combined into a single, overall analysis and a relatively small number of broader knowledge areas have been identified.

While all this suggests that great care must be exercised when interpreting the results presented here, it is also worth pointing out that the list of emerging competencies does appear to be logical and that the purpose of this data analysis was to capture the range or scope of competencies which are applicable to disaster resilience professionals in order to inform the design of a course of instruction and research at the professional doctorate level. For that purpose, the list of 66 emerging competencies is considered relatively robust and, from a practical perspective, very useful.

CONCLUSIONS

The qualitative analysis of twenty semi-structured interviews of private sector respondents has resulted in the identification of a list of 66 current and emerging competencies required of construction professionals for disaster resilience of the built environment. These reflect the broad range of needs and skills identified from the interviews.

The methodology in terms of respondent selection, choice of needs and skills descriptions, consistency of coding decisions, etc., suggests that, whereas the number of needs and skills identified is very difficult to accurately interpret, the range of emerging competencies does appear to adequately reflect the educational demands for professionals undertaking a professional doctorate course in disaster resilience in the built environment. In this sense, the analysis appears appropriately robust and useful.

As these results are combined with the lists of current and emerging competency requirements generated from the perspectives of the four other groups of stakeholders and aggregated into a smaller number of broader 'knowledge areas', the robustness of the overall research findings will further improve. A series of verification workshops is also planned.

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THE UNTAPPED POTENTIAL OF INFORMATION FLOWS FOR LONG-TERM URBAN RESILIENCE POLICY

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ABSTRACT

Recent decades have seen urban resilience becoming a more popular term internationally both within academic and policy circles. However, relatively little attention has been paid by the literature to the policy implications of striving towards more resilient urban systems and the challenges introduced by the complex, multi-level and multi-actor policy network that forms their context. The central hypothesis of this research is that resilience is a long-term goal, beyond immediate disaster planning and management, and an ongoing process that requires a proactive approach (as opposed to a reactive approach). This builds on the idea that focusing only on the immediate outcomes of extreme events keeps the city on a "catch-up mode", which is both unsustainable and inefficient in the long-term. This research proposes that in order to progress towards resilience that endures, the policies that underpin these efforts must remain effective and "survive" short-term pressures. It attempts to pinpoint the main elements that, if understood and addressed, can help policies withstand sources of stress and remain effective in delivering more enduring or sustainable forms of resilience.

While there are many factors that have already been identified, this paper will explore only one aspect: Information flows. This is a topic that although is often mentioned as "important" in policy literature, it is also rarely explored. The following is the result of a qualitative meta-analysis of over 100 references relating to resilience, sustainability, and multi-actor network and complex problems policy. This paper also includes the results from the first half of a series of interviews with policy experts from industry, government and research from Australia, the UK and the USA.

Key words: resilience, urban policy, information, sustainable, policy framework

INTRODUCTION

The term resilience has been increasingly used in recent years both in academic literature and urban policies. This is often seen as "*part of a broader drive towards more 'safe' and sustainable communities and in particular is connected to concerns about environmental sustainability"* (Coaffee & Bosher, 2008). In order to progress towards more resilient and sustainable cities, Chelleri et al. (2015) argue that resilience needs to be discussed as a set of principles that form the policy framework within which sustainable development goals and cities are delivered. Resilience is thus a framing mechanism or approach that aims to develop the capacity to cope with uncertainty while "*maintaining the overall system persistence*" (Hassler & Kohler, 2014b). Within this context of uncertainty, persistence may depend on foresight, proactive policies and the capacity to quickly adapt to changes (Moffatt, 2014). Urban policies are a critical factor in moving towards higher levels of resilience and bringing global problems, such as climate change, to a local governance context (Jabareen, 2013).

Hjorth and Bagheri (2006) point out that managing for the future is a "wicked" problem for policy makers and implementers. This is because challenges are constantly changing and it is not possible to discern the ultimate consequences of present actions with certainty. Coaffee and Bosher (2008) further argue that the only way to deliver long-term resilience that is in line with sustainability principles is to include systems of governance that seek to coordinate efforts across organisational boundaries of the policy networks that design and manage cities. The present research adds to this line of argument that for resilience efforts to be effective, the policies that frame those efforts also need to be resilient in order to ensure sustained outcomes over the long term.

The role of information flows

We are living in a world of networks, and these networks are becoming more interdependent every day. Social networks are inextricably entangled with communication networks, transportation networks, logistical networks, and the like. The increasing dependencies and the increasing densities of these networks imply that a disruption in any one affects all the others. For a policy to be effective in such complex systems, response has to be very rapid, but their very complexity makes decision-making difficult and time-consuming.

(Barrett, et al., 2011)

Like cities, policy processes can be seen as "*a complex phenomenon of continuous interactions involving public policy and its context, events, actors, and outcomes"* (Weible, 2014). These interactions, it is here argued, include the interplay between policy processes and outcomes, politics, institutional and financial arrangements, and societal and socio-technical networks that support all of the above. These interplays are highly dependent on decision-making actors and the information flows that support their actions.

These interactions are however often ignored in academic literature that focuses on complex issues, such as sustainability and resilience, that require sustained action across different levels of governance and time scales (Bulkeley & Betsill, 2005). Nevertheless, understanding this context of local policy-making and the ways in which these forces influence policy choices "*is an important priority for research in this field*" (Vogel & Henstra, 2015).

"The role and use of information in policy is an ongoing matter of discussion in public policy" but poor information commonly results in poor policies (Dovers, 2005)*.* Information has a fundamental role to play in policies that deal with problems characterised by complexity and uncertainty (Mintrom & Norman, 2009). This research is underpinned by Dovers' (2005) concept of Type 3 institutional resilience. This is characterised by openness and adaptability within a context of uncertainty and constant change. Although sometimes considered an elusive objective, complex issues such as sustainability and resilience require a great deal of coordination of information, communication and policy efforts across political and governance boundaries (Dovers, 2005). The assessment of the effectiveness of these policies is also "*critically dependent upon the flow of data between information providers and users"* (Vogel, Moser, Kasperson, & Dabelko, 2007)*.* The complexities of the challenges faced by and the technological context of urban environments are proposed to require a new approach of decision-making based on continual information flows. This is "*massive in scale, fine-grained in resolution, and distributed over many data sources"* (Barrett, et al., 2011)*.* The following sections will briefly explore the three main elements related to information that were found in a literature review and the early feedback from resilience experts.

METHODOLOGY

Literature review and framework development

This research includes a meta-analysis of resilience, sustainability, and multi-actor network and complex problems policy publications in order to identify general patterns of what the literature reports as characteristics of effective and ineffective policy strategies. Here effectiveness relates to the ability of a policy to deliver sustained outcomes within and beyond the voting/funding cycle. This meta-analysis followed a similar methodology to that outlined by Carey and Crammond (2015), based on a thematic analysis of published literature that discusses how resilience and sustainability thinking can affect policy development and implementation processes and content. The research focused on answering the question of what processes help deliver policies that can remain effective and proactive over the long term.

The initial search was done through Google Scholar, Scopus and UNSW Library Catalogue, however it was then extended based on references found in relevant publications. The latter is sometimes referred to as snowball sampling technique (Park & Gretzel, 2007). The search terms were: resilience policy, sustainability thinking, resilience thinking, sustainable resilience, proactive resilience, urban policy for complex problems and multi-actor networks, and climate change policy. The inclusion criteria were: academic and policy papers and book chapters that discuss the topics of resilience, sustainability, multi-actor network and complex problems within a policy context; published in English; and published since 1970. This provided 278 papers and book chapters which were considered to be relevant to the study. These were then screened for those that contained specific insight to the topic outlined above. The detailed literature review that informs this research has so far included over 100 references and may be expanded in the future as a result of the interviews. This review was complemented with an online search, via the key words outlined above, of recent (since year 2000) urban resilience programs and initiatives.

Expert consultation

The expert consultations are being informed by a series of one-hour interviews, either face-to-face or via telephone/video call. This research activity aims to test the factors found in the literature and gain critical insight into potential missing factors. Experts are divided into three categories, each containing three individuals; these are: Research, Government and Industry. The selection criteria for the interviewees are: (i) ample knowledge about urban resilience/sustainability policy internationally or in Australia; (ii) at least 10 years of experience; and (iii) willingness to participate. This paper includes the results from the first five interviews of two industry and three researcher experts from Australia, the UK and the USA.

FINDINGS AND DISCUSSION

Policy settings often exist within a context of ambiguity (Storch & Winkel, 2013). However, information flows are proposed here to be a fundamental part of allowing policy systems to remain contextually aware and adaptable. There were three elements related to information found to be highlighted as supporting long term policy adaptability and efficacy, or if missing hindering it: Information infrastructure and ICT, science-practice interface, and information literacy.

The interviews highlighted the importance of availability and accessibility of data and information. Specifically, they pointed out its relevance for innovation, scenario modelling and communication, early detection of issues, and the ability of individuals to self-organise and make informed-decisions driven by resilience-thinking. The interviewees also agreed that information infrastructure and support systems, information/data needs and funding mechanisms for ongoing information flows were areas of importance for resilience policies.

Information infrastructure and ICT

Meerow et al (2016) and Sanchez et al (2016) highlight that socio-technical networks have significant impact on the resilience of the cities they are embedded in. These are networks where technologies and technological functions closely interact with social functions and social interests (Hodson & Marvin, 2010; Kling, McKim, & King, 2003). Considering these networks as part of the fabric that makes cities means reconceptualising "*cross-scale* *interactions as interdependencies between technical and social networks*" (Ernstson, et al., 2010). This emphasises that cities are formed by multiple networks (social, ecological and technical) whose functioning depends on the sharing of information.

Information communication in general is also a key part of the principles of cohesion and coordination of the sustainable resilience concept proposed by Sanchez et al. (2016). ICT tools used "*to promote citizen participation in planning decision making and more active contributions to the planning process* have *huge significance for pursuing the principle of collaboration needed to make progress toward resilience*" (Collier, et al., 2013). This appears especially relevant now that information and communication technologies (ICT) continue to gain a centre place in policy delivery. However, "*while the amount and diversity of data continue to proliferate, along with their increased accessibility, the information and procedures that satisfy the level of detail and contents needed for addressing urban resilience are sparse and unsystematic at best*" (Collier, et al., 2013). Collier et al. (2013) further suggest that certain information infrastructure needs to be established to ensure the relevance and interoperability of datasets that can underpin integrated and accessible information systems that support progress towards achieving long-term, complex policy goals. Standards that outline issues such as language, scope, scale, attributes and formats are therefore suggested to be fundamental components of such information infrastructure.

Part of this information infrastructure may include data portals and urban information modelling. Sanchez et al. (forthcoming 2017) further explore the implications of this component for sustainable resilience policy.

The experts interviewed highlighted the importance of maintaining systems that allow free access to longitudinal records that are available to decision makers, and especially regarding information that can be used for purchasing decisions and by local residents. One of the research experts who had considerable prior experience working with governments in Australia and the USA pointed out how for city planning, comprehensive and integrated databases of prior policy decisions and their results across jurisdictions supports better future decision making.

The use of smart city programs to support information sharing across urban jurisdictions, the ability to make this information open source through open platforms were also mentioned as positive steps towards establishing better information infrastructure for more effective resilience planning. These kinds of systems were seen as potentially disrupting the traditional policy and funding cycle to identify issues faster and promote innovation from other sectors. One of the challenges raised was the privatisation of infrastructure and the lack of leadership from the public sector in making sure data owned by the private sector that is relevant to urban resilience is available to decision-makers and the broader public. Examples included risk, post disaster and other relevant data owned by insurance companies;

and private infrastructure information flows. The literature adds to this the difficulties already involved in accessing information owned by public entities, see for example Bettencourt (2015).

Besides information systems, the interviewees mentioned as critical areas:

the smart design of contracts to ensure information flows are maintained,
embedding data flows as routine/automated part of existing and well-established processes by apolitical institutions; for example, the bureau of statistics gathering and publishing certain information as part of their annual statistics reports,
systems that support information coordination across complex networks
processes that support the scalability of data/information,
using regional associations formed by multiple actors to leverage limited local funds in order to fund information systems and make them more politically and economically stable, and
mapping the information needs of those involved in the policy network that will enable the long-term delivery of policy programs.

Science-practice interface

"Policy processes draw on information from many sources within government circles, the community and specialist sources such as research bodies" (Dovers, 2005). In countries such as Norway, one of the main barriers for effective climate change adaptation policies has been found to be the lack of familiarity with relevant data, lack of data itself and lack of local expertise (Amundsen, Berglund, & Westskog, 2010). Given the emerging nature of complex challenges, Amundsen et al (2010) highlight the need to ensure useful scientific knowledge reaches municipalities and other decision-makers. Research and information are however often not a deliberate part of the policy process (Weiner, 2011).

Vogel et al (2007) propose that science-practice can no longer be a linear, unidirectional process. Instead, they argue that the interface between information, knowledge and policy needs to become "*a multi-level system of governance and knowledge production among a range of actors engaged in understanding and managing environment–society interactions"*. Where actors can work together in a coordinated way in order to maintain the sensitivity of the system to context changes and quickly adapt as required. Within this context, knowledge flows in many directions; "*scientific input can occur at any or all stages"* of policy decision-making. This process may be able to continually support decision-makers by creating lines of communication that ensure scientific information meets their information needs. It may also help avoid issues such as that highlighted by a UK study by Davoudi et al. (2013) where an interviewee expressed that the unprecedented pace at which science and understanding is currently moving is a critical barrier to keeping policies relevant.

The interviewees agreed on the importance of establishing more dynamic ties between research and practice. One interviewee from the financing sector mentioned its role in driving change through experimentation. Another interviewee from the research sector highlighted that co-production of knowledge is also an area that remains mostly unexplored within the urban context. This however can be significantly challenging due to the large number of actors but with potentially considerable rewards in terms of developing enduring policies.

Information literacy

This relates to whether resilience policies also consider the information literacy of their target audience. This *is "an understanding and a set of abilities enabling individuals to recognise when information is needed and have the capacity to locate, evaluate, and use effectively the needed information"* (The University of Sydney, 2016). Information literacy has been directly linked to empowerment of individuals and society as well as life-long learning (Weiner, 2011). Young and Middlemiss (2012) suggest that policies that aim to influence attitudes and change behaviours, should consider instruments that ensure information provided is transparent, unbiased and can be easily related to the target's personal context.

One of the interviewees highlighted that this aspect needs to be more developed in resilience policies, creating an understanding of the information literacy of different levels of decision making, especially around resilience benefits. This was supported by an industry expert who highlighted this as an improvement area for most resilience policies. Another research sector interviewee highlighted the relevance of having processes that support decision-makers' ability to understand and create knowledge based on existing information flows and that without this ability information is meaningless.

CONCLUSIONS

Although the role of information flows and its practical implications are often overlooked by policy frameworks, this research suggest that three elements may be important when designing new policies that aim to deal with long-term, complex goals. These are: information infrastructure and ICT, science-practice interface and information literacy. These are here argued to have the potential to support more adaptive, flexible, efficient and effective urban resilience policy. Future research will continue to explore these elements through more expert consultations and case studies of resilience policy development and implementation.

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BUILDING RESILIENT QUEENSLAND COMMUNITIES

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Over the past decade, Queensland has experienced a series of summers characterised by severe tropical cyclones and floods. These events have had high costs for our communities, with Queenslanders experiencing first-hand the pain of natural disasters: lives lost and dozens more injured; the evacuation of towns; and billions of dollars in damage and losses.

Many regions in Queensland have been repeatedly impacted by natural disasters, while at the same time drought was declared across 86 per cent of the state in 2015. With the increasing impacts of climate change, Queensland recognises that resilient communities are critical to the safety and security of Queensland's future.

This presentation will discuss the characteristics of resilient communities in a Queensland context, using recent flood and cyclone events as evidence. It will explore the five elements for building resilient communities in Queensland – research and analysis, disaster risk reduction, preparedness, response, and recovery. Emphasis will be placed on our shared responsibility approach to building disaster resilience, where the actions of the individual can influence disaster resilience at the community level.

Case studies will be used to showcase Queensland's resilient communities, along with selected government initiatives implemented to build disaster resilience at the local level, including the relocation of an entire town that was devastated by flood in January 2011; the RACQ Get Ready Queensland program; the Queensland Flood Mapping Program; and the construction of flood mitigation levees in regional towns.

KEY WORDS: Betterment, damage, disaster, reconstruction, resilience.

RETHINKING SCHOOLS AS COMMUNITY HUBS IN DISASTER PREPAREDNESS, RESPONSE AND RECOVERY

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The author followed five school communities through their experiences of the 2010/2011 Canterbury earthquakes. From their immediate responses through their elongated recovery to their current situation, schools remained significant community resources. Whether they were relief centres in the immediate aftermath, sites of of social, emotional and psychological support through the recovery; and whether they are still supporting their communities today or were lost to their communities through school closures, their focus never wavered. Children, young people, their families and the wider community were supported above and beyond what could be expected by school personnel who were recovering from their own trauma and working in difficult conditions, often with an uncertain future. This presentation will outline the role schools played in the Canterbury earthquakes, before making a set of recommendations: (1) that schools and the education sector more broadly are brought to the disaster planning table so that they can share their prior experiences and/or have a sense of what they might be called on to do; (2) that as there is an expectation that schools will play a major role in disaster prevention, response and recovery that training is provided for each of these expectations; (3) that schools are supported to engage with their communities, both in the formal and informal senses, in order to help build community cohesion and resilience; and (4) that the roles that schools have played and will continue to do, receive due recognition.

KEY WORDS: Canterbury earthquakes, Communty Resilience, Disaster preparedness, response, and recovery, Schools

WAVES OF ADVERSITY, LAYERS OF RESILIENCE, ADAPTATION PATHWAYS IN THE ANTHROPOCENE

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Greater Christchurch and the surrounding region experienced devastating earthquakes in 2010-2011. The city also experienced severe flooding in 2014 and 2015, adding to recovery woes. Furthermore, some coastal communities are prone to sea-level rise impacts, including increased risk of storm inundation and progressive retreat of low-lying shoreline areas. These 'waves of adversity' bring to the fore the imperative to build resilience into recovery efforts. Many communities face waves of adversity. New Orleans and many Gulf communities experienced the devastating impacts of Hurricane Katrina in 2005, and a series of subsequent hurricanes, as well as the travails of the Global Financial Crisis, and the 2010 BP-Deepwater Horizon oil spill. To compound matters, they also face flood risk from the Mississippi River, and the region is a global hotspot for sea-level rise and climate change impacts. What are the prospects for those living in cities like Christchurch and New Orleans – which facing escalating disaster risk in the Anthropocene*? How might such communities build resilience to buffer their vulnerability to waves of adversity? This paper critically reflects on the nature of resilience. The experience of Christchurch and New Orleans communities seeking to build resilience is recounted. Both cities now have a 'resilience strategy' and they are part of the Rockefeller 100 Resilient Cities initiative. Translating resilience rhetoric into practical reality is, however, elusive. Informed by this experience, and resilience scholarship, a conceptual framework is proposed that, first, outlines the need for communities to build 'layers of resilience' as a safeguard against waves of adversity. Drawing on the 'capital' metaphor, and critically reflecting on the use of this metaphor, and building upon and extending the community capitals framework (Flora & Flora 2004), the layers of resilience include: financial, built, human, cultural, social, political, moral and natural capital. Second, the framework indicates how communities can make resilience-building decisions and interventions in the short-term, while keeping open options to chart adaptation pathways in the medium- to long-term. It focuses particular attention on exploring alternative governance narratives and modalities and selecting robust adaptation pathways in the face of the complexity, turbulence, uncertainty and contestation that characterise the Anthropocene.

* The Anthropocene is a proposed geological epoch describing the dominant influence humans now have on global biogeochemical processes.

BUILDING BACK BETTER

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Queensland has the most exposure to natural disaster risk in Australia. In the past five years, the state has experienced 44 significant natural disaster events, including 11 cyclones, leaving Queensland with an ongoing reconstruction task worth $13 billion. With Tropical Cyclone Oswald causing more than $2 billion in damage to public assets already damaged and restored after earlier disasters in 2011 and 2012, the Queensland Government initiated the Betterment Fund to create a more strategic approach to building resilience against future disasters.

Jointly funded by the Queensland and Australian governments, the Betterment Fund provided $80 million to allow assets to be 'built back better', improving their standard to be more disaster-resilient , thereby reducing risk to the community and reducing reconstruction costs from any future events.

The 2013 Queensland Betterment Fund delivered 230 projects with a total cost of more than $150 million, which included up to $80 million in Betterment funding). Its success led to an additional $20 million injection to further assist communities affected by Tropical Cyclone Marcia in 2015.

The Queensland Reconstruction Authority also developed a Framework for Betterment to help streamline the funding submission and assessment process for local governments. This paper will demonstrate how Betterment has not only achieved substantial cost savings through more resilient infrastructure, but has improved the lives of those living in impacted communities, with roads and bridges not only withstanding weather events, but returning to functionality much sooner in the immediate aftermath of a disaster.

KEY WORDS: Betterment, damage, disaster, reconstruction, resilience**.**

HISTORY AND APPLICATION OF EMERGENCY LIGHTING IN NEW ZEALAND

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ABSTRACT

This paper gives a brief history of emergency lighting in New Zealand and provides a backdrop to present-day regulations. Basic system types are defined and lamp technologies are discussed. A series of case studies are used to highlight system vulnerabilities. It is found that emergency lighting systems in New Zealand have failed in times of great need. This important topic requires further research in order to identify weaknesses in both design practice and the systems used, with the ultimate goal being to protect lives and safeguard against tragedy.

Keywords: Building Code, emergency lighting

INTRODUCTION

New Zealand's historical newspapers make mention of emergency lighting rules in 1926. At that time new regulations were gazetted for safety in cinemas. Those who breached the regulations risked a £100 fine ("The Herald," 1926).

Meanwhile, other building types seemed to fly under the regulatory radar, with emergency lighting being provided as a matter of public interest rather than by law.

Such an example is hospital lighting. This became a subject of newspaper columns in early 1936, when Auckland Hospital was without lighting for several hours during a storm ("Emergency lighting plant," 1936). After another power outage in late 1936, it was noted that the hospital had been fortunate that no major issues had been caused by the lack of emergency equipment. The medical superintendent took the opportunity to remind the hospital board that they might not be so lucky in the future ("Superintendent's warning," 1936). Duly cautioned of this public responsibility, emergency lighting was installed in mid-1937 ("Emergency power," 1937). This system comprised of 46 batteries in a central location, which were capable of providing 2530 Watts of lighting for three hours. The happy conclusion to this story is a September 1937 article which noted that a 17 minute power outage had not affected surgery that was underway in the operating theatres ("Electric power fails," 1937).

Fast-forward to the present day and emergency lighting requirements are set by law rather than good conscience. Clause F6 of the Building Code was first put in place in 1992, under the Building Act 1991 (Building Industry Authority, 1992). It contains lighting requirements for safe evacuation as well as for areas where the occupants must remain in the building under emergency conditions (MBIE, 2014).

PRESENT-DAY EMERGENCY LIGHTING

The Building Code

New Zealand's Building Code is performance based. It lists an objective as well as functional and performance requirements. For emergency lighting, these are:

Objective: The objective of this provision is to help safeguard people from injury in escape routes during failure of the main lighting.

Functional Requirement: Specified features in escape routes must be made reasonably visible by lighting systems, other systems, or both, during failure of the main lighting.

Performance: Specified features in escape routes must, when the systems for visibility are at their design level, be reasonably visible. (MBIE, 2014, p. 3)

Compliance with F6 is achieved either through using the Acceptable Solution F6/AS1 or by providing an alternative engineered design. F6/AS1 initially referred to the New Zealand emergency lighting standard NZS6742:1971 before switching to the joint Trans-Tasman 2293 series of standards in 1995. While F6/AS1 still refers to the 2293 series in its entirety, only one of three parts remains officially under the Standards New Zealand banner. For reasons beyond the scope of this paper, the other two parts were de-jointed in 2005 and became Australia-only. This has led to some confusion amongst those who assume that all parts of the standard can be found through the Standards New Zealand website, given that F6/AS1 calls for them to be referenced. Instead the website provides the accurate but misleading information that AS/NZS2293 parts 1 and 3 have been "withdrawn without replacement". The standards are now set to be re-joined (Ponting, 2016).

While the 2293 suite of standards is referred to by both New Zealand and Australia, our emergency lighting requirements have their differences; the most notable perhaps being New Zealand's requirement for a minimum of 1 lux in exitways and "at every change in level in an escape route" (MBIE, 2014, p. 13). New Zealand also has a relaxed rule for the first 20 metres of travel. The Acceptable Solution for F6 states that:Performance F6.3.1 does not apply to specified features in the initial 20 metres of an escape route if the risk of injury, or impediment to movement of people, due to the specified features not being visible is low (for example, because people are familiar with the escape route, the escape route is level, and people do not require assistance to escape). (MBIE, 2014, p. 3)

The 20 metre rule is a cause of confusion amongst the lighting industry, as it is open to interpretation.

These differences between New Zealand and Australia are not the subject of this paper, but are included to remind us that New Zealand's emergency lighting methodology is unique to this country.

Systems and equipment

Early systems, such as that noted above for Auckland Hospital, were "central" systems, comprising a central generator or battery bank which fed out to the emergency luminaires. "Semi-central" systems are similar to central systems, though they use more than one generator or battery bank, each feeding a particular section of a building. Self-contained units are a more recent development which became popular in the latter part of the 20^{th} century. These units have an individual battery for each luminaire, which is located in close proximity to it. Central, semi-central and self-contained systems all have their supporters and detractors.

The individual batteries for self-contained units potentially bring with them higher maintenance costs. However they spread the risk of failure, as they rely on multiple batteries in the same area rather than the other system types which have only one power source per area. Self-contained units have only a short distance from the battery to the luminaire, resulting in less volt drop (and potentially more light output) than the other centralised types. If a building already has a generator, it could be seen as an economic option in some situations. While the standards still refer to central and semi-central systems, self-contained luminaires make up the majority of today's emergency lighting for new builds in New Zealand.

40W lamps were used in Auckland Hospital in 1937 ("Emergency power," 1937). Though the technology type is not mentioned, it is assumed that these were incandescent lamps, given what was available at the time. More recently, fluorescent and halogen lamps predominated. In the present day LEDs are becoming the norm.

CASE STUDIES

While it is reassuring to have emergency lighting systems in place, they are of no use if they don't work when they are called upon. Emergency situations could have devastating effects if no emergency lighting is available. It is perhaps easy to assume that New Zealand would fare well in such circumstances due to our regulations. However the remainder of this paper will consider some New Zealand case studies where the emergency lighting proved to be inadequate.

Forsyth Barr Building

On 22 February 2011 the Forsyth Barr building on Colombo Street, Christchurch, underwent significant earthquake damage. Occupants reported that it was near impossible to see the stair treads, due to failed emergency lighting in the stairwell (*Forsyth Barr Building*, 2011). This would have made escaping safely extremely difficult under the circumstances.

The cause for the failure was later discovered to be a collapse of the stairwell below the landing on the 14^{th} floor, which presumably took the emergency lighting supply with it. The second stairwell had met a similar fate. The occupants reported that not all of the emergency lighting was out of commission, as the toilet area in the vicinity of the stairwell on the 17^{th} floor was still functioning.

Christchurch Hospital

McIntosh et al. (2012) carried out a study on Christchurch Hospital after the same February quake. They found that the top two floors of the 7-storey "Riverside" hospital building had been evacuated immediately after the earthquake, due to water damage from roof-top tanks. The evacuation process was hampered by non-functioning emergency lighting in the stairways. The evacuation was therefore a slow (approximately 35 minute) process by flashlight.

The reason for the failure of the emergency lighting is uncertain, though the report by McIntosh et al. notes that the building sustained damage to its suspended ceilings. Therefore structural damage may have been at fault.

The 22 February earthquake discussed in both cases above occurred in the middle of the day (12:51pm), when natural daylight would have been available to rooms on the buildings' perimeters. This is perhaps why mention is only made of lighting failures in the stairwells, which are traditionally in the dark building core. It cannot be assumed from these reports that only the core lighting failed, but only that its loss was very evident as it greatly hindered escape efforts.

As the devastating Christchurch earthquakes are the common theme for the Forsyth Barr and Christchurch Hospital studies, the conclusion could perhaps be drawn that the systems would have functioned were it not for the structural damage. From that conclusion, it could then be deduced that emergency lighting systems in New Zealand are robust except for in extreme earthquake conditions. However, there are numerous accounts of emergency lighting failures under far less onerous conditions.

Embassy Theatre

In 2003, TVNZ's National News reported that 700 school children and teachers had been evacuated from the Embassy Theatre in Wellington in the dark when the emergency lighting failed during a routine drill (TVNZ, 2003). This evacuation was carried out in perhaps the best of circumstances; a planned drill in a building with no structural damage or any other hazards such as smoke. Yet the emergency lighting failed.

The cause of failure was not reported in the article. This is not surprising, as it is perhaps not a detail that the general public would be interested in. However, those in the industry also show a reluctance to formally discuss emergency lighting failure. Most likely because in our small country everyone is connected in some way, and reporting someone is bad for business. When researching this paper, the author was told many stories that remain off the record for that reason.

ASB Tower

A 2006 article from The New Zealand Herald discusses a major power outage in Auckland, in which the 29-storey ASB Tower in Wyndham Street had to be evacuated using flashlights due to failed emergency lighting. This time the blame was laid on an emergency generator, which failed at approximately 11am (Orsman, 2009).

SYSTEM VULNERABILITIES

While the mechanism for failure in each of the four situations above is not always clear, the studies serve to show that system vulnerabilities exist. Emergency lighting is a critical life-safety element that should not be left to amateurs. Territorial Authorities are responsible for upholding emergency lighting requirements. For example, Auckland Council holds a register of independently qualified people who are able to sign-off emergency lighting installations (Auckland Council, 2016). It is important for building owners to realise that they should seek expert advice on all matters regarding emergency lighting.

It is also important for building owners and occupants to realise the dangers of remaining in a building during a power cut if the local emergency lighting is only intended for short-duration escape. If building occupants do not perceive an immediate threat, they may choose to stay in the building when the power fails. An example of this was reported in June 2007. The duty manager of the Bridgeway Cinema in Northcote Point noted that during a power cut "some of our patrons sat there for a while, hoping the power would come back on" (Binning, Dearnaley, NcNaughton, & Gay, 2007).

A similar situation also occurred at Massey University in 2016, when a power outage was experienced at the Albany Campus. The occupants of the university's engineering building were reassured by a company-wide email that an electrical fault at a remote location was to blame. Business-as-usual therefore continued in the daylight-filled offices, while the emergency lighting lit the internal corridors. The danger of such behaviour is that emergency escape lighting is typically designed to last for a set period of time in order for safe egress to occur. Had the mains power not been restored within that timeframe, the occupants would have still been able to work at their offices; however they would not have had safe egress in the inner dark core of the building. While they may not have been exiting under emergency conditions, the very fact that they were exiting in darkness could have *created* an emergency.

CONCLUSIONS

The above studies show that emergency lighting is a critical part of building design and has the potential for catastrophe if it does not function correctly. More work is required in this critical area in order to ensure that lives are protected.

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A CRITICAL REVIEW OF EARTHQUAKE PLANNING IN NEW ZEALAND'S LOCAL COUNCILS

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ABSTRACT
Local councils are a critical part of disaster planning in New Zealand. Most of their contingency arrangements have historically been contained in long term plans, where strategic visions are legally linked to budgets and key performance indicators. This paper discusses disaster planning within councils, questioning the suitability and standard of these plans in the current New Zealand context. A review of institutions within the New Zealand context, existing disaster planning, and importance of company size all help frame this argument. They highlight the potential problems surrounding the planning for black swan events, where the level of risk is only one factor of many that is considered. To support this, qualitative research highlights the vast differences in earthquake preparedness around the country.

Key words: business continuity planning, critical national infrastructure, civil defence, long term planning, sustainability.

INTRODUCTION

New Zealand context

Earthquakes

New Zealand is at high risk of earthquakes, with approximately 20,000 per year being recorded by groups such as the Earthquake Commission and GNS Science (n.d.). Of these, one every two-and-a-half years is of the same magnitude as the Canterbury earthquakes in 2011 (Earthquake Commission & GNS Science, n.d.). This series of quakes devastated the city of Christchurch and prompted government to reconsider their earthquake preparedness at all levels. Local councils, who have historically played a large role in civil defence planning, continue to be a central figure in this field.

Disaster preparedness within councils

Because of this very high risk of disasters like earthquakes, the New Zealand context is a critical factor when examining disaster preparedness. Paton, Bajek, Okada and McIvor (2010) noted that the level of disaster preparedness is influenced by characteristics that are inherent in society itself. As evidenced in one Wellington City Council Long Term Plan (2011), councils around New Zealand are unique in that they prepare for these black swan earthquake events knowing that they will absolutely occur at some point in time. This can be seen in nationwide responses to the 2011 Christchurch earthquake, where disaster planning intensified post-earthquake. Despite this, the standard of disaster planning in New Zealand is not beyond reproach. Giovinazzi, Wilson, Davis, Bristow, Gallagher, Schofield, Villemure, Eidinger and Tang (2011) showed that the Christchurch earthquake highlighted the importance of disaster planning, but also of the need for improvements. Similarly, Becker and Johnston (2002) examined discrepancies between earthquake plans for different regions of the North Island prior to the Christchurch quakes. They found that, regardless of the real risk of earthquakes, there were generally low levels of earthquake information and earthquake policies. Yet Britton and Clark (2000) noted that, when improvements were made, they tended to reflect qualities lauded in the Sendai Framework for Disaster Reduction 2015-2030 (henceforth, the Sendai Framework); councils are moving away from reacting to disasters and beginning to focus more strongly on preparing for them.

Institutional setting

Long Term Plan

There are 67 territorial authorities in New Zealand, and these are solely responsible for making local decisions on behalf of residents and providing local service (Department of Internal Affairs, 2015). Future directions are outlined in the long term plan (henceforth, LTP). A long term plan is a ten-year strategic document that is legally required for every local council in New Zealand (Local Government Act 2002). "The effect of a long-term plan...is to provide a formal and public statement of the local authority's intentions in relation to the matters covered by the plan" (Local Government Act 2002). As a key document for accountability, councils are required to have long term plans at all times, with a revised edition being published every three years (Local Government Act 2002). It is critical to note that the document, whilst legislated, is not binding. "A resolution to adopt a long-term plan or an annual plan does not constitute a decision to act on any specific matter included within the plan", and no individual can force the local authority to implement the provisions of its LTP (Local Government Act 2002).

Although there is a wide range of variation in how long term plans – and the decisions within them - are formatted, only a narrow range of documents control and influence their contents. The Local Government Act 2002 gives detailed directives on the contents of the LTP, as well as the process of developing those contents. A number of supporting and recommendation documents also exist to aid councils in developing long term plans. Among them are reports such as SOLGM Jigsaw, "A SOLGM Guide To Preparing an Integrated Long-Term Plan Under The Local Government Act 2002" and the Auditor General's commentaries on previous LTPs (New Zealand Society of Local Government Managers, 2014). These documents provide detailed assistance to council planners on the process of producing LTPs, suggest foci, and explicate mandatory disclosures.

Civil defence planning disclosures are also guided by the Civil Defence Emergency Management Act 2002 (henceforth, CDEM Act 2002). This Act specifically focuses on non-routine disasters. Reflecting the sentiments of the Sendai Framework, the CDEM Act 2002 requires that four aspects of disaster preparation are focused on: reduction; readiness; response; and recovery. LTPs therefore generally had a section that described and explained each of these in turn, although there was significant variation between the quality of different councils' plans.

In earlier LTPs, civil defence actions were entirely planned for and controlled by the territorial authorities. However, these responsibilities have been increasingly delegated to regional Civil Defence Emergency Management groups (CDEM groups), resulting in less detail being included in the LTPs. Instead, these groups produce and publish their own reports. This still abides by the CDEM Act 2002, which states that the role of local governments is to "ensure the ability of continued function during and after emergencies, [and] plan and provide for civil defence emergency management within their district". As key financial data relating to civil defence planning – such as budgets – are still located in the LTPs, they remain a critical document in civil defence planning. This is the case even though the latest LTPs generally contain little detail about the nature of civil defence planning, and often have no detail on the nature of disaster risk itself.

These three pillars – the LGA 2002, CDEM Act 2002 and supporting documentation – are the key legislative and directive definers of the civil defence sections in long term plans. The first two are both fundamental to the plans produced by all councils. However, supporting documentation is not mandatory, and reading through multiple LTPs clearly highlights the reality that some councils use them much more extensively than others. Nonetheless, they form an important part of the institutional setting surrounding LTPs and civil defence planning.

Managerial attitudes towards disaster planning

Calculative rationality and normalization of risk

Wilson et al (2010) identified four main attitudes towards risk minimization. These are (a) the decision to avoid pre-emptive preparation for extreme events, (b) symbolic, hypothetical engagement, (c) structural empowerment of individuals, who may choose to carry out specific actions, (d) rejection of the these individuals and their disruptive effect on the status quo (Wilson et al, 2010). Each of these necessarily leads to a vastly different attitude towards disaster planning, thereby causing differing levels of preparedness. Yet, subjective preferences aside, there are a number of reasons why disaster planning is of importance, and these can be seen through the effects on emergency response processes. For example, Lai, Leoni and Stacchezzini (2014) state that accounting procedures are a critical part of the recovery process post-disaster because of the visibility, dialogue, and interdependency that they foster between stakeholders and around recovery actions. It also helps to increase mutual understanding and solidarity between victims. These implications of disaster risk planning show that the level of preparation in a region has a material impact on the experiences of individuals post-emergency. Divergent attitudes towards civil defence planning become significant in light of this impact upon individuals and communities when – not 'if' - those plans are actualized.

The importance of managerial attitudes is compounded by the reality that many managers treat all risks as economic in nature (Sullivan-Taylor & Wilson, 2009). Wilson, Branicki, Sullivan-Taylor and Wilson (2010) noted that disaster preparedness tends not to be a long-term strategic priority, but is based on managerial preference for a calculative rationality. Sullivan-Taylor and Wilson (2009, p.270) concluded that "this reveals a gap in the ability of existing management tools and methodologies to deal with current threats facing [organisations]". They also noted that perceptions of uncertainty and theories of action differ between organisations, and that this depends upon factors such as the accuracy and completeness of information, previous experiences, and the level of prioritisation ascribed to the threat (Sullivan-Taylor and Wilson, 2009). This effectively weights decisions against prioritising disaster preparedness. Gephart (2004, p.23) goes further, stating that

"one outcome of ecosystems accidents is the normalisation or routinization of risk. People adapt their beliefs and expect such events are inevitable and a normal price of progress."

In perpetuating a set of beliefs in which disasters were normalized, the notion that some people incur damage and costs is far more readily accepted (Gephart, 2004). In the New Zealand context, where multiple extreme earthquake events have occurred, this is a dangerous observation. It also goes some way towards explaining Wilson et al.'s (2010) observation of a calculative rationality in regards to risk management.

Company size is critical

There are strong associations between company size and the features of risk disclosures (Sullivan-Taylor & Branicki, 2011). Sullivan-Taylor and Branicki (2011) noted that small and medium enterprises have "distinctive perspectives" to larger organisations. Other studies have suggested that larger companies who face less risk tend to have more, better quality disclosures. Studies have highlighted significant associations between company size and the number of risk disclosures (Linsleya and Shrives, 2006; Patten, 2002), the availability of disclosures with an environmental or social orientation (Hackston and Milne, 1988), and the quality of the disclosures (Brammer and Pavelin, 2006). Linsleya and Shrives (2006) and Patten (2002) found the presence of environmental and social disclosures is negatively associated with the level of environmental risk. They conducted a content analysis of the annual reports of 79 companies and discovered a highly significant association (at the 1% level) between company size and number of disclosures (Linsleya and Shrives, 2006). However, in relation to environmental risk disclosures, no firm causal link was proven (Linsleya and Shrives, 2006).

Joshi and Gao (2009) found that companies in better financial shape tended to voluntarily disclose more environmental information. However, they distinguished financial and social disclosures, stating that the latter were more closely correlated with company size (Joshi and Gao, 2009). Nonetheless, the quality of disclosures was positively associated with firm size and corporate environmental impact according to Brammer and Pavelin (2006). They noted that larger companies were "significantly (p=0.000) more likely to make better quality disclosures", whilst factors like media visibility and current profitability were not found to have a significant role (Brammer and Pavelin, 2006, p.1183). However, these disclosures may have limited usability. Linsleya and Shrives (2006) noted that risk disclosures tended to be dominated by general, unhelpful statements of risk policy. Oliveira, Rodrigues, and Craig (2011, p.817) concurred, stating that disclosures tended to be "generic, qualitative and backward-looking". This attitude could be described as self-laudatory (Deegan and Gordon, 1996), with companies using risk disclosures to manage their reputations (Oliveira, Rodrigues, and Craig, 2011). Oliveira, Rodrigues and Craig (2011, p.817) conducted a content analysis of 81 companies' annual reports, and discovered that "public visibility" was crucial in explaining risk disclosure behaviour. It is interesting to note that no papers were noted that identified a positive association between environmental risk and quality or number of disclosures.

RESEARCH METHOD

This study was a comparative systematic review of the discourse in the local council planning artefacts around New Zealand. A sample of five councils was picked as miniature case studies, with an attempt to choose councils that represented a variety of sizes and locations. There is great diversity between the types of councils and the areas that they represent around New Zealand, so it seemed more important to reflect this diversity than to have a completely randomised method of selection. This resulted in two councils being selected from the South Island (Gore and Dunedin) and three from the North Island (Whangarei, Carterton and Wellington). Two councils could be considered very rural (Carterton and Gore), one presides over a major city (Wellington), and the other two fell somewhere in between (Whangarei and Dunedin).

Secondary data was collected from the 2012 and 2015 long term plans of these councils, as this represented the financial and legal source of responsibility for civil defence planning. Secondary data was also collected from the regional CDEM group reports, as recent long term plans indicated that many responsibilities had been delegated to these groups. This allowed for the most complete picture of earthquake planning in the selected areas to be established.

Data was categorised according to recommendations and frameworks established by Becker and Johnston (2002). There were six areas of focus: (1) Local commitment to hazard mitigation, which emphasized legislation and performance measures; (2) Local planning capacity, which looked at assessment criteria and acknowledgement of limitations; (3) Local perception of natural hazard threat, where the specificity of objectives was examined; (4)feasibility of taking hazard mitigation action, which included searching for specific areas with fault lines; (5) degree of risk, which examined the documentation of local conditions; and (6) policies as guidelines, where specificity of goals, outcomes and budgetary alignment were examined. A binary scorecard was used to judge the presence or absence of these elements of risk planning, thereby allowing for an objective analysis of the level of earthquake planning in each region.

RESULTS

Table 25: Scorecard results for each of the sample cities, as based on the criteria above.

Territorial Region	Score			Average (Mean) Score
	2012 LTP	2015 LTP	CDEM Group report	
Whangarei	6	4	15	8.333
Carterton	8	7	15	10
Wellington	18	12	15	15
Dunedin	8	3	12	7.667
Gore	11	16	17	14.667

Table 26: Average (Mean) scorecard results for each city, as compared to the level of earthquake risk in that city, as well as its population size.

Territorial Region	Average (Mean) Score	Level of Earthquake Risk*	Population Size**
Whangarei	8.333	1	55,400
Carterton	10	5	5030
Wellington	15	5	398,300
Dunedin	7.667	5	117,400
Gore	14.667	5	12,108

*Level of Earthquake Risk was taken from hazardscape analyses conducted in CDEM group reports. The qualitative scale found in most CDEM reports was then simplified into five-point scale, where 1 means 'very low risk' and 5 means 'very high risk'.

**Taken from Statistics New Zealand website.

FINDINGS

This comparative study, whereby each council was treated as a miniature case for a cross cases comparison, shows that there is no simple relationship between the proficiency of civil defence planning and the level of real earthquake risk. Areas that – in the secondary data above - describe themselves as having exactly the same level of earthquake risk have vast differences in their level of earthquake planning. The CDEM group which Dunedin is a member of describes themselves as being "least ready" for an earthquake out of all potential hazards in the region, despite it being the highest risk event (Otago Region Emergency Management Group, 2011, p.16). On the other hand, Wellington and Gore – which also had high earthquake risk - had scores that suggested that they have high levels of earthquake planning.

Population size – which should indicate territorial authority size – also lacked a linear relationship to the level of earthquake preparedness. Wellington and Dunedin had the largest populations, yet had vastly different levels of earthquake preparedness. Carterton and Gore are both small towns, yet Gore had a massive 4.667 points more than Carterton in terms of its earthquake planning.

DISCUSSION

The findings above show that there is no simple explanation for the discrepancies between the civil defence planning of different territorial regions. This lack of relationship between the risk of earthquakes and level of preparedness suggests that other factors may be playing a disproportionately important role in the quality of planning. This is problematic, as the level of risk preparedness may have less to do with the actual need for that preparedness, and more to do with the individuals creating the risk policies.

One of these factors could be managerial style. Wilson et al.'s (2010) observation of a variety of managerial attitudes to risk planning may go some way to explaining these discrepancies. In determining perceptions of uncertainty and theories of action, which may influence the outcome of a rationally calculated attitude to risk planning, a number of factors were described. Anecdotal evidence suggests that each had their place in the sample cities: Dunedin admitted that it had low completeness of information; Wellington has had extensive previous experience of earthquakes; and legislated priorities explain the importance ascribed to earthquakes by Whangarei. Therefore, future studies should further examine managerial attitudes within these councils and CDEM groups, so as to gain a deeper understanding of the importance of this factor.

Another of the potential factors not examined in this study is the quality of disclosures. The scorecard didn't analyse the quality of disclosures; it only looked at the presence of them. However, a number of the studies that were described earlier showed that quantity of disclosures does not guarantee quality. Brammer and Pavelin (2006) stated that company size was associated with the quality of risk disclosures, whilst Linsleya and Shrives (2006) noted that risk disclosures are often general, unhelpful statements of risk policy. A number of the LTPs only made inflationary adjustments in their annual civil defence budgets, and CDEM group plans contained no financial data. This points to the possibility of generalized or unhelpful statements (Linsleya & Shrives, 2006). Given Wilson et al's (2010) observations of the limitations of quantitative, financial rationale in decision-making, future research should examine the specificity and directive orientation (forward- or backward- looking) of these civil defence disclosures. Dominance of this quantitative financial rationale may further explain and identify problematic variations in earthquake planning.

If Linsleya and Shrives' (2006) observations hold true in the New Zealand earthquake risk planning context, this raises serious questions about the level of preparedness of these areas for new threats. General, backward-looking earthquake risk policies could be explained by the 2011 Christchurch earthquakes. However, it would mean that insufficient planning was occurring for potential non-natural hazards in the future.

CONCLUSIONS

This study has looked at the proficiency of disaster planning in New Zealand. A review of institutions within the New Zealand context, existing disaster planning, and importance of company size helped frame this argument. They highlighted the potential problems surrounding the planning for black swan events, where the level of risk is only one factor of many that is considered. To support this, qualitative secondary research highlights the vast differences in earthquake preparedness around the country. It showed that the level of preparedness for a black swan event, like an earthquake, has little to do with the real level of risk associated with that event. Theoretical discussion questioned other potential relationships, asking where potential associations may lay. Finally, it highlighted the need for further comparative investigations into this area, in order to determine the degree – and potential causes - of regional variation in civil defence planning. This should be explored through primary research, which could uniquely show how CDEM plans are informed, revealing the current rationale and motivations of key personnel and highlighting drivers for future change. This research is critical, as black swan events are almost impossible to identify in advance. This makes the organisational structure surrounding CDEM planning of utmost importance.

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IMPROVING PRODUCTIVITY AND VIABILITY OF SME CONTRACTORS: RESILIENCE MANAGEMENT FRAMEWORK

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ABSTRACT

Research and initiatives have been focused on how to train and equip small-medium enterprises (SMEs) in construction to acquire requisite skills to improve their productivity in the industry. However, there is little research on how the SMEs could remain resilient, viable and successful over the long-term. This study aimed to investigate the priority areas of SMEs' operations, which if well-managed, could enhance their resilience to everyday shocks, productivity, growth and viability over the long-term. Results revealed 33 priority areas that could make or mar the resilience, productivity and viability of the SME firms. The priority areas were aggregated into four broad categories for ease of management: input, internal, external and output systems. The broad and sub-component priority areas provided the basis for formulating a resilience management framework for use by construction SMEs in managing issues in the identified areas with a view to achieving sustained resilience, productivity, growth, viability and long-term success.

Keywords: Construction, Productivity, Resilience, SMEs, Viability.

INTRODUCTION

The construction industry is a key contributor to the economy and well-being of the nation. For instance, PricewaterhouseCoopers (PWC, 2011) reported that the New Zealand construction sector accounts for one in 12 jobs and contributes nearly 50% of all gross fixed capital formation. Being responsible for 80 – 90% output of the construction industry (Productivity Commission, 2012), the productivity and performance of the industry rest on the small-medium enterprises (SMEs). The Ministry of Business, Innovation and Employment (MBIE, 2014) defined SMEs as any type of enterprise or firm with fewer than 50 employees.

Several studies have looked at the challenges and risks faced by construction SMEs and the construction sector as a whole. These risks and challenges have resulted in high rates of insolvency and business failures among the SMEs. This is evident in the Ministry of Business, Innovation and Employment (MBIE, 2015) report of a staggering 22% of total bankruptcies within the building sector in 2015. The business failure rates among construction SMEs need to be investigated and resolved because their failures could constrain the ability of the construction sector to meet the $110 billion building and infrastructure development planned for 2015-2025 (National Infrastructure Unit, 2015).

Research and initiatives have been focused on how to train and equip construction SMEs to acquire requisite vocational and technical skills to improve their productivity and performance in the industry. However, there is little research on how the construction SMEs' business could remain resilient, viable and successful over the long-term. In a recent survey of 411 business executives, the Economist Intelligence Unit of the British Standards Institution (BSI, 2015) found that organisational resilience has become a clear competitive differentiator and a key factor in productivity and performance improvement as well as long-term success of organisations. Resilience can therefore be a key lever for productivity and performance improvement of the construction SMEs and a driver for their long-term success. Developing a resilience framework could help to sustain SMEs' productivity, growth and success.

LITERATURE REVIEW

Organisational resilience

In the organisational context, the British Standard BS65000 (2014) defines 'organisational resilience' as the ability of an organisation to anticipate, prepare for, respond and adapt to, incremental change and sudden disruptions in order to survive and prosper". This definition points to two broad categories of organisational resilience – resilience to sudden shocks and resilience to gradual change. Both aspects could be systemic, affecting all organisations globally, nationally or within the industry; they could also be specific to individual organisations based on the way they position themselves to the vagaries in the business landscape. The sudden shocks are less frequent but much more devastating, and are usually driven by disaster events such as large scale earthquake, flood, landslides, or fire. The gradual shocks are almost everyday occurrence and are usually driven by threats in the business landscape such as stiff competitions, stringent regulations, skills shortage or financial crisis.

Variations to the key drivers of both aspects of resilience have given rise to several perspectives of the concept. In relation to resilience to disaster-driven sudden shocks within the construction sector, Wilkinson et al. (2016) described 'organisational resilience' as the level of a construction firm's preparedness to respond to crises, including having emergency or disaster management plans mainstreamed into the construction processes. In relation to resilience to gradual or everyday shocks, the British Standards Institution (BSI, 2015) defined 'orgnisational resilience' as the ability of organisations or businesses to respond effectively to short-term setbacks and adapt to long-term shifts in their operational environments.

Relating resilience and productivity

Statistics New Zealand (2016) defined 'productivity' as a measure of how much output is generated per unit of input. On this basis, growth in productivity can be achieved through increasing output, while maintaining the same level of inputs; maintaining output while reducing the level of inputs; or a combination of the above. Resilience can help an organisation to achieve its productivity targets by shielding its processes and operations from sudden and gradual shocks in the business landscape.

The following sections provide reviews on some of the factors affecting resilience of construction firms to sudden and gradual shocks.

Factors affecting the resilience of construction firms to sudden shocks

The Resilient Organisations (2012) identified some indicators that can be used to assess the resilience of an organisation to sudden shocks as highlighted below. Majority of the indicators are also applicable for assessment of gradual shock-induced resilience.

Leadership: Providing good management and decision making during times of crisis.

Staff Engagement: Engaging and involving staff who understand the link between their own work, the organisation's resilience, and its long term success.

Situation Awareness: Encouraging staff to be vigilant about the organisation, its performance and potential problems.

Decision Making: Giving staff appropriate authority to make decisions related to their work, with ability to delegate authority to enable a swift crisis response.

Innovation and Creativity: Rewarding staff for using their knowledge in novel ways to solve new and existing problems.

Effective Partnerships: Awareness of the relationships and resources the organisation might need to access during a crisis.

Factors affecting the resilience of construction firms

The UK Department for Business Innovation and Skills (DBIS, 2013) outlined key factors which if deployed adequately could affect growth and competitiveness of the UK construction sector. These and other factors are summarised in the following sections; they are applicable to the construction SME businesses in New Zealand, and if properly addressed, could enhance the everyday shock-driven resilience, productivity and long-term success of the SMEs and the sector as a whole.

People and skills: The argument here is that a skilled and flexible workforce will be vital to the construction sector's future performance and competitiveness. 'Flexible workforce' in this context means a workforce that is readily adaptable to changes in the internal and external business landscape.

Access to finance: Inability of the construction SMEs to access finance constrains their ability to successfully execute their projects and remain in business (Mbachu, 2011). DBIS (2013) reported that construction contracting SMEs in UK face more difficulties than other SMEs in accessing finance from financial institutions owing to their higher risk profiles.

Innovation: This drives productivity, competitiveness, survival and growth of any business (McKinsey, 2013). DBIS (2013) identified reasons for low levels of innovation in the construction sector to include fragmentation and limited collaboration, unsuitable procurement and contract strategies, and risk-averse attitude.

Poor customer service: With customer service underlying the mission of every organisation, poor customer service undermines the existential basis for, and therefore the resilience of, construction firms (Mbachu, 2011).

Volatility: The boom-bust cycle in New Zealand results in low investment in skills and scale over the long-term; this exacerbates continuous downward decline in productivity (PWC, 2011).

Summary of review of literature and gap in knowledge

Review of literature to date has provided insights into some of the factors that could influence the resilience of contracting companies, including the SMEs. However, there is little research on a robust structure or framework that encapsulates a range of resilience practices for supporting the productivity and long-term survival of the SMEs.

Research aims and objectives

Being mindful of the generic information available in the literature, this study aimed to investigate the structure and key components of an effective resilience framework for enhancing SMEs' productivity, growth and sustenance over the long-term. The key objectives of the study were as follows:

To investigate priority areas of construction SMEs' operations, which if well-managed, could enhance resilience to everyday shocks, and productivity, growth and viability of their businesses over the long-term.

To structure the identified priority areas into resilience management framework for use by the SMEs in managing issues related to the priority areas so as to achieve sustained resilience, productivity and success in the long-term.

Scope of the study

As explained in earlier sections, there are two broad categories of organisational resilience – resilience to sudden shocks and resilience to gradual change. Though both resilience have profound impact on productivity of the SMEs, this study focused on organisational resilience to gradual or everyday shocks in the operating environment; this aspect of resilience is a major challenge to the small-medium enterprises (SMEs). Owing to their limited organisational resource and research capacity, they are more prone to the prevalent shocks than the big players in the industry.

RESEARCH METHOD

Qualitative or exploratory survey method was adopted for this study because the aim was to generate constructs from few intense observations in order to develop some theories or hypotheses to be tested at a later stage quantitative survey. Feedback provided by small-medium enterprises (SMEs) who were members of the Registered Master Builders Association (RMBA) in New Zealand constituted the units of analysis for the study. With SMEs (i.e. businesses employing fewer than 50 employees) constituting 91% of building contractors in New Zealand (Productivity Commission, 2012), the RMBA served as the main directory of SME contractors. Since qualitative method requires intense observation of the phenomenon under study, data collection was by in-depth interviewees. Using purposive sampling method (Bernard, 2011), the initial plan was to recruit prospective interview participants from the RMBA directory by random sampling; however, there was no access to this database due to privacy reasons. Contacts were made with interviewees at this stage of the study via RMBA membership events held in Auckland, Wellington and Christchurch. Feedback obtained from the pilot interviews was analysed using thematic analysis. This analytical technique was chosen because the aim was to structure the constructs provided by the interviewees into clusters of related ideas.

RESULTS

Interview details

Request to participate in an in-depth interview was sent out to 30 owners of construction SMEs contacted during RMBA events in Auckland, Christchurch and Wellington. In line with the exploratory nature of the study, the intention was to recruit a minimum of five interviewees from each of the three main cities of New Zealand. Five interviewees from each city were arbitrarily chosen to ensure enough data points for exploring patterns in the data structure. 18 interviewees granted the interview request – nine in Auckland, four in Christchurch and five in Wellington. Empirical data for the study was therefore based on the feedback from the 18 interviewees.

Demographic profiles of the interviewees

Analysis of the demographic profiles of the interviewees showed that majority (i.e. 61%) were owners of small and micro enterprises employing 0 - 20 staff. The remaining 39% were small-medium sized construction firms employing on average 23 permanent staff. 67% were mainly involved in commercial building projects, while the remaining interviewees specialised in residential and refurbishment projects.

Priority areas of construction SMEs' operations for resilience management focus

The interviews aimed to obtain feedback from owners of SME contracting firms about areas of their operations which if well-managed could enhance their resilience, productivity, growth and viability. Content analysis of the interviewees' feedback revealed 33 strategic and operational areas. Through thematic analysis, the 33 areas were clustered into four broad categories of construction SMEs' operations: Input systems, internal system, external systems and output systems. Table 1 presents the broad and sub-component areas of resilience management for sustaining the productivity and viability of the construction SMEs as found in the study.

Table 27: Areas of resilience management for sustained productivity and viability of construction SMEs

Major and sub-component areas of resilience management in the SMEs' operations	
A	**Input systems resilience**
1	*Client system*: Understanding of client needs and value system
2	*Project resourcing*: Cost-effective sourcing of project finance and insurance, quality materials, equipment and workers.
3	*Risks*: Proper risk identification, analysis and contingency/ response framework
4	*Project scope*: Well defined and specified scope of work
5	*Contract conditions*: Clear understanding of contract conditions, risks and obligations
6	*Information quality*: Accuracy of information for critical decision-making
7	*Market intelligence*: Well established network for intelligence gathering
8	*Supply chain management*: Vertical and horizontal supply chain integration and coordination
B	**Internal systems resilience**
1	*Leadership quality*: Inspirational and responsive leadership
2	*Organisational culture*: Culture and attitudes that foster teamwork, flexibility and adaptability to change
3	*Workforce*: Skill, training, motivation and commitment; life-long learning (upskilling to be up to date with current knowledge and best practice in the area of specialism)
4	*Project planning and coordination*: Adequate project planning, scheduling and coordination
5	*Performance management*: Adequate supervisions, incentives, performance monitoring, reporting and control
6	*Quality management*: Quality assurance planning, monitoring and control.
7	*Cost/financial management*: Good accounting system, budgeting /cash flow forecasting and expenditure control; prompt invoicing and chasing of payments.
8	*Variation/ change management*: Effective monitoring of project scope, variations and claims
9	*Operations & technology*: Efficient work processes through technology applications
10	*Communication:* Efficient information flow
11	*Documentation*: Efficient documentation and timely retrieval of vital information for decision-making

12	*Relationship management*: Good client and stakeholder relationship and collaboration
13	*Contract administration*: Operating according to terms and conditions of contract, good conflict management, negotiations and dispute resolutions.
C	**External systems resilience**
1	*Bidding/ tendering strategy*: Ability to secure bids, especially on negotiated basis; focus on contracts that are within key areas of strength; ensuring profitable bidding.
2	*Compliance management*: Good understanding and response to obligations under the Health and Safety At Work, Resource Management and Construction Contracts Acts
3	*Trend monitoring*: Monitoring industry and general market trends, proactive response and adaptation to major shifts
4	*Insurance*: Maintaining adequate insurance cover against insurable risks and uncertainties in the operating environment
5	*Networking*: Establishing useful networks for job leads, information sharing and collaborations
6	*Resource optimisation:* Optimising capacity and capabilities within elastic limits; avoiding over commitments and sub-optimal resource utilisation.
7	*Competitive advantage*: Focus on and excelling in areas of key strengths; utilising key strengths to optimise opportunities and minimise exposure to threats.
D	**Output systems resilience**
1	*Risk implications of guarantees and warranties*: Ensuring that there are no call-backs, especially during the defects liability period
2	*Reputation managemen*t: Ensuring a legacy of good reputation and positive word-of-mouth from clients.
3	*Post-completion satisfaction survey*: Evaluating user and client satisfaction with services and completed building; taking steps to address any concerns; ability to secure repeat business or good reference for future jobs.
4	*Continuous improvement*: Undertaking post-completion performance audit, documenting challenges and utilising lessons learnt for future jobs.
5	*Quality checks*: Ensuring that the completed facility meets the fitness-for-purpose tests.

Resilience management framework for sustained productivity and viability of construction SMEs

Based on the findings summarised in Table 1, a Resilience Management Framework (i.e. Figure 1) was developed to meet the second objective of the study.

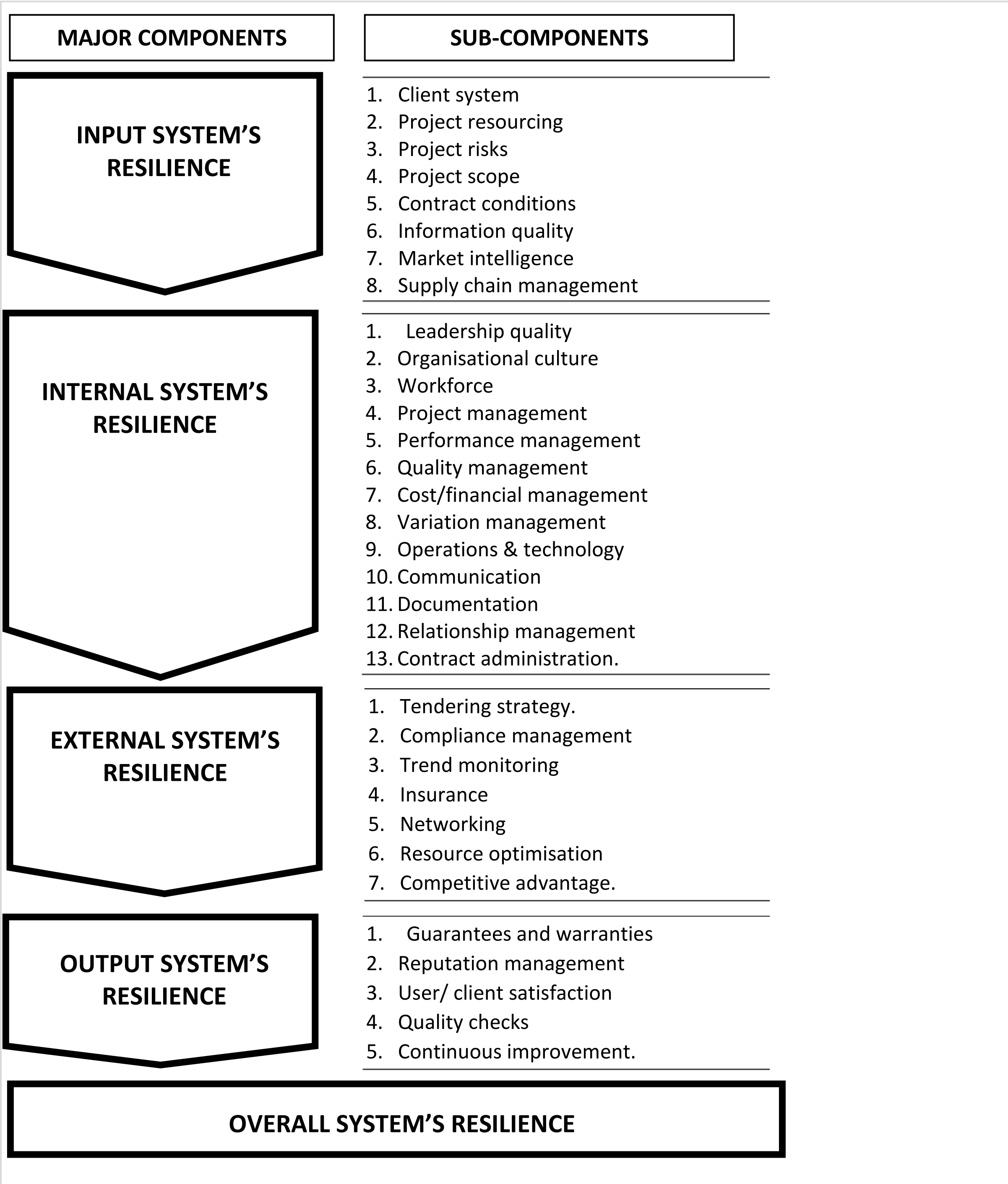

Figure 22: Resilience management framework for sustained productivity and viability of construction SMEs

DISCUSSIONS

A hypothesis implicit in the results summarised in Table 1 and Figure 1 is that the productivity, growth, viability and success of the construction SMEs rest on the ability to manage everyday resilience factors in four key areas: input, internal, external and output systems. The four component framework is an extension of the OECD (2016) three component productive systems framework but with the addition of the external systems. OECD

(2016) recommended the input-process-output framework for studying economic productive systems or units where the focus is on productivity and performance measurement and improvement. These are discussed as follows.

Input system's resilience: Table 1 shows that priority resilience factors to be managed in the input systems comprise issues related to the client system, project resourcing, project risks, project scope, contract conditions, information quality, market intelligence and supply chain management. As corroboration to these findings the British Standards Institution (BSI, 2015) argued that understanding and meeting customer needs better than competitors is a top prerequisite to achieving organisational resilience and long-term success.

Internal system's resilience: 13 priority areas identified under this cluster ranged from leadership quality and organisational culture to having highly skilled and workforce, effective project management, stakeholder relationship management and efficient contract administration. Consistent with these findings, the British Standards Institution (2015) observed that dynamic leadership is one of the three top prerequisites to achieving organisational resilience and long-term success.

External system's resilience: Seven priority areas were identified under this cluster. These range from having a competitive tendering strategy, to developing strong industry network, resource optimisation and competitive advantage. These generally represent the opportunities and threats in the business landscape. Resilience of the construction SMEs is reinforced by leveraging key strengths to exploiting opportunities and minimising exposure to threats. This could be accomplished by effectively managing the identified seven priority areas.

Output system's resilience: Factors under this cluster range from guarantees and warranties, through reputation and user satisfaction, to quality checks and continuous improvement. The way the cluster is managed has the highest impact on how the quality of services of the construction SMEs is perceived, and as a result, the satisfaction or dissatisfaction of the users and owners, and whether or not there will be repeat business.

CONCLUSIONS

This study has investigated the priority areas of construction SMEs' operations, which if well-managed, could enhance their resilience, productivity, growth and viability over the long-term. Results revealed 33 priority areas for this purpose. The priority areas were aggregated into four broad categories for ease of management: input, internal, external and output systems. The broad and sub-component priority areas provided the basis for formulating a resilience management framework for use by construction SMEs in managing issues in the identified areas with a view to achieving resilience, productivity and long-term success. The findings are recommended to be tested in a quantitative research to determine their reliability, validity and generalisability.

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ANDROID PHD WORKSHOP

TOWARDS EARTHQUAKE-RESILIENT BUILDINGS: EXPOSURE/DAMAGE DATABASE FOR THE 2013 BOHOL PHILIPPINES EARTHQUAKE

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ABSTRACT

Fostering resilience against earthquakes necessitates proper evaluation of building performance. The core elements at risk whenever a huge earthquake occurs are the people and the buildings. While an exposure database describes these elements at risk before an earthquake happens, the damage database provides an inventory of damage incurred during the event. In this study, a comprehensive database featuring both damaged and undamaged structures related to the M7.2 Bohol Philippines earthquake is assembled. It accounts for over 25,000 buildings located at various earthquake intensity levels, in urban and rural areas. Interviews were conducted involving health workers and local officials. Each structure in selected sites is described based on structural materials, building use, height, occupancy, site morphology, construction era and damage sustained during the event. With full range of parameters defining the structures, this allows for a meaningful seismic risk assessment where the earthquake performance of buildings is investigated. This study highlights the key role of empirical data in validating building fragility and vulnerability models for improved seismic regulations and credible impact forecasts.

Keywords: Bohol earthquake, building fragility, exposure database, seismic risk assessment, vulnerability models

INTRODUCTION

A new set of programs for disaster risk reduction and management has been formulated in Sendai, Japan as part of an ongoing effort in promoting resilience against disasters. Succeeding the Hyogo Framework for Action (HFA) and integrating global platforms aligned with the Millennium Development Goals of United Nations International Strategy for Disaster Reduction (UNISDR), the Sendai Framework recognizes the need to understand elements of disaster risk including exposure, hazard and vulnerability in strengthening disaster risk governance (Aitsi-Selmi *et al*., 2015).

Seismic risk assessment is one of the components of disaster risk that needs to be addressed especially for earthquake prone areas. With the end goal of achieving building resilience, it requires enough knowledge on exposure, hazard and vulnerability related to building structures. This study highlights the importance of an empirical exposure/damage database in the conduct of a credible seismic post-event assessment –one aspect that would immensely contribute to the Sendai Framework.

While empirical data best capture the actual conditions in the field, there have been few attempts to assemble detailed exposure/damage databases especially in Asia. With the scarcity of post-earthquake data, this inhibits proper empirical seismic risk analysis and loss estimation modelling (So & Pomonis 2012 and Jaiswal, Wald & Hearne 2009). This study demonstrates how actual conditions and available information on site can be developed into useful tools for evaluating the earthquake performance of structures. It offers a baseline strategy which is of prime importance to developing countries like the Philippines, where there is paucity in post-earthquake data even though the risk of impacts to earthquakes is very high.

Reliable information on building fragility and vulnerability is a key factor in the convolution of fundamental seismic risk elements. Seismic fragility functions represent the relationship between earthquake damage and a ground motion parameter, the application of which in various engineering structures is well documented (Baker 2015, Noh, Kiremidjian & Lallemant 2015, Nasserasadi *et al.* 2008, Padgett & Des Roches 2008, Sengara *et al.* 2010 and Straub & Der Kiureghian 2008) following either one or a combination of these approaches: (1) empirical analysis based on statistical evaluation of post-earthquake damage data; (2) analytical analysis using numerical simulations of structural models; or (3) heuristic analysis based on engineering judgement and expertise (Lallemant, Kiremidjian & Burton 2015).

Furthermore, this study specifically explores the risk factors that have played key roles in the outcome of the M7.2 Bohol Philippines earthquake. This event showcased a devastating impact brought about by strong ground shaking, leaving over 70,000 buildings with partial or total damage corresponding to more than a quarter of the total housing units in the island (EMI, 2014). With the notable structural damage in building systems and the wide spread of intensities inferred to have shaken the island, the Bohol earthquake has the essential ingredients required in furnishing a meaningful seismic risk assessment, a step towards building earthquake-resilient structures.

THE EXPOSURE/DAMAGE DATABASE FOR BOHOL EARTHQUAKE

Bohol is the 10th largest island in the Philippines, covering an area of 4,821 square kilometres and accommodating over 1.25M population.

Based on the 2010 census conducted by the Philippine Statistical Authority (PSA), the total housing units in Bohol sums up to 259,520 wherein 34% have outer walls made of concrete, brick or stone, 26% have bamboo, cogon or nipa and 22% utilize a combination of both materials (EMI, 2014). The unaccounted percentage, which was not reported, would probably represent makeshift houses. The October 2013 earthquake resulted in 14,480 collapsed structures and 57,405 with partial damage (EMI, 2014). These details set the context of exposure wherein buildings are taken into account as the main elements at risk.

Post-event Survey

In creating the database, the survey consisted of interviews with the local officials and health workers who conduct monthly visits to each housing unit for health care administration and related services. Through a series of field visits and pilot interviews, the coherency of the method and the completeness of the survey form were tested and found adequate.

The main objectives during the interview include characterizing the existing structures prior to the occurrence of the earthquake and acquiring information on the type of damage in accordance with defined damage thresholds. These are achieved by using a simple digital form equipped with the requisite attributes in a drop-down menu format. Figure 1 depicts the survey form and the typical building types found in the study area.

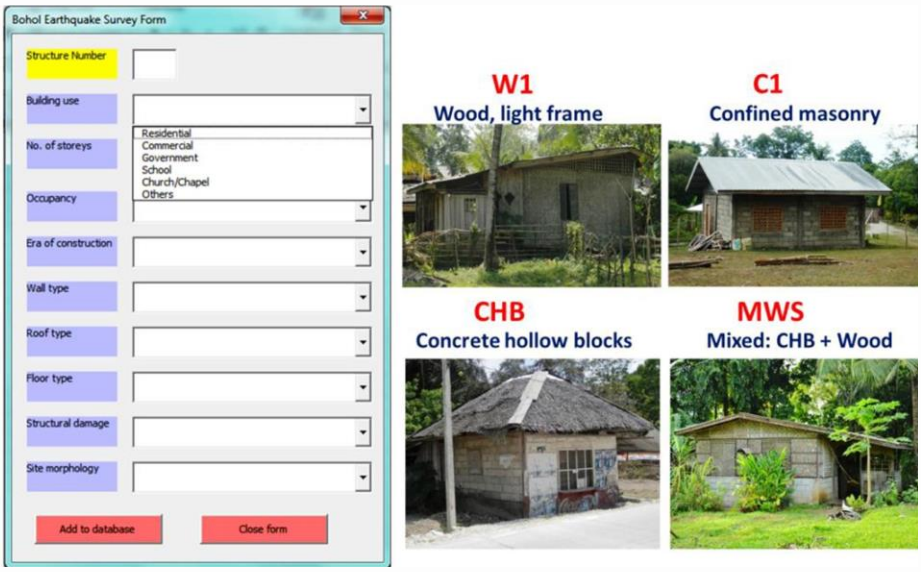


Figure 1. Left panel: Survey form featuring the structural attributes considered in the interviews. Right panel: Typical building systems found in Bohol

Each structure in the selected village is described based on building use, number of storeys, occupancy, construction era, site morphology, damage state and structural materials used for wall, roof and flooring. Most of these attributes can be described with ease except for the construction era. In this case, the interviewees were encouraged to select the most suitable option that would best describe the structure.

The construction era is defined in accordance with the structural code amendments in the Philippines (ASEP, 2010). Represented by three vintages, this attribute is distinguished by the years 1972 when the first edition of the code was released and 1992 when a contemporary code was instigated. Pre-code stands for structures constructed before 1972, low-code for structures erected from 1972 to 1992 and high-code for buildings built after 1992 (UPD-ICE, 2013).

On the other hand, damage thresholds delineated the susceptibility of each structure to earthquake loads. The severity of damage is categorized in four damage states: (1) No Damage: covers minor tilting for wooden structures and no visible cracks for concrete buildings; (2) Minor Cracks: for structures with hairline or slight cracks that do not warrant any repair;

(3) Repairable: corresponds to structures that are still standing but has endured extensive damage, thereby requiring reparation; and (4) Collapse: for structures rendered inefficient to repair and require total reconstruction.

Building Typology

The vast majority of the buildings in the compiled database are of residential type, with one or two storeys, housing one to seven people and constructed in flat terrain. From the mix of construction types present in Bohol, a large proportion of buildings utilize wood, concrete hollow blocks, a combination of both or confined masonry for walls, galvanized iron sheets for roofing and concrete slab for the flooring.

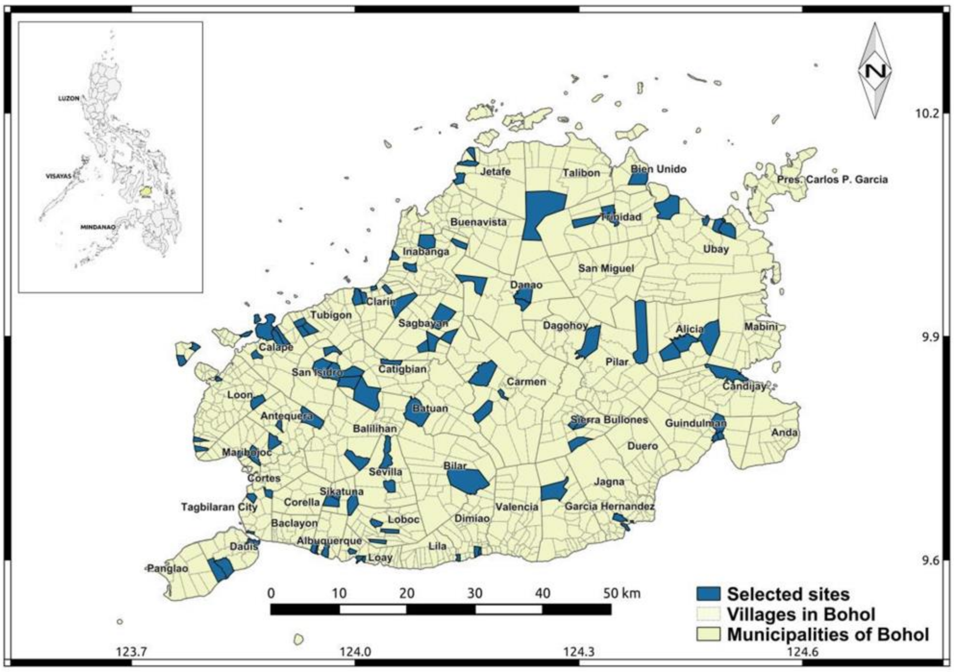
As previously featured in Figure 1, the database revealed four predominant building stocks: (1) wood with light frame [W1]; (2) confined masonry [C1]; (3) concrete hollow blocks with wood or light metal [MWS]; and (4) concrete hollow blocks [CHB].

To be able to validate the fragility models for these structures, the building definition and nomenclature were aligned with the building typology formulated by local engineers who proposed the fragility and vulnerability models for key building types in Manila –the capital city of the Philippines (UPD-ICE, 2013).

Site Selection

A total of 100 *barangays* –the Filipino term for villages, were selected for interview, the locations of which are depicted in Figure 2. This accounts for more than 25,000 structures located at various inferred earthquake intensity levels. These sites were selected after considering several factors l i k e earthquake intensity (USGS, 2013), existing damage.

reports/surveys (CEDIM, 2013 & UNOCHA, 2013) and urban and rural site classification (PSA, 2010).



DISCUSSION AND RESULTS

Improving knowledge of seismic building fragility requires two pertinent details: (1) a detailed earthquake source model; and (2) a reliable statistical description of building damage. The source model translates into a ground motion estimate which can then be calibrated to the exposure/damage database for seismic risk estimation.

The Bohol Philippines earthquake, the seismic hazard considered in this study, is an inland quake as a result of the movement along a previously unknown thrust fault called the North Bohol Fault. Further details of the tectonic framework in the region are described in PPDO (2014) and Naguit *et al.* (2015). For the earthquake source model, the USGS model (USGS,

2013) is considered in this analysis. This finite fault model is derived using teleseismic broadband seismic data resulting to a southeast dipping rupture plane as illustrated in Figure 3. Also shown in the same figure is the USGS shake map where the intensity estimates were extracted.

Note that the cross correlation between the source model and damage estimates shows that the structures with high proportion of Repairable and Collapse levels are confined within the fault plane, implying that the damage data conforms quite well with the location of the source model. A few villages away from the fault zone that exhibit substantial Repairable damage levels are possibly influenced by site effects.

In this analysis, each building type is well represented in the surveyed *barangays*, although CHB has relatively low sample size as compared to other types. As shown on the left panel of Figure 3, aside from the full scale interview covering all buildings in a *barangay*, additional ten *barangays* were targeted for CHB interviews only in order to increase the number of CHB data, resulting to a total of 1,112 CHBs in the database.

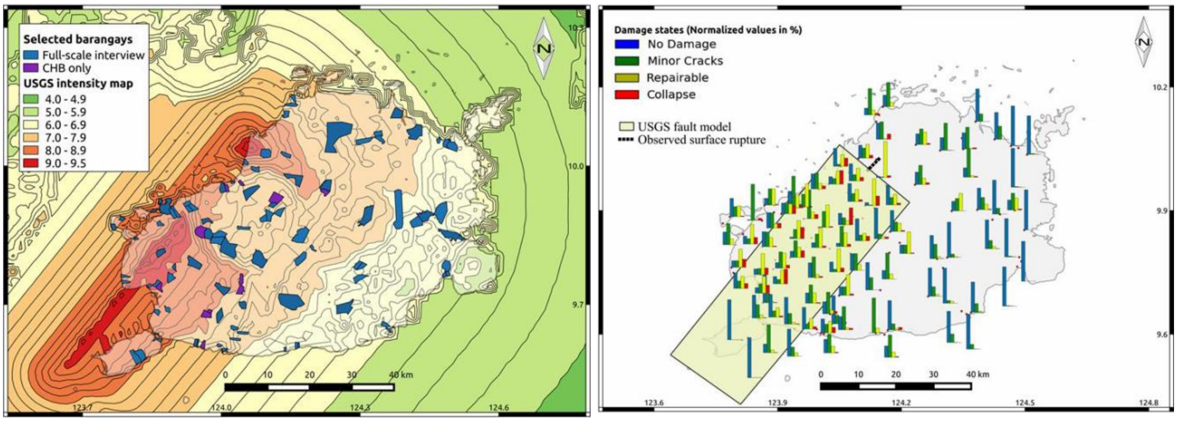


Figure 3. Left panel: Contours of intensity levels based on USGS shake map, with the island of Bohol and selected sites superimposed on the map. Right panel: Distribution of damage per *barangay* and the surface projection of the USGS fault model.

Different eras for MWS and C1 appear to exhibit similar performance. As a percentage of the total building count in each class regardless of era, 5% is in Collapse and 18% is in Repairable for C1 while for MWS, the respective percentages are 4% and 22%. On the other hand, CHB yields a poor performance with at least 25% of the total population in need of repair. This is most likely due to lack of steel reinforcement while some CHB walls followed a non-staggered fashion in layering and were supported by weak framing, as shown in Figure 4.

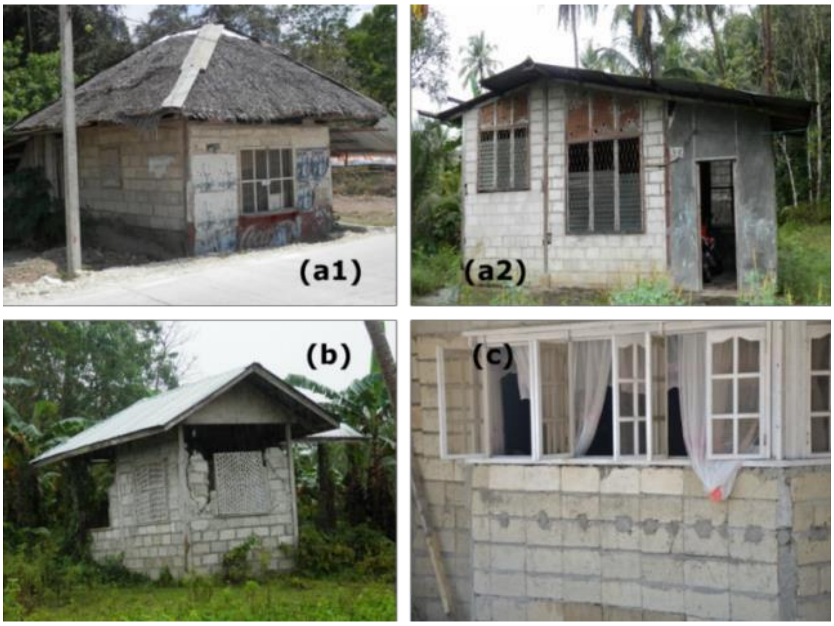


Figure 4. (a) Residential dwellings under the CHB building class; (b) Weak walls due to absence of steel bars; and (c) CHBs piled on top of the other various eras of construction. Moreover, data binning divides the total sample in each building class with respect to intensity contours, construction era and damage states. An intensity value is assigned to every village, depending on its geographical location. The fraction of the total number of buildings for a certain damage state in each intensity level and era are computed.

Figure 5 summarizes the proportion of damage in each bin. All building classes follow a general trend wherein severe damage states become visible with increasing earthquake intensity. High-code buildings are expected to yield an improved earthquake performance as opposed to lower and pre-code buildings, but this observation is clearly visible only for W1.

From these statistical estimates, the structure-specific fragility models for these building types are validated as depicted in Figure 6. The scatter plots of actual damage observations were compared against the existing fragility curves. Among the four building types, W1 established a better trend in probability estimates. This improves as the vintage progresses. Other building types show a wider scatter of probabilities with CHB displaying an irregular pattern of distribution especially for Minor Crack.

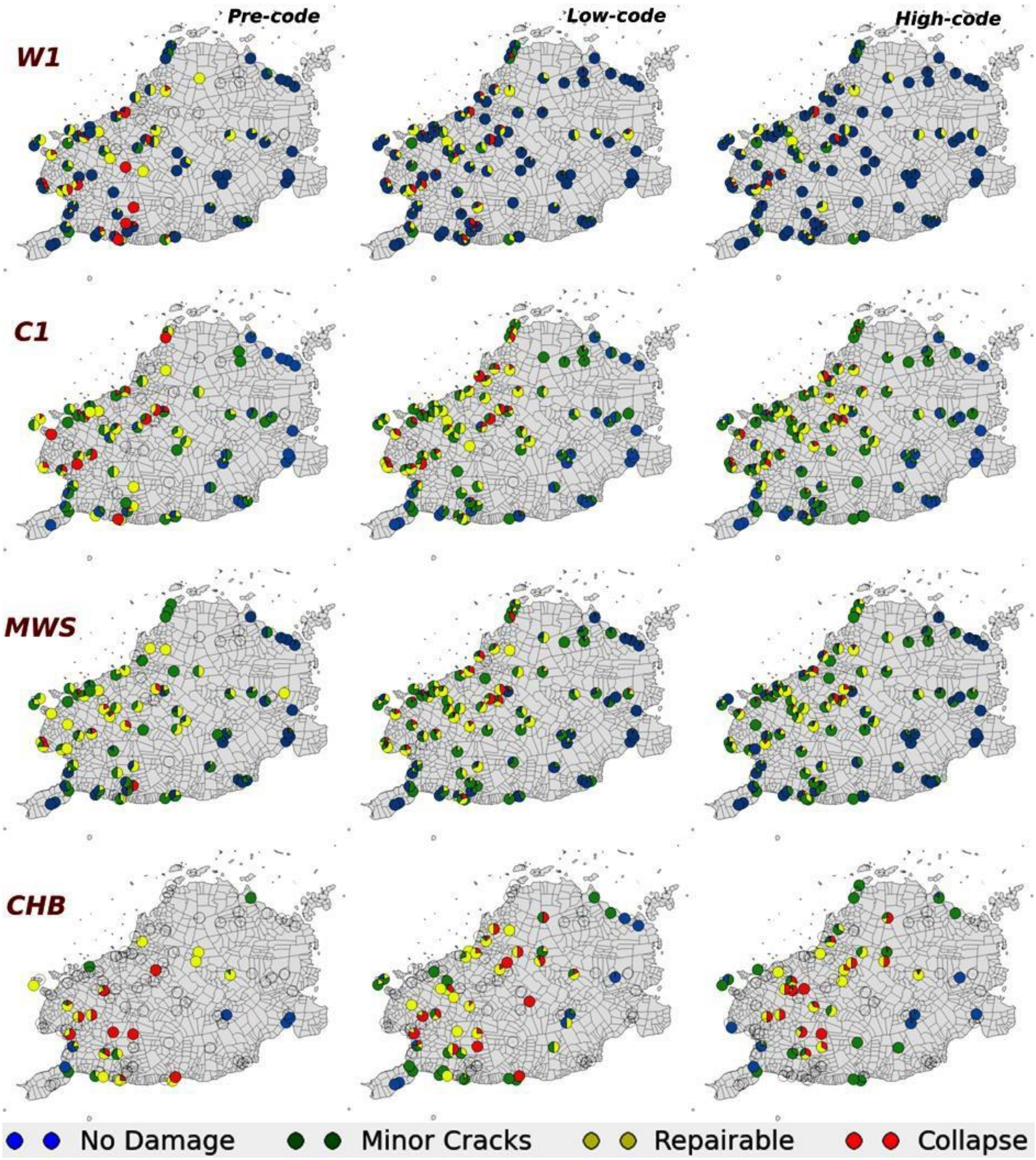


Figure 5. Earthquake performance of dominant building types in Bohol at

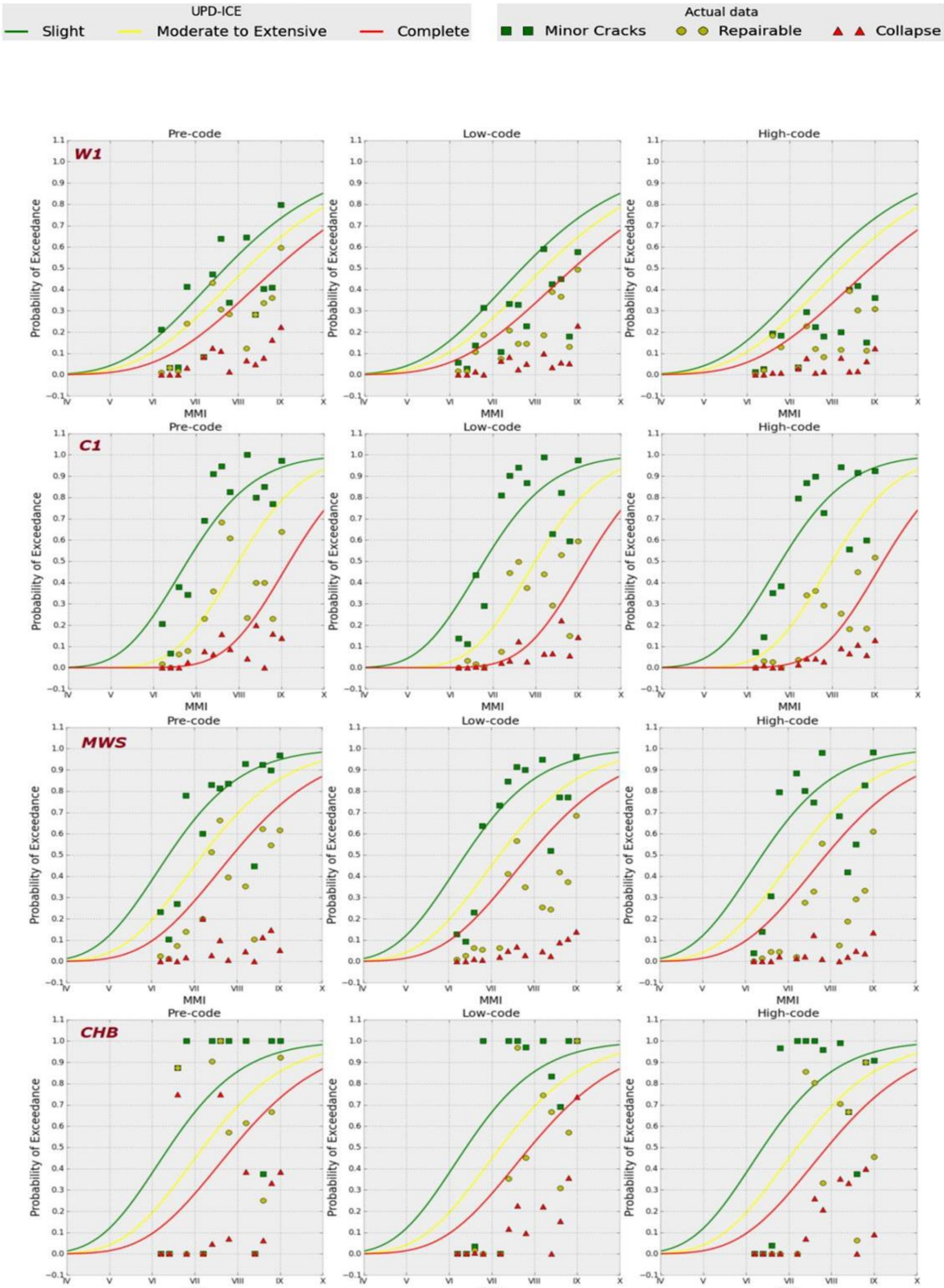


Figure 6. Validation of fragility curves for predominant building types in Bohol, Philippines

The foregoing analysis highlights the extent by which an earthquake source model can explain the pattern of damage when correlated with a complete exposure/damage database. Using the Bohol earthquake as a case study, this empirical approach allows placement of observational constraints on building fragility functions, where knowledge on how fragile and vulnerable buildings are become apparent.

CONCLUSION

An exposure/damage database has been assembled to account for the observed structural damage due to the M7.2 Bohol Philippines earthquake. Prevalent building classes that emerge from this database include wood (W1), confined masonry (C1), concrete hollow blocks (CHB) and low masonry skirt walls with wood (MWS). These include low-rise buildings sampled in both urban and rural settings at various construction vintages. Furthermore, the dataset features four well-represented damage states with good variation of intensity spanning from VI to IX.

For the earthquake performance of structures, W1 seems to be the most resilient building type among the four types evaluated in this study. W1 returns lower likelihood of exceeding the damage thresholds. The proportion of damaged buildings is less for modern buildings than the old ones, perhaps reflecting an improvement in seismic code over time. Also, structures in urban areas seem to perform much better than rural structures, probably due to the variation in construction practices.

Linking various facets of building components and construction to earthquake intensity resulted in improved seismic fragility modelling using empirical data. Although the fragility analysis presented herein is limited to the four predominant building types in the database, results show that in general the UPD-ICE fragility curves are conservative especially for severe damage states. However, estimates of probabilities at Slight/Minor Crack are higher as justified by actual damage observations.

For future undertakings, the vulnerability curves corresponding to selected building types can be validated. Information on costs of repair and reconstruction costs sourced from local engineers and contractors can constrain and update these vulnerability models.

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THE IMPACT OF THE ENVIRONMENT OF POST-EARTHQUAKES CHRISTCHURCH ON CREATIVE IDEA ENACTMENT: ENABLERS AND OBSTACLES

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ABSTRACT

Findings are emerging from a study designed to investigate what influences the enactment of creative ideas in a post-disaster setting. The study aims to identify and explore the personal and contextual factors that influence individuals to enact creative ideas for community or commercial benefit in the post-quake environment of Christchurch, New Zealand. How the participants responded to the environment, and how the post-disaster setting impacted on their idea enactment, are the focus of this study. The project also aims to investigate which factors hindered or supported the process of putting novel ideas into practice. This is an exploratory study that will predominantly utilise data gathered from approximately 45-50 participants during in-depth interviews. The preliminary findings from the initial coding and broad analysis of the first 30 interviews will be discussed in this paper, with a particular focus on what appears to have enabled or hindered the enactment of creative ideas in post-quakes Christchurch. A key emerging finding is that a desire to promote and demonstrate values is the predominant driving force for many participants. This could indicate that developing the financial robustness of creative ventures - that many creative ventures depend on for survival - is a secondary consideration. If this is the case, the longevity of these enacted ideas may be inhibited, ultimately curtailing potential societal benefits. Also, the fact that over 60% of study participants identify achieving social benefits as a primary goal suggests that a post-disaster setting, in which increased concern for community has been a notable feature, does impact on creative idea enactment (Rowney et al, 2014).

Key words: Creativity, Disasters, Resilience, Christchurch, Innovation

INTRODUCTION

Creativity has been a significant topic of interest to researchers of resilience (Coles & Buckle, 2004, Colten et al, 2008, Metzl, 2009). In the context of this paper, creativity is defined as the production of novel and useful, or appropriate ideas (Hennessey & Amabile, 2010).In recent years there has been a greater focus on the social psychology of creativity, or how individuals' interaction with their environment can lead to creative output (Hennessey & Amabile, 2010). As the social psychology of creativity has developed, a need to more specifically account for the role of place became apparent. 'Amabile (1983a, 1983b, 1996) proposed a comprehensive theory of creativity that integrated conceptualizations of intrinsic motivation and the social environment with the cognitive and personality constructs that earlier theorists had emphasized'. That theory is the componential theory of creativity (Amabile & Pillemer, 2012, p.10). While such a theory appears pertinent to this study, much of the related literature refers to creativity within organisational environments. Little was found referring to either the social psychology of creativity or the componential theory in relation to a post- natural disaster setting.

The increase in creativity that emerged after the Christchurch earthquakes has been both nationally and internationally recognised (McClure, 2014). This paper discusses the emerging findings of a partially completed doctoral study that focuses on identifying the personal and contextual influences of those who have been primary actors in the enactment of a creative idea in Christchurch, New Zealand since September, 2010. What led to the decision to act on – as opposed to generate or develop - the idea is of primary interest. Another key question of the research is to determine what factors have enabled or impeded the enactment of the creative ideas in the post-disaster setting. It is believed these factors are relevant in the context of building resilience. The preliminary findings in relation to these factors will be outlined in this paper.

METHODOLOGY

This is a qualitative exploratory study within a constructivist or interpretivist paradigm. This approach assumes a relativist ontology, as based on the perspective of Blumer's (1969) symbolic interactionism, which espoused the notion that meaning was revealed through human interactions with their society and contrasted with the dominant positivistic approaches of the time (Mills & Birks, 2014, p.5).

This methodological approach has been selected due to the study's exploratory nature. This means methodologies and methods that offer, as stated by Hesse-Biber (2010) "a multi-layered view of the nuances of social reality" and "tend to be open to new information" (p.456) are required. The findings will emerge through inquiry that will generate the analysis and interpretation.

The participants of this study have all been involved in the enactment of a novel idea that has resulted in commercial or community benefit. The degree of novelty of each idea varies, from entirely unique to not known to have previously occurred in Christchurch.

To date, 30 participants have been interviewed in semi-structured, in-depth interviews. Participants were asked to answer questions in relation to the following topics: the creative idea itself, personal and contextual influences, motivational factors, obstacles and enablers and their experience and views in relation to the earthquakes and resulting environment.

The sample is comprised of 15 men and 15 women. Two of the sample group are in their sixties, 7 in their fifties, 6 in their forties, 11 in their 30s and 4 in their twenties. Fourteen of these participants were involved in primarily commercial ventures, while 6 could be considered commercial for the sake of remaining in existence, at least. Another participant was acting in their role as an employee of a government department and the remaining 9 were operating for either a social enterprise, not-for-profit organisation or creating a public art work. All except two ideas were enacted prior to 2014.

Eighteen of the participants were purposefully approached due to being featured in the media in relation to their creative ideas. The other 12 were either suggested by other participants (snowballing) or referred by organisation leaders in a position to know individuals who would meet the study criteria.

Written transcripts of the interviews were coded using Nvivo, as well as manually–through the search for repeated themes and topics (Lofland et al., 2006). At this stage of the study, broad coding has led to the identification of data that relates to the overall objectives of the study. However, the data have been more rigorously coded to specifically determine the enablers and obstacles to creative idea enactment in the setting. In the results section, each participant is identified by one of the following codes that precedes a numerical identifier. The code indicates which category each of the ideas was intended to predominantly benefit, noting there is some overlap. The emerging findings revealed in this paper are the *perspectives* of the 30 participants.

Code	**Type/Purpose of Creativity**
S	**Social/community**
C	**Commercial**
SC	**Social and commercial**
A	**Art/Entertainment**

THE SETTING

Christchurch, New Zealand's second largest city, with a population of approximately 370,000 people, was devastated by a series of seismic events that began with a 7.1 magnitude earthquake on 4 September 2010. Five months later, on 22 February 2011, the most devastating of the earthquakes, a shallow 6.3 magnitude aftershock centred near the central city resulted in the loss of 185 lives (Potter et al, 2015). As well as the tragic loss of lives, more than 6600 people were injured during, or within the first 24 hours following the most devastating earthquake of 22 February, 2011 (Ardagh et al., 2015). To compound the situation, 'the ongoing aftershocks caused a disrupted environment in which to recover' (Potter et al, 2015, p.6). Many of the city's heritage buildings, housing and infrastructure were destroyed or made unusable for a long period. The following sections will outline some of the emerging findings with regard to the enablers and obstacles of creative idea enactment in Christchurch during this tumultuous time.

PERSONAL APPROACHES

Initial analysis of the data reveals a desire to act on ideas that demonstrate or promote personal – particularly social and environmental – values. These beliefs could be seen to have enabled enactment due to a determination to achieve a personally meaningful purpose. Nineteen participants talked of being driven or inspired to act in support of social, charitable or environmental beliefs. One, a social enterprise operator who has enacted an idea that provides greater peace-of-mind to rubbish recyclers, said 'I don't want to end my life knowing that I chose to ignore the calling.' (SC22). A picture is emerging of participants determined to act on their beliefs, sometimes to a degree that caused psychological discomfort. 'It was like I was possessed. I worked all the time. There was so much meaning in finding a solution to that problem. The problem for me was very distressing' (SC27).

It appears the ability to successfully balance the desire, or passion, for the idea with the ability to strategically enact it with the goal of financial reward, is important. 'I think thinking outside-the-box is great, but actually it's about results at the end of the day' (C7). Another participant who established a brewery housed in a uniquely crafted building of unprecedented style, expressed this, along with the need to have a point of difference. 'Creativity is about harnessing something that I'm passionate about that I believe is going to be a financial success as well. Some people will go 'I'm going to paint these pictures and I'll probably only sell one a year, but I'm happy'. But I'm not like that…. it's got to be commercially successful and it's got to be different' (C10). One of the younger participants, whose idea had almost run its course, said 'I've always more enjoyed helping people than making a lot of money. So if people are like well, I can't afford to pay you all up in front…..there was a lot of leniency when I first started, and it meant that I got big, big crowds of people but it wasn't particularly profitable to start off with' (C17). Moving forward with this study, the apparent need to alleviate a perceived stigma associated with wealth accumulation and material aspiration will require further investigation in future interviews. It may be that being driven by the goal of wealth accumulation, particularly at the expense of social or environmental benefit, has become somewhat personally and socially distasteful in a post-disaster setting.

THE SPIRIT OF RECOVERY

One aspect of the post-disaster setting in Christchurch that could be seen as an enabler of novel idea enactment was the prevalence of a spirit of recovery (Rowney et al, 2014). Potter et al (2015, p.11) state 'residents reported that the earthquakes helped increase sense of community, and also contributed to improving social connectedness'. The way people worked together inspired those setting up unique businesses. C7 reveals '…one of the things that gave us the confidence to do this was during the earthquakes we saw the best of people…..this overwhelming…shocking level of support from humans, and we wanted to capture that in an environment and see if you could replicate that and continue and build it.' Another participant was pleased with community assistance given without the expectation of great reward. 'I had two guys who took two weeks holiday to come up here and help us out…I'd give them a beer afterwards and half a scoop of chips for lunch…' (C8) However, as time progressed some expressed that the community spirit began to wane, as people became disheartened or unhappy with insurance outcomes. It became more difficult to get assistance: '…people are tired. And you're always asking for help from the same people.' (A1)

THE NEW NORMAL : A PROVIDER OF EXCITEMENT AND OPPORTUNITIES

The physical and social environment that is post-earthquakes Christchurch is, itself, responsible for enabling the creative activities this study focuses on. 'There is a lot of creativity that has sprung out of that necessity…that desperation' (S23). Twenty-one of the participants interviewed enacted an idea directly prompted by the after effects of the earthquakes. 'It was a frightening time, and it was sad, but I was more excited than anything….it gave me a real opportunity' (SC14). Some ventures evolved in response to need: '…we had no intention of carrying on but people kept getting in touch through Facebook or email and saying 'the libraries are closed we need your help to do a book project' or 'all the cinemas are closed'. Let's do something.'(S4) Others developed unique ways of exhibiting art, or providing places to work because lost spaces needed to be replaced. 'The reason [our project] exists is because we needed somewhere for those people to work. Due to a shortage of usable office space most rents had doubled in town. There was nowhere to go, so we were desperate' (C7).

Others saw the chance to make their mark. 'Christchurch, I think, is in the moment of self-definition. For me this is the most exciting city in the world right now, where someone like me, who's kind of a nobody I have a chance to have an impact on the shape and flavour of this city' (S26). Some came to the city because they knew it offered a unique opportunity: 'I think with Christchurch it's that smaller city and all the talk about rebuild….it gave me the realisation that 'Yeah, I can be a part of that'. What city in the world gets the chance to rebuild their CBD? (C24) One experienced business person, looking for a way to capitalise on an existing investment said: 'Very quickly….even the first few minutes after the earthquake I could see the potential….money, insurance money, council with their guard down, now's the time to get them. I had all that running through my head. I was right on it. Within minutes.' (C30)

LESS CONSERVATIVE, MORE CREATIVE

The interviews revealed that there seems to have been an attitudinal shift away from more traditional and conservative approaches taken in pre-earthquakes Christchurch. There is 'more appetite for the new and unusual' (S26) and what 'used to be a slightly stuffy city….a little bit out of date' (C8) has been 'picked up by the collar and rattled around (A21). There is acknowledgement that conservatism has not been completely eradicated: 'There's still quite a lot of conservatism, but it's a lot easier to go around it and to find people who will champion whatever' (S26). However, something appears to have changed as a response to the post-disaster environment that leads to greater likelihood of successful novel idea enactment: 'A lot of the things we've done would have been possible before the quakes. They would have been harder practically….like siting them or whatever…but of course they would have been possible, it's just that with people going through that collective experience with the trauma of the earthquakes, it changed people's perceptions about what's possible…. the city is now more creative.' (S20)

INTERACTIONS WITH LOCAL AND GOVERNMENT AUTHORITIES

Participants who have had to deal with the Christchurch City Council share a mixed range of perceptions with regard to their interaction with local government. Some chose to avoid them (C5 and C6), believing they would rather 'fly under the radar' (SC14), than attract potential problems brought about by a deliberate approach. Overall, more favourable than negative comments were made. Said one creative network developer, 'We have a really good group of people who are not there for political glory, who actually came in at the hardest possible time and are really doing their best because they believe in what the city can be.' (S26). Another, who has interacted with councillors regularly claimed 'the general ethos….at least with the particular team that we usually work with, has been to try and solve those problems and be facilitative.' (S4). Some were sympathetic: 'I think the city council probably suffers from a lot of the same issues as we do…..silos, people not talking to each other' (S23). A number expressed the perception that the service you received was dependent on which individual was interacted with: 'I think the relationship is everything. And I probably haven't found my relationship in the council.' (S23). Some believed certain councillors and council workers showed personal favouritism with regard to which projects were supported: 'Some of the councillors are more open to transitional projects' (SC25). And despite applying for funding: 'We're the only show [of its kind] in the country that isn't supported by the council' (C16). Others were dissatisfied with one council department, while satisfied with another: 'But I did find that as well as the epic war with building consents that put ten years on my life, at the same time I had a lovely experience with the planning department' (C8). One participant knew how to take advantage of the situation: ‘It was a clear run. Because I was the only person spending money, I walked in the door and they said ‘this is great’ (C30).

The participants who were prepared to comment, and some would not go into detail, generally expressed dissatisfaction with the central government established Christchurch Earthquake Recovery Authority (CERA). An assortment of statements made in relation to any interaction with CERA evoke similar sentiments: ‘I don’t want to say too much about them really. It’s ridiculous if it comes down to one person and he doesn’t like it. I don’t like the thought of central government controlling Christchurch’ (A21). ‘Central government has been worse than you can possibly imagine to work with’ (S4). And: ‘It’s really hard because CERA are involved…. I forgot how hard this is going to be’ (SC12). It seems fair to assume that participants of this study to do not perceive CERA to be enablers of creative ventures in the post-quakes environment.

Other enabling factors included the monetary grants that helped support some businesses during the period immediately after the February earthquake (C3, C15, C18, SC27). ‘I remember, at the time, you had a grant…small businesses…and that really kick-started…it was a sort of lump sum for three months, and that was amazing. That was enough to get a bit of advertising started….it was a good thing’ (C3). Others received council funding (S4, C7, SC12, S20, SC22, S23 and S26) or government support from the likes of New Zealand on Air (C28). A scholarship benefitted another creative enterprise. ‘I got a UC innovators summer start up scholarship. That gave you $5000 to create the enterprise….everything was just so well done and brought together in a timely way’ (SC29). Others believe they have been unfairly declined council funding (SC25 and C16). And, of course, a number of ventures were enabled by insurance pay outs: ‘I ended the fight with my insurance money quite quickly. I settled for a little less money to get the cash in the bank’ (C30)

Networks and agencies were utilised by a number of the interviewees. The agencies mentioned were generally designed to enable the establishment of creativity in post-quake Christchurch. They appear to have served that purpose. Some have specific roles: ‘The whole idea is that Life in Vacant Spaces get really good at navigating that bureaucracy so that other people don’t have to’ (S4). Support for outside-the-box activities is available: ‘Basically we’re saying there’s a whole community here. You’re not crazy just because you have a crazy idea. There are a lot of people who are crazy, just like you, and if you want to do this crazy thing we’ll help you.’ (S26). Association seems to lead to further benefits: ‘Gap Filler, Life in Vacant Spaces and Ministry of Awesome … they’ve sort of bought me into that network as well, and it’s fabulous. Even my accountant’s a social enterprise...they said ‘Just choose what discount you think you need’. When does that happen? (SC22). ‘So I approached Gap Filler and they just said “yeah, you can do it” and I just kind of went to them and they were like ‘just do whatever’ (SC14). The support offered to, especially transitional projects and those enacted by the socially-minded, have received invaluable support from these – themselves – creative ventures.

CONCLUSIONS

At this stage of the study, a broad analysis of 30 transcribed participant interviews reveals findings that indicate the post-disaster environment of Christchurch, New Zealand has been an enabling factor in the enactment of creative ideas. Not only did the city experience a greater level of community engagement, it became more open to less conventional ideas. These factors seem to have presented an opportunity for those with a creative mind set to put unique ideas into practice. Data reveal that a range of support options, including those from local government, have been valuable, although those involved in the so-called transitional projects more often claim to have benefitted from this than do other participants. Information gathered from participants with predominantly commercial goals support another emerging finding; that those who have more overtly considered the financial viability of their creative ideas –at least as much as the potential for social or other benefits - are more likely to sustain the benefits produced. A potential limitation of this study is that a broad enough range of enacted creative ideas cannot be found to investigate. However, although the transitional projects are more prominent, and their enactors more seasoned commentators, others – once identified- seem easily encouraged to share insights. The next stage of this research will involve increasing the sample size to further investigate the emerging findings related to drive and the ability to sustain creative ventures (DiCicco-Bloom & Crabtree, 2006). As it is now five and half years since the first earthquake, questions about how creative projects plan to evolve and overcome what has been described as a threatening 'creative fatigue' (S20) will also be asked. If this path is followed then perhaps ways of preserving the spirit and benefits evoked by those bold enough to instigate a unique idea can continue to contribute to the building of a resilient Christchurch.

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ACCEPTABLE FLOOD RISK IN RESIDENTIAL LAND-USES IN IPSWICH, QUEENSLAND

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ABSTRACT

The role of land use planning in mitigating risks from natural hazards, including flooding hazards, while promoting a better quality of life for communities is well practiced. In recent decades, there has been a tendency to use the 1% Annual Exceedance Probability (AEP) flood to represent minimum level of flood-risk occupants should be exposed to. However, larger floods can and do occur, such as those which devastated southeast Queensland in 1979, 2011, 2013, Victoria 2010, 2011 and Newcastle in 2015. The outcome of contemporary land-use planning, to some level, has increased flooding risk of residential areas across Australia. Further to this, the perceptions of floodplain residents who may experience the impacts of flooding are rarely explored when assessing acceptable risk levels that inform the establishment of flood-prone land use policy. From this, what may actually constitutes an acceptable level of risk for residential development is a vexed issue.

This paper constructs a research approach that aims to analyse determinants of flood risk acceptance and their interdependence. Based on theory and previous empirical evidence, we develop an analytical model that involves personalised risk assessment, based on: cognitive/affective evaluations, stable psychological variables (such as trust) and contextual/personal variables (such as age, gender, residency period, and geographical differences). This model will be tested through an Australian survey data using multivariate analysis techniques that apply structural equation modelling.

Key Words: Flood risk acceptability, Flood-prone land use, Model, SEM, Ipswich

INTRODUCTION:

Establishing 'acceptable' risk standards is a decisive element in the practice of flood risk management ensuring ecologically sustainable land planning and building flood resilience (Godber, 2002). Research within the broader context of flood risk perception has tended to concentrate on why people decide and persist to invest/live in flood-prone lands; how they evaluate and perceive location-related risks, benefits and land-use regulations; and what socio-economic and demographic circumcentres make them more vulnerable to and/or prepared for flood hazards (White, 1945,1962; Fordham,1992; Bollens,Kaiser & Burby, 1988; Godber, 2002; Vogt,Willis & Vince, 2008; He, 2009; Ludy & Kondolf, 2012). Nevertheless, the concept of flood risk acceptability remains vague in terms of how it is conceived and rationalised in the context of flood-prone land use.

The determination of acceptable risk thresholds, at an individual level, is not straightforward, and it is a relative notion. In essence, as each individual holds a unique view towards the environment they choose to occupy, with its location-related risks (Fischhoff, 1994; Vrijling, Van Hengel & Houben, 1995; Bell, Glade & Danscheid, 2005). Furthermore, the determination of risk acceptance involves numerous complex interrelated factors, including: the perception of risk and benefit (Starr, 1971; Fischhoff, Slovic & Lichtenstein, 1979), affective evaluations (Merk and Pönitzsch, 2016), and trust in entities that promote, regulate and communicate the risk to individuals and communities (Gough, 1990; Eiser, Miles & Frewer, 2002; Poortinga & Pidgeon, 2005; Bronfman, Vázquez, & Dorantes, 2009; Bronfman & Vázquez, 2011).

In this study, we aim to analyse the nature of the interdependence among the determinant factors affecting the degree of flood risk acceptance in occupying flood-prone residential land. This paper extends previous research and develops a new analytical model describing individual's perception and acceptability of flood risk. At a later stage, this model will be tested through a structural equation modelling tecniques.

The rest of the paper is structured as follows. In Section 2, derives the analytical model for our analysis. The study area and background are shown and discussed in Section 3. Section 4 lays out the survey, the measurement concepts, and the details of the analysis. Section 5 concludes and discusses potential implications.

ANALYTICAL MODEL:

The proposed model builds on established theories of risk perception and attitude formation and combines them into a comprehensive framework. It accommodates both the psychometric paradigm (Fischhoff et al., 1979) and the affect heuristics (Finucane, Alhakami, Slovic, & Johnson, 2000) in assuming that risk can be subjectively defined (via both cognitive and affective routes) by individuals who may be influenced by a wide array of psychological, institutional, and contextual factors (Slovic, Finucane, Peters, & MacGregor, 2004;Slovic & Peters, 2006; Slovic, 2010)). The full framework is depicted in Figure 1, which consists a set of diverse variables linked by solid arrows that show direct (hypothetical) correlations and dashed arrows that show indirect correlations. Its components are described below together with previous empirical evidence.

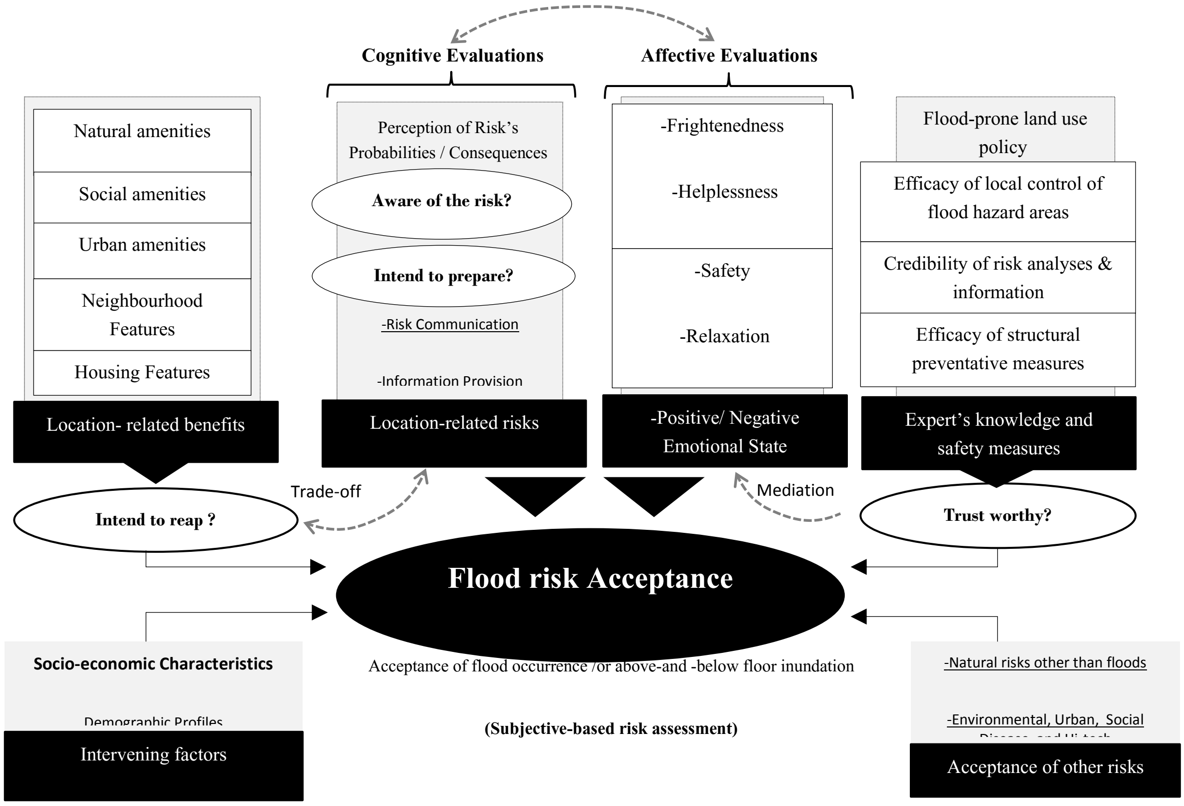

Figure 1. The determinant factors of flood risk acceptance in the context of flood-prone land use: Analytical model

From a theoretical perspective, the proposed model describes a dynamic system in which the level of acceptable risk can be altered by changes in both influential factors and the correlations among them. More precisely, in the individual's psychophysical/cognitive systems, the balancing of these factors and their aspects linked to the physical system (the flood-prone environment) defines a level of acceptable risk that can be seen as, in essence, a subjective assessment. This level is therefore dependent upon the chosen land use practices of a particular flood-prone environment, as well as, the psychophysical/cognitive systems that steer how individuals perceive location-related risks, and therefore react and undertake risk preparedness measures.

Within the proposed model, the centrality of risk perception is of vital importance and is formed by evaluating the correlations among qualitative risk characteristics: awareness, worry and preparedness. Empirically, many previous studies has sought to investigate the correlations among these characteristics (for instance, (Raaijmakers, Krywkow, & van der Veen, 2008; Maidl & Buchecker, 2014; Meng, Liu, Liufu & Wang, 2013). Further to this, evidence from previous empirical studies has sought to demonstrate the influence of some intervening variables (i.e. informational, contextual and personal circumstances) on individual's perception of flood risk and hence lessen/strengthen their willingness to accept that risk (Pagneux, Gísladóttir & Jónsdóttir, 2011; Burningham, Fielding & Thrush, 2008; Prelog & Miller, 2013; Botzen, Aerts & Van Den Bergh, 2009; Armaş & Avram, 2009; Lindell & Hwang, 2008).

Nevertheless, the determination of flood risk is not explained solely with respect to the perception of location-related risks. More complex decisions emerge when the individuals seek to balance their perception of locational risks with their residential satisfaction (He, 2009) and perception of derived locational benefits, such as natural amenities and waterfront activities –i.e. observing, dining, hiking, swimming, fishing, boating and so on-(Vogt et al., 2008; Guofang Zhai & Ikeda, 2006). Implied in this hypothesis is that the perception of derived benefits cannot be linked directly to the criteria of risk acceptance without undertaking a trade-off process first. Simultaneously, when the individuals who strive to interpret standards of acceptable risk decreed on them by entities that regulate the risk, and then to harmonise these with the levels they obtain from their own perceptions (Gough, 1990). In light of this, there is extensive evidence that trust in administrative bodies that regulate the risks is intimately the determining factor in flood risk perception, acceptability and preparedness (Frewer, Howard, Hedderley, & Shepherd, 1996; Whitmarsh, 2008; Terpstra, 2011; Su, Sun & Zhao, 2015).

Previous studies on the acceptability of flood risk highlighted the impact of multiple determinant factors on individuals' willingness to accept flood risk, and consequently their attitudes towards the risk. Table 1 below summarises some key findings provided by these studies.

Table 1. Summary of empirical studies on flood risk acceptability.

Author (Year)	Research Design	Research Variables	Key findings
Goober (2005)	-Gold Coast OLD/Australia -130 households -Written surveys -Tabulation and basic descriptive analysis	-Perceived likelihood -Awareness -Preparedness -Responsibility -Risk information -Trust -Flood disaster experience -Length of residency -Educational level Measurements of acceptable risk -Perceived floodwater depth -Potential impact consequence *(moderate/minor/major)*	-The perception of the consequences associated with flood hazard may be a more effective indicator of risk acceptance than quantitative estimates, and even perceived voluntariness of exposure. - Flood risk awareness has no great influence on flood risk acceptance. *(acknowledging the possibility of flooding)* -When considering a range of specific land-use purposes, variations in acceptable flood risk may emerge.
Motoyoshi (2006)	-Tokai Region of Japan -4,000 households -Written and face-to-face surveys - Structural equation modelling	-Risk perception -Worry (Fear) -Interest or awareness about flood hazards and mitigation measures -Consciousness of self-responsibility -Preparedness -Trust in administrative bodies -Zero risk expectation -Consciousness of general risks -Consideration of society	- Consciousness of the acceptance of flood risks is directly and positively correlated with the consciousness of self-responsibility -Taking disaster preparedness measures is related to an attitude that is to perceive and accept disaster risks. - When people depend on measures to prepare hardware structures, and believe that science and technology make it possible to achieve zero risk, they perceive that it is impossible to accept flood risks.

Zhai and Ikeda (2008)	- Toki-Shonai River region of Japan -500 households -Phone surveys -Covariance structure analysis -Rational Actor Paradigm	-Flood risk perception: frequency and consequences of flood risk -Housing characteristics -Residential attributes -Activities at waterfront (benefits) -Multi-risk context (natural disasters other than floods, environmental disease, urban, and social risks) -Preparedness for disasters -Social measures	-Whether a risk is accepted depends on its perceived importance relative to others in a multi-risk context as well as the balance of its cost and benefit. - Preparedness for flooding is a factor for the acceptability of above-floor inundation. - No statistical evidence indicates that geographical differences, like the distance to a river and the regional differences between the upper and lower reaches of the basin, affect risk acceptability
Molino and Karwaj (2012)	-QLD and NSW/ Australia -400 responses -Online survey - Basic descriptive analysis	- Perception of flood risk - Flood disaster experience -Acceptable occurrence of flooding for above- and below-floor inundation	-The consequences of flooding are a significant determinant of acceptable risk. -Those who have previously experienced flooding at their current property are more likely to accept flooding than others.

However, none of the above studies have explicitly investigated the nature of the interdependence among the determinant factors affecting the degree of flood risk acceptance. For example, it is not clear yet whether the cognitive pathways are more prominent in directing the net correlations rather than affective pathways; whether the level of residential satisfaction is the consequence or the cause of flood risk acceptance; and, generally, whether the integrated correlations are direct, indirect (mediated via other factors) or spurious. Further to this, the relative importance of these factors in the net correlations remains vague. To address such problematic matters, there is an imperative for empirical studies assessing the performance of our proposed model on the basis of embedding all influential factors and for different rural and urban contexts. We can better understand the correlations among different psychophysical/cognitive scales of flood risk acceptance by conducting more extensive multivariate and mediation analyses (e.g., Structural Equation Modelling).

The analysis of this research is guided by the following hypotheses:

A discrepancy exists in the perception of acceptable risk against the current context of management and land-use planning.
Positive and negative affect, as well as the perception of risks and benefits have a direct effect on flood risk acceptance. They also mediate the influence of other relevant variables –including trust, risk aversion (resettlement), residential satisfaction, consciousness of responsibility, contextual/personal circumstances and attitudes (preparedness intentions). However, these variables can also influence acceptance directly (not only via an altered cognitive/affective evaluation).
Affect is the strongest driver in flood risk acceptance. Affect influences both risk and benefit perception. While positive affect increases benefit and decreases risk perception, the reverse is true for negative affect.
Residential satisfaction is a stronger predictor (a cause rather than a consequence) of acceptance and benefit perception.
The flood risk acceptability depends on not only the factors of flood risk itself but also other types of risks involved in our modern society. The severer the flood risk is perceived or the less other risks are recognized, the

lower the acceptability of a large chance of flood occurrence becomes, and vice versa.
Flood risk perception is mainly related to the flood consequence perception (much more than that of the flood risk perception to the flood probability perception).
The awareness about and preparedness for flooding impact the flood risk acceptability to some extent. Those who intend to prepare much more for flooding may have lower flood risk acceptability. While those who are more sufficiently aware about the risk may have higher perception of the actual levels of flood risk they may be exposed to and therefore, they will not be willing to accept a high level of flood exposure within their suburbs or to their properties.
Those who trust the acceptable flood risk benchmarks -established by the local government, for land-use within flood-prone areas- may have lower perception of the actual levels of flood risk they may be exposed to and therefore, have higher flood risk acceptability.
The contextual/personal factors such as distance to a river, income per capita, education, and building style may be insignificant with respect to flood risk acceptability.

STUDY AREA

Ipswich Local Government Area ILGA, which is the focus of this study, is a dynamic area in South East Queensland with a wide range of topography, changing demographics and diversified industries that may be occasionally subjected to the impact of flood hazards. Established on a floodplain, the city of Ipswich (*Queensland's oldest provincial city* (Coster, 2008) has experienced 20 events exceeding the town gauge reading of 11.70 m (major Flood). The three largest floods in Ipswich occurred in February 1893 (also known as the '*Great Flood'* or the '*Black February Flood'*), January 1974 and January 2011 More recently, the January 2013 flood was another timely reminder of the potential impact of flooding on Ipswich. The residents affected by the January 2013 flood are many of whom have only just recovered from the January 2011 flood (IPS:07, 2013).

Geographically, most of ILGA lies within the Bremer River catchment. Small areas to the north and east of the city drain directly into the lower Brisbane River near Moggill. The Bremer River is the second largest tributary of the Brisbane River, with a total area accounts for approximately 1790 km2 (ICA, 2011). The more than double increase in the number of developed properties affected in Ipswich is the result of the increase in urbanisation on the floodplain over the intervening past period (Middelmann, Harper, & Lacey, Online; ICA, 2011: p 19). On the Ipswich floodplain the number of dwellings has increased from approximately 26,409 in the 1990s, to just over 63,137 in 2011 (ABS, 2011). Not only has this development increased the number of occupied private dwellings potentially 'at-risk' from flooding, it estimated that by 2031 the area will attract a new population of approximately between 380,487 and 580,682 persons (for the most flood prone suburbs in Ipswich) many of whom have little or no experience with flooding on the Ipswich City.

SURVEY DESIGN

A criterion for selecting the survey area is that the respondents live in suburbs located within the designated flood zones that had experienced flooding and at risk of serious floods. The sample frame covers the following suburbs: Gailes, Goodna, Collingwood Park, Barellan Point, Moores Pocket, North Booval, Bundamba, East Ipswich, Brassall, Lehichardt, and One Mile.

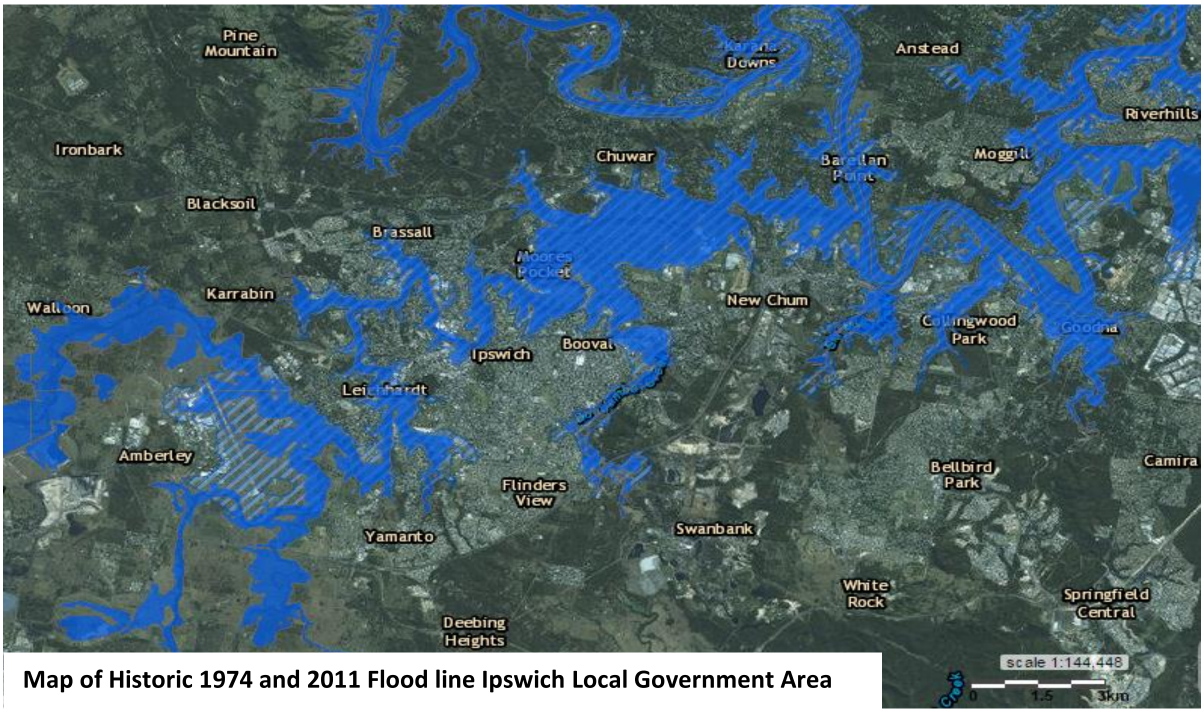

Figure 2: Location of the survey area within the Lower Brisbane & Bremer river catchments. Source (QG-DNRM, Online)

Probability sampling through multi-staged clustered techniques was applied to sample participants from the selected suburbs. This sampling process is similar to the techniques used in the field of flood hazard perception research following (Godber, 2002; Dewi, 2007; Horney, MacDonald, Van Willigen, Berke & Kaufman, 2010). We conducted a prior power analysis in order to compute the sample size that is appropriate to obtain a sufficient statistical power and to detect effect on the proposed Structural Equation Model (SEM). Using Cohen, J. (1988) and Westland, J.C. (2010) as references for the formulas; we found the minimum sample size required for this study is about 670 (given that the estimated number of low-density residential properties located within the designated flood zones in the study area is approximately 3000 (sample frame). And also given that the number of observed and latent variables in the model are (63) and (9) respectively, and the anticipated effect size is (0.1), the desired probability (0.9) and the statistical power level is (0.05)).

Residents who have been involved in the decision-making of acquiring/living the property, and above the age of 18, were invited to participate in the survey. The survey methods involved the use of structured and predefined (close-ended) questions that were based around six themes as outlined in Table 2 below.

Key Themes	Items
Residential Satisfaction: Benefits Perception	1.Visual amenities (view from the house/apartment) 2.Natural amenities (availability of nearby natural recreation opportunities like fishing, green Spaces, parks, clean air, etc.,) 3.Social amenities (travel distance to friends, family or other social relationships) 4.Urban amenities (travel distance to your workplace; school/day care; retail stores/ public transportation; and health-care facilities) 5. Quietness/Safety of neighbourhood. 6. House features (visual attractiveness; architecture, size.) 7. Price or rent you paid for your house
Risk Perception	Awareness (Cognitive evaluations): - Previous disaster experience - Familiarity with the following items: 1. The potential factors that contribute to flooding in Ipswich 2. The anniversary of the 1974 and 2011 floods 3. Household Emergency Plan issued by Ipswich Local Council 4. Ipswich Council's Property Specific Flood Report 5. Ipswich Council's Interactive Flood Awareness Maps 6. Wivenhoe Dam and the protection afforded to Ipswich City
	The perceived frequency of above-and below-floor inundation: (Once a year or once in 2, 5, 10, 20, 50, or 100 years) Worry about the consequences of flooding, e.g: 1. Substantial damage to public facilities (roads, parks, etc.) 2. Disruption of electricity, telephone, internet or water supplies. 3. Substantial damage to your house or possessions. 4. Pollution, soiling of the house. 5. Financial loss. 6. You and/or your family will face a life-threatening situation. 7. Your daily life (job and other daily routines) will be disrupted. 8. Inconvenience of recovery process after flood.
	Affective Evaluations (frightenedness, helplessness, annoyance, restlessness, safety, relaxation, hopefulness, joyness)
Preparedness Intentions	1. Assembling an emergency kit (including water, food, a battery powered radio, a first aid kit, etc.). 2. Collecting information about flood consequences, evacuation routes, and safe/high locations. 3. Making a to-do list that is helpful in case of an evacuation or flood 4. Making agreements with family, friends, and neighbors on how to help each other in case of evacuation/flooding. 5. Acquisition of sandbags or other barriers against water. 6. Elevating floor levels of the habitable rooms above ground level. 7. Renovating building to make it more flood resistant 8. Purchasing flood insurance.
Trust	1. The safety provided by raising floor levels up to the adopted flood regulation line plus a freeboard. 2. The efficacy of local control of flood hazard areas (zoning, subdivision regulations, planning process and building code system). 3. The credibility risk analyses and information that inform the design and strength of local flood controls in Ipswich. 4. The efficacy of structural preventative measures (dams, levees, etc..) 5. Local emergency services (Police, Fire or Ambulance services)
Perception of other risks	Earthquakes, Severe thunderstorms, Fire disasters, Terrorist attack Burglary/Robbery, Pest & disease outbreaks, Traffic accident, Electric shock
Contextual/personal circumstances	Age, Gender, Income, Number of people in household, Residence period, Education, Building style, Structure, Quality, Ownership and distance from a river.

Following a number of previously validated measures (adopted in Godber 2005, Zhai & Ikeda 2006, 2008, Bell & Tobin 2007, Botzen et al., 2009; He, 2009; Ludy, 2009; Reese et al., 2011; Terpstra, 2011; Ludy & Kondolf

2012; Molino & Karwaj 2012; Oruonye 2015; Su et al., 2015) the questionnaire requires participants to provides answers on 74 closed-responses with questions that mostley offer interval and ordinal data within numerical rating scales (Likert-type scale).

At this stage of the study, data collection via mail, online is continuing. Next, the collected data will be coded and analysed using statistical software packages such as SPSS (Statistical Package for Social Science) SAS 9.1.3 (Cary, NC) and AMOS (Analysis of Moment Structures). Statistical testing of association, significance and covariance (Bivariate analyses, Chi-squared test, Confirmatory Factor Analysis, Standardized regression/coefficients and Covariance structure analysis) will be conducted to test our proposed model (figure 1) so as to examine the nature of the interdependence among the determinant factors affecting the degree of flood risk acceptance. More precisely, a factor analysis will be first conducted to reduce the number of factors and to draw out the main that influence the main measured variables. Covariance structure analysis will be then conducted. This type of analysis is an extension of the regression model and is used to test the fit of a correlation matrix (as set of structural linear regressions) against two or more causal models being compared (Bentler & Bonett, 1980; Zhai & Ikeda, 2008,). It tests hypothesized patterns of directional and non-directional relationships among a set of endogenous and exogenous latent variables (Suhr, 2008).

In covariance structure applications, the assessment of goodness-of-fit and the estimation of parameters of the hypothesized models are the primary goals (Hu & Bentler, 1999). The most popular ways of evaluating model fit are those that involve the chi-square goodness-of-fit statistic, Cronbach's alpha and the so-called fit indices that have been offered to supplement the chi-square test. The fit indices include, for example (Hu & Bentler, 1999): 1. Comparative Fit Index (CFI) which is equal to the discrepancy function adjusted for sample size. CFI ranges from 0 to 1 with a larger value indicating better model fit. Acceptable model fit is indicated by a CFI value of 0.90 or greater. 2. Root Mean Square Error of Approximation (RMSEA) is related to the residuals in the model. RMSEA values range from 0 to 1 with a smaller RMSEA value indicating better model fit. Acceptable model fit is indicated by an RMSEA value of 0.06 or less (Hu & Bentler, 1999). If model fit is acceptable, the parameter estimates are examined. The ratio of each parameter estimate to its standard error is distributed as a z statistic and is significant at the 0.05 level if its value exceeds 1.96 and at the 0.01 level it its value exceeds 2.56. 3. Normed Fit Index (NFI) (Suhr, 2008).

The result of the Pearson’s correlation coefficients (Cronbach’s alpha) will show the correlations between the exogenous variables (factors affecting flood risk acceptability). While the results of the covariance structure analysis will show the most important factors for flood risk acceptability that which have the largest standardized regression weights of the total effects.

PROSPECTIVE OUTCOMES AND CONCLUSION

In a practical sense, the application of our proposed model will provide a basis for understanding the notion, degree and factors of flood risk acceptance from the perspective of individuals seeking a residential location. The model involves personalised risk assessment, based on: cognitive/affective evaluations, stable psychological variables (such as trust and consciousness of self-responsibility) and contextual/personal variables (such as age, gender, residency period, and geographical differences). In fact, the rationale behind studying individual's perception and acceptance of flood risk is not ensure acceptance, but to understand their concerns about and attitudes towards the risks where they invest/live. This in turn may lead, for example, to mitigate the existing/residual risks or modify existing flood regulation levels (including minimum floor levels) to levels deemed acceptable by the public (i.e., floodplain occupants/investors). It may also steer how relevant flood risk information should be communicated to the individuals/communities at risk, in a way that may enhance their trust in controlling agents, leading to enhanced capability to adapt or mitigate flood risks, and promoting their safety and resilience.

Other important implications for ultimately understanding the concept of flood risk acceptance that can be derived from our conceptual model which focuses essentially on a risk literacy-building at a long-term process that empowers the public in risk evaluation processes, enhances the legitimacy of floodplain management policy and ensures community and urban development occurs in a sustainable manner. The major outcome of the study will be an illustration of how floodplain occupants perceive the flood risk and acceptable risk within a 'real world' setting, providing an opportunity to amend existing frameworks for more effective hazard management, and land-use planning outcomes. While it is noted that the results for the case study within this project will be unique to this region, it is anticipated that the model could be used to facilitate the integration of land-use planning and hazard management processes in other local government.

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INFLUENCE OF RISK COMMUNICATION ON INTENTION TO PREPARE FOR FLOOD HAZARDS IN INFORMAL SETTLEMENTS

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ABSTRACT

Flood hazards are the most frequent, recurring and destructive hazard accounting for more than half of all related fatalities and one-third of economic losses. Informal settlements suffer greatly from the consequences of flood hazards due to their physical location on flood plains, high poverty levels, overcrowding, high population growth and poor quality housing. Though, informal settlement denotes negative connotations yet their contribution towards the development of countries cannot be overlooked. This has prompted several efforts from government agencies and other development partners to improve vulnerabilities and build resilience in informal settlements. However, efforts to model informal settlements to live with flood without harm have failed due to excessive emphasis on structural measures of mitigation. More so, the action of installing in informal settlements preparedness behaviour has received little attention in literature and practice. Risk communication has gained currency in modern studies in disaster management; however, its full potential in the area of risk management has not fully been exploited especially in preparedness to flood hazards. This paper proposes a framework that informs how risk communication influences preparation intentions of informal settlements dwellers. This paper is anchored on extensive literature review of articles, chapters, archives and books written by well renowned scholars on disaster hazard preparedness, risk perception and risk communication. Selection of articles for the study was based on three major criteria, which included; 1) the article relevance to the study 2) the article is applied to risk perception, risk communication and disaster preparedness. 3) Downloaded document has citations and references of authoritative scholars in risk perception, risk communication and disaster preparedness.

Keywords: Resilience, Risk Communication, Informal Settlement, Flood Hazards, Risk Perception, Vulnerabilities

INTRODUCTION

Attempts by countries to achieve the vision of sustainable development have been hindered by several factors especially disaster hazards. According to Basher (2006), the devastating impacts posed by disaster hazards present a glaring evidence of underdevelopment in most developing countries of the world. For instance, a total of 346 disasters were experienced in 2015, which killed 22,773 people, affected 98.6 million people and inflicted a property damage of US$ 66.5 billion (EM-DAT, 2016). Flooding has been identified as the most frequent, recurring and destructive natural hazard over the same decade accounting for more than half of all disaster-related fatalities and one-third of economic loss from all natural catastrophes (Bradford et al., 2012).

The danger posed by flood hazards on the development of countries has drawn the attention of international organisations, countries and researchers towards the investigation of the devastating impacts from flood hazards. The research has uncovered climate change (IPCC, 2001; UNISDR, 2010) and increased human exposure and vulnerability (Douglas et al, 2008) as the major sources. Pelling (2007) indicates that urban areas especially informal settlements are areas in the world that mostly suffer from the disastrous impacts posed by flood hazard. Informal settlements are fertile grounds for the occurrence of flood due to their vulnerable locations on flood plains, high poverty levels, high population density, overcrowding and poor condition of housing (De Risi et al, 2013). Furthermore, UN-Habitat, (2013) opines that the negligence of urban planning authorities to provide basic facilities such as drainage systems has worsened the extent of flood vulnerability in informal settlements.

Various stakeholders in the field of flood management have raised concern about finding an ideal approach to prevent and provide a lasting solution for flood impacts. Efforts towards mitigating flood hazard impacts have included the use of sophisticated risk assessment tools by experts and erections of protective structures to serve as flood defensive barriers (Maidl and Buchecker, 2015). Over the last two decades, structural form of flood mitigation has increasingly received consideration and progressed significantly in practice yet flooding continues to be a major challenge to sustainable development especially in developing countries (Yamada et al, 2011). The inadequacy of the structural approach to flood management requires an additional effort to fortify social capacities such as flood risk communication in at-risk communities.

Risk communication has gained significant attention over the past decades in the context of flood resilience. Moreover, influence of risk communication in informal settlements is very important. The influence of risk communication on the flood risk hazard awareness is well discussed in several studies (Covello et al, 2012). However, the translation of the awareness into motivating people to take up proactive actions towards flood risk hazard has received little research attention. Also, with informal settlements being highly vulnerable to flooding, an approach of flood management that models informal settlement dwellers to live with flood without harm is the most ideal. On the basis of this, the study explores how risk communication influences flood risk preparedness intentions in informal

RESEARCH METHODOLOGY

This paper is anchored on extensive literature review of articles, chapters, archives and books written by well renowned scholars on disaster hazard preparedness, risk perception and risk communication. In general, a total of 321 articles, books and chapters were downloaded and collated from high standard databases in social sciences and arts and humanities such as Scopus, Science direct, Environment complete, Taylor and Francis and Wiley Online Library. Selection of articles for the study was based on three major criteria, which included; 1) the article 's relevance to the study 2) the article is applied to risk perception, risk communication and disaster preparedness. 3) Downloaded document has citations and references of authoritative scholars in risk perception, risk communication and disaster preparedness.

Downloaded articles, books and chapters were obtained by the combination of keywords such as disaster hazards, risk perce*, risk communicat*, disaster prepar*. The use of asterisk enabled articles that had "risk perception" "perceived risk", "risk communication", "communicating risk", "risk communicating", "communicate risk", "disaster preparedness", "disaster preparation", "preparing for disaster" etc in their title and abstract to pop up. The word hazard was also used to search for documents that referred to flood, fire, earthquake and tsunamis as hazard, natural hazard or environmental hazard. Downloaded articles were then read to enable sorting based on the criteria set for the studies. A total of 47 and 28 documents were discarded on the grounds of duplication in the databases and irrelevance to the study respectively. The use of the criteria reduced the number of articles for analysis to 245, which forms the basis of the paper.

INFORMAL SETTLEMENTS: FLOOD VULNERABILITY PERSPECTIVE

Informal settlements, slums, squatter settlements, unplanned towns and shantytowns are terms that are used interchangeably in literature. Conversely, the definition of the term informal settlement is arguable and subject to much academic debate (Hague 1982 cited in Nguluma, 2003; Dovey and King, 2011). Informal settlements are places built outside land-use scheme developed without planning permission. They are composed mainly of makeshift houses that deviate from the standard building regulations. More so, areas marked as informal settlement have inadequate access to safe water and sanitation facilities, irregular supply of electricity and road for emergency access. Similarly, they have an overcrowded population and an insecure tenure of stay (Mutisya and Yarime, 2011; UN-Habitat, 2013). These characteristics coupled with increased frequency and unpredictable climate has made informal settlement vulnerable to all forms of environmental related disaster hazards especially flood (De Risi et al, 2013).

Over the world, the location of informal settlement on hazard risk areas has been discussed extensively in literature (De Risi et al, 2013). Vulnerability of informal settlements to flood hazard is categorised into four areas namely: physical, economic, environmental and social vulnerabilities (Blaike et al, 2014). The location of informal settlements (flood plains, marshy areas, low-lying areas and river courses) coupled with increasing population size, poor planning and quality of housing (Abunyewah et al, 2014) renders them vulnerable to flood hazards.

Dwellers of informal settlements, mostly in-migrant, have low economic capabilities (Fakade, 2000) that impact upon their ability to prepare adequately for an impending flood risk. A high percentage of in-migrants are low-income earners or unemployed rendering them incapable of renting a house or room in a properly laid out residential area. Their economic position pushes them to rent apartments in informal locations, as they have cheaper residential opportunities. In addition, the low-income characteristics of such people inhabit their ability to use structural mitigation measures to reduce flood impacts (Wang et al, 2010).

Expansion in terms of population and industry in informal settlements triggers an increase demand for land for both residential and industrial development reasons (UN-Habitat, 2003). This in turns results in natural vegetation destruction to accommodate the rising demand for land, which increases settlers' susceptibility to flood hazards. Changes in land-use patterns areanother phenomena that arise in the course of urban population inrease. The predominant changes usually occur in agricultural land-use to residential or industrial land-use (United Nation, 2006). Features of urban construction such as paving of surfaces reduce infiltration, and permeability of run-off water through the soil, thus making informal settlements susceptible to flood hazards.

Inequality among humans, countries and communities give rise to social vulnerability, which shape the susceptibility of various groups to flood hazard. The vast differences in susceptibility levels result in differences in preparation and resilience rate. Informal settlements are characterised by low access to political power, low levels of education together with culturally and linguistically diverse minority groups (Usamah et al, 2014). Low level of education in communities and among people hinders their capability to decipher warning information and access to preparatory and recovery information (Heinz Center for Science, Economics, and the Environment, 2000 cited in Cutter et al, 2003). The diverse culture and ethnic structure of informal settlements may make communication of risk an arduous task as risk message needs to be communicated in several languages.

FACTORS INFLUENCING FLOOD RISK COMMUNICATION

The timely and accurate relay of information regarding a flood hazard among stakeholders is a major tool for effective flood management. Flood risk information given out at the right time and accurately provides at-risk individuals and communities to employ measures and structures to mitigate the magnitude of its impacts. However, risk communication on flood has not been able to achieve its intended purposes in recent periods and Basher (2006) attributes its failure to poor and inadequate early warnings. Furthermore, the perception of people on flood hazard also influences the status and effectiveness of risk communication (Van-Djik et al, 2008). Miscommunication, which arises from one or, all of components of risk communication (communication source, communication channel and communication message) is also another factor that leads to failure in risk communication purposes (Lundgren and McMakin, 2013).

Perceptions about the probability and magnitude of a flood event happening differ greatly between people and societies. While some people (fatalists) perceive the non-existence of flood hazard, others also have low or high perception about the existence of flood hazard. Wachinger et al (2013) classify all the factors influencing risk perception into four categories namely: informational factors, personal factors and contextual factors. Literature has shown that strong linkages exist between risk perception and risk communication (Smith, 2013). For instance, individuals and cieties who lack direct experiences of a hazard manifestation perceive risk based on what they hear and read from the media as well as what they hear from experts and authorities.

The source of a communication encompasses all people, entities and institutions that initiate a communication to the public (Lindell and Perry, 2004; Covollo et al, 2012). It includes government authorities, flood managers, media personalities, friends, family members and neighbours. Receivers of flood risk information first examine the credibility of the source to determine whether or not flood is likely to happen (Basher, 2006). The credibility or otherwise of a source of a communication is an indication to ascertain how readily people will accept risk. Studies have shown that a communicated risk from an unbelievable source raises questions and give opportunity for recipients to consult other people for clarification and confirmation (Spence et al., 2007). Clarification and confirmation of risk from other sources has a high tendency of influencing the perceptions of some message recipients negatively, which implies refusing to take precautionary measures. The credibility of source varies from one individual to the other. With respect to these variations Aldoorey and VanDyke (2006) suggest that communication of flood risk should emanate from a team made of experts, credible government officials, reputable organis ations and familiar and respected personalities.

The medium through which a risk is communicated is known as communication channel. Channels of flood communication are also as important as the source of communication. Channels of communication include face-to-face contact, telephone, siren, radio, newspaper, television and Internet. Each channel of communication has its strengths and weaknesses, (Coiera, 2013) and that a combination of the channels is key to ensuring precision in communication. Wogalter and Mayhorn (2008) challenge the precision of communication through television or radio, though they are fast and have wide coverage area. They further elaborate that receivers of flood risk messages from television and radio sources include those who are not at risk and may sometimes mistakenly accept that they are also at risk. Face-to-face contacts and telephone are precise (Basher, 2006) yet they are the slowest.

The assessments made by experts and recommended actions for preparation and evacuation regarding flood constitute message content. Certainty and clarity of communicated flood message is an essential tool for influencing the perception of mass audiences (Lindell and Perry, 2004). As noted by McCallum and Heming (2006), clarity and specificity of flood communicated message enhance credibility and acceptance of risk. The content of a risk message should incorporate the type of hazard, expected time and the recommended protective actions to prevent or mitigate the impacts (Houston et al, 2015). This propagates the acceptance of risk and adherence to recommended actions for preparation and evacuation.

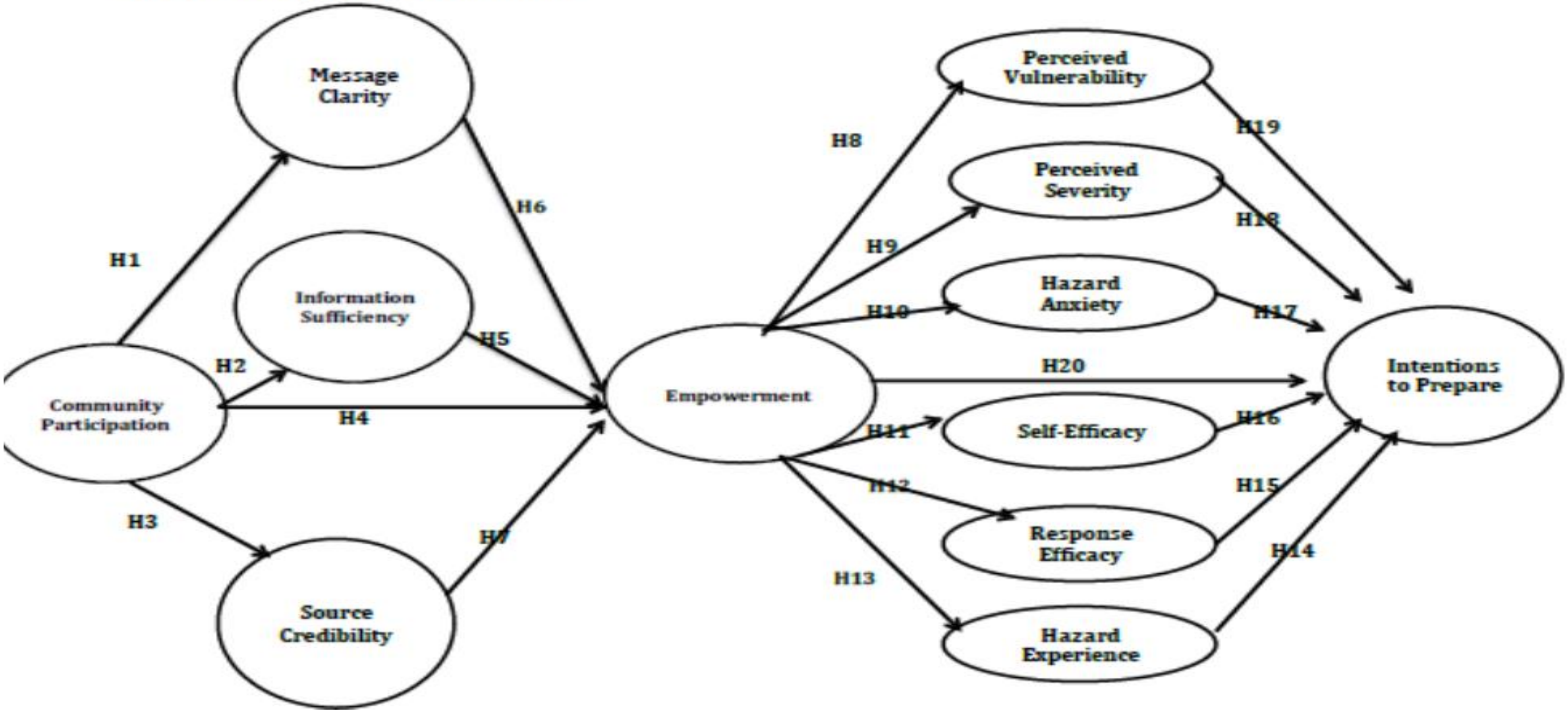
PROPOSED THEORETICAL FRAMEWORK

Communication of risk is pivotal to the effective and smooth management of flood hazards. It cuts across pre-disaster, disaster and post disaster phases of disaster hazards management (Blanchard-Boehm and Cook, 2004). However, efforts to use risk communication to prepare "at risk" individuals and communities to take up protective measures has not fully been achieved due to socio-cultural and psychological factors such as risk perception (Beecher et al, 2005), lack of trust (Slovic, 2000; Pinto et al, 2005), ambiguous and unclear risk message content (Twigger-Ross et al., 2009), inadequacy of risk message contents and interrupted communication channels (Horner and Walsh, 2000; Pitt, 2008). Similarly, loose/poor community-authority relationship has also been identified as another barrier for sound risk communication (Raaijmakers et al., 2008; Hoppner et al, 2010).

In **Figure 1.1**, it is posited that message clarity, adequacy of flood hazard information and source credibility are foundations to ensuring smooth communication of flood risk. Community participation serves as a platform to enable a cordial relationship between community members, which invariably enhances credibility, and trust building (Andrulis et al, 2007; Klaiman et al, 2010). Continuous engagements encourages community members to ask questions about hazards uncertainty and protective measure to meet their needs and expectation. Lion et al (2004) indicate that regular interaction among key stakeholders clear all doubt and enhance community empowerment that is a recipe to flood risk preparedness.

More so, adequacy in flood hazard knowledge, clarity in risk message content and source credibility built through community participation does not necessarily translate into flood risk preparedness. Other factors that predict intentions to prepare toward flood hazards include: perceived vulnerability and severity, response efficacy, self- efficacy, hazard anxiety and hazard experience (Slovic, 2000; Siegrist and Gutscher, 2006). In other words, the action of people taking up protective action is also dependent on their perception about flood hazard, self- and response efficacy as well as the person's experience of flood disaster. High correlation exists between positive behavioural intention and actual preparedness (Terpstra, 2010; Wachinger et al (2013).

Figure 1.1: Theoretical Framework



CONCLUSION

Informal settlements are very difficult to eradicate especially in developing countries where policies to check urban population growth are inadequate and lacking. Vulnerability of urban areas especially its peripheral informal settlement surroundings increase making it a center of attraction to flooding and other forms of disaster hazards. The increasing negative consequences posited by natural hazards have fuelled efforts to prepare communities and people towards disaster risk reduction yet social and economic impact keep increasing. Risk communication has been indicated to potentially reducing flood risk yet further studies have not been conducted to ascertain risk communication potential of preparing residents towards flood.

The paper proposes a model to show how risk communication influences intentions of people to prepare towards flood hazards. The Protection Motivation Theory (PMT) and Theory of Planned Behaviour (TPB) are the two major psychological theories that inform the proposed model.

APPENDIX

The meaning of the constructs used in the proposed framework are summarised below

Perceived vulnerability refers to the likelihood of being affected by flood

Perceived Severity means the seriousness recipients of flood messages associate to the consequences of flood

Community participation refers to the continuous exchange of flood information between experts and people at-risk to flood

Information Sufficiency refers to the assessment of additional information at-risk individual require to cope with flood hazard

Empowerment means equipping people at risk to flood with adequate and sufficient information about flood hazard to enable them to prepare towards it.

Source credibility encompasses the trust and believe flood message recipients have on message communicator

Message clarity involves the clear articulation of content of flood messages (severity of flood, expected time and the recommended protective actions to prevent or mitigate the impacts) in simple and plain language to audiences

Response-Efficacy denotes the degree to which receivers of flood messages believe that the recommended actions will prevent or mitigate the impending flood impacts

Self-Efficacy means the extent to which receivers of flood message have the ability to perform the recommended protective actions

Hazard anxiety refers to the fears and worries perceived or associated to flood consequence by message receivers

Hazard experience involves either direct or indirect encounter with flood hazard by message receivers

Preparation intention means the likelihood of receivers of flood message taking up actions to prepare towards flood hazard

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CHALLENGES FACING THE RELOCATED COMMUNITIES FOLLOWING THE 2004 INDIAN OCEAN TSUNAMI: A STUDY IN INDONESIA

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ABSTRACT

Post-disaster relocation is likely to disrupt the lives of those displaced by disasters. Separation from their previous environment and social relations also impact the displaced communities to recover and assume normal livelihoods. This paper investigates the challenges faced by the relocated communities to resume their livelihood following the 2004 Indian Ocean tsunami. Questionnaire and in-depth interviews were conducted on two relocation sites in Banda Aceh, Indonesia. It found that access to previous income and livelihood sources has been a prominent issue experienced by the relocated households. Lack of infrastructure, such as water utilities and public transportation, has added to the difficulty in the recovery of their livelihood. While the Government and NGOs livelihood supports in terms of cash grants and working tolls played a significant role in the short term, there is a need for diverse livelihood support strategies and a coherent/cohesive community spirit to increase the ability for livelihood recovery. This article highlights the importance of introducing targeted employment generation programmes, such as vocational training or business enhancement credit, in assisting the post-disaster housing relocation.

Keywords: disaster recovery, Indian Ocean tsunami, livelihood, relocation

INTRODUCTION

Housing is a basic need for disaster victims. It plays a significant role not only as a shelter but also as an economic, social and cultural means for the disaster victims to connect to a society (Barakat, 2003). In a reconstruction, post-disaster situation, the provision of housing for the displaced people could be undertaken either by rebuilding on previous locations or relocating the victims to a safer place when the risk of mitigation in the existing place seems to be impossible or costly.

The importance of livelihood recovery in the post-disaster recovery process is clear, however, there is little research undertaken in this field, particularly for the relocated communities following a disastrous event. Therefore, this study investigates the challenges of livelihood recovery faced by the communities that were relocated after the 2004 Indian Ocean tsunami. By surveying the relocated households in Banda Aceh, Indonesia, this paper identifies the barriers to restoration of their livelihood and suggests recommendations for improving the livelihood resilience of the relocated beneficiaries.

LITERATURE REVIEW

Relocation is the process of rebuilding a community's housing, assets and public infrastructure in another location (Jha & Duyne, 2010). The purpose of relocation is to provide the beneficiaries not only a house, but a home which is secure, has access to infrastructure, livelihood and community activities.

(Badri, Asgary, Eftekhari, & Levy, 2006; Jha & Duyne, 2010) argue that if not managed or planned well, relocation could negatively impact the affected communities in many aspects, particularly the vulnerable groups. These impacts include inadequate sanitation on the relocated sites, a declined quality of education, less employment opportunities, disruption to the social cohesion and network, as well as the loss of cultural assets. These negative impacts could be felt more by communities whose livelihoods are site specific, such as fisheries, agriculture or forestry (Fu, Lin, & Shieh, 2013; Jha & Duyne, 2010). For instance, following the 2004 Indian Ocean tsunami, coastal communities had experienced severe disruption to their livelihood due to their high dependency on natural resources (Pomeroy, Ratner, Hall, Pimoljinda, & Vivekanandan, 2006).

One of the primary challenges of relocation is community recovery, especially the recovery of their livelihood (Fu, Lin, & Shieh, 2013). Being separated from their previous source of income, particularly the involuntary ones, usually needs a longer recovery time in comparison with the voluntarily relocated beneficiaries or people who rebuild in place rebuild in place.

Rebuilding livelihoods of the relocated people is a complex task and needs to be managed and organised well to minimise the unintended consequences for these relocated people. The concept of livelihood is not only limited to their income and employment, but also includes the ways people access food, shelter, basic infrastructure and social services, security and protection (United Nations Development Programme, 2003). It comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Chambers & Conway, 1992).

One of the issues worth discussing in disaster livelihood recovery is assistance gap (Esnard & Sapat, 2014). The issues include mismatching between assistance availability and the victim's needs, or the time when it is needed; ability of the assistance provider to deliver it and the timeframe of delivery; and when they should start or be stopped. Livelihood support assistance for relocated people should be carefully considered to promote their self-reliance, so as not to create dependency on outside donations.

RESEARCH METHODOLOGY

Field study in Banda Aceh, Indonesia

On Sunday, 26 December 2004, a 9.0 Richter scale earthquake occurred at 3.307°N, 95.947°E 30 km below sea level. The earthquake generated a tsunami which directly impacted 11 countries, killing up to 300,000 people and displaced more than one million victims (deconstruction Aceh's reconstruction). The highest destruction was experienced in the province of Aceh, the northern part of the island of Sumatra in Indonesia, where a total of 811,409 people were displaced and 166,760 were killed, with 127,749 unaccounted for (Athukorala & Resosudarmo, 2005).

At the end of December 2008, 140,304 permanent houses had been built, as well as infrastructure such as roads and an airport. Houses for beneficiaries who had land were built on previous locations while the victims who could not rebuild on the land affected by the tsunami were moved to housing relocation areas which were mostly located on the hills and out-skirts of the city centre (Matsumaru, Nagami, & Takeya, 2012).

A Taiwanese NGO, the Tzu Chi Foundation, built the Neuheun relocation site on the hills up skirt of Banda Aceh. It is located 15 km from the centre of the city. No documentation has been done on the number of people living on this site. In late 2015, approximately half of the 750 houses built in 2006 were inhabited. As a part of the Neuheun Village, it is coordinated by a complex head under the Chief of the Neuheun Village.

The Tzu Chi Foundation built another relocation site on the edge of the Aceh River on government-provided land in the city of Banda Aceh. This site consists of 700 houses of 42 m2 groups in 23 blocks under the administration of the Pante Riek Village. In 2013, the Pante Riek relocation was indwelt by 939 families amongst 1,257 households of the Pante Riek Village. Residents of both relocation sites come from many villages around Banda Aceh. Most of them are people who had houses in the area that had been declared a buffer zone or renters who had not had houses previously.

A pilot study was held in October 2015 on those relocation sites to investigate the challenges faced by the beneficiaries in recovering their livelihood after being moved from their previous settlement. The location of the surveyed sites is seen in Figure 1.

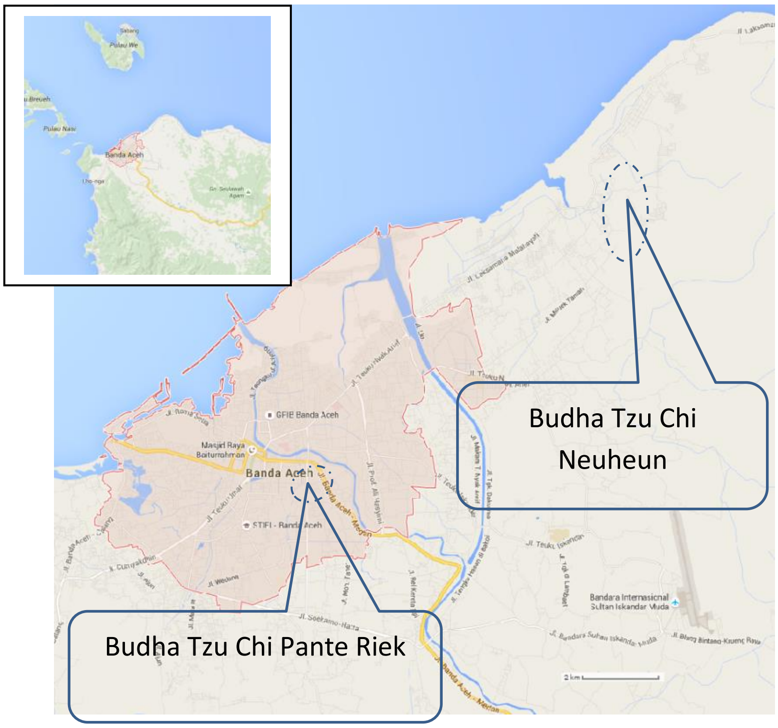

Figure 1: Location of the study area

Research method

Questionnaire survey which is focused on absorbing the information levels of livelihood on these relocated communities and the determinants of their livelihood changing and a qualitative method using in-depth interviews and field-based observations are intended to understand the relationship of the factors that have influenced the communities' livelihood resilience. The targeted respondents are the beneficiaries who are still living in those relocations. Due to the unavailability of official data, a trial was done on a block of the Pante Riek relocation site to find out the percentage of relocation beneficiaries among the recent population. The results found that 22 out of 40 houses in the block were lived in by renters or had been sold to other people. Based on these findings, the beneficiaries were assumed to be 325, which is about 45 % of the houses. Similarly, the number of beneficiaries in the Neuheun relocation site is assumed based on the information received from the Chief of the relocation sites that only half of it was indwelt by tsunami victims. Assumed beneficiaries and targeted respondents are summarised in Table 1.

Table 1: Beneficiaries participated in the survey

Relocation Site	Assumed current beneficiaries	Responded participants	Response rate
Pante Riek	325	104	30.85 %
Neuheun	375	94	25.06

Respondents were randomly selected based on their willingness to participate. As the unit of analysis in this research is the household in the relocated villages, targeted participants in the surveys and interviews were the heads of households. The heads of each household were asked to answer a set of questions below:

To recover your livelihood, what are the main challenges you found in your relocation site?
What livelihood supports did you get, if any, when you moved to the relocation site?

RESULTS AND DISCUSSION

Findings of the field trip are discussed below and focus on the challenges faced by those relocated, particularly in livelihood recovery, receiving livelihood support and the main actors who played a significant role in their livelihood recovery.

The challenges faced by the relocated households

Moving to a new settlement posed some challenges to the relocated tsunami victims. Figure 2 depicts some major challenges faced by residents of the Pante Riek and Neuheun relocation sites. People who lived in Pante Riek faced different challenges compared to their fellows in Neuheun. More than half of the respondents there claimed that they had not experienced any challenges while living in Pante Riek since being relocated. Less than a fifth of the beneficiaries experienced difficulties in finding a job. Other significant stated challenges are connecting to neighbours and a change of lifestyle.

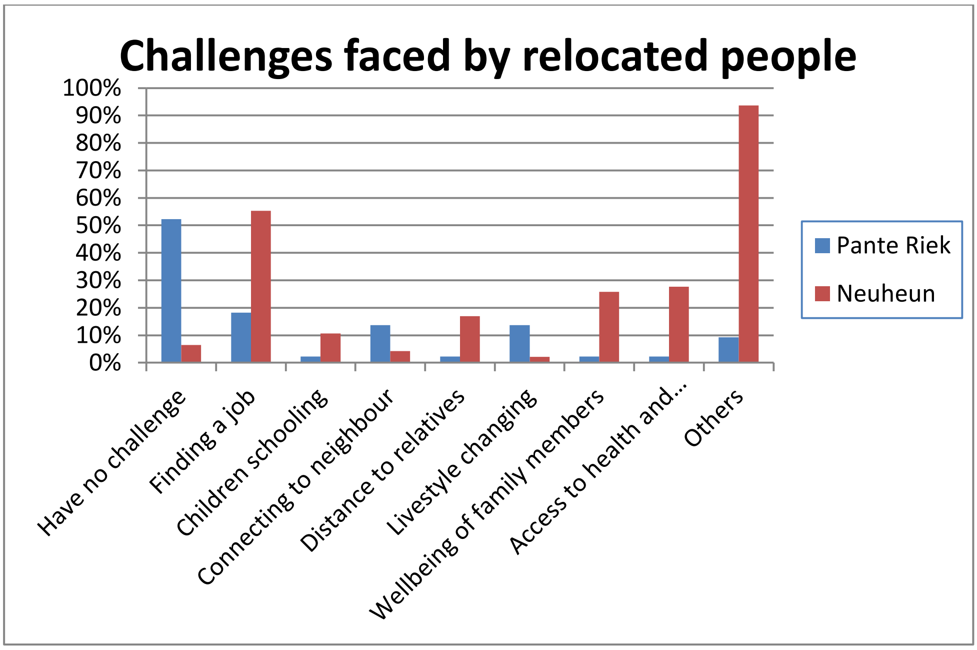

Figure 2: Challenges faced by the relocated people

On the other hand, people living in Neuheun dealt with different difficulties. More than half of them found it hard to find jobs. As the relocated people at Neuheun had mainly worked in Banda Aceh previously, therefore moving them to a place further away without sufficient public transport separated them from their sources of income. There were not many job opportunities to be found near their present place of living. Meanwhile, due to unreliable and high costs of transportation, working in Banda Aceh while living in Neuheun, posed another problem.

"We have to spend Rp. 30,000 per day only for transportation. It is too expensive and unaffordable for us" (anonymous, female resident of Neuheun relocation site).

Many of the residents of the Neuheun relocation sites are underemployed, working as labourers in construction or in small trading businesses in Banda Aceh with a daily income average of Rp. 70,000 – Rp. 100,000. Spending almost 30 % of their income just for commuting costs greatly influences their livelihood. As they have already suffered from a disaster, even small expenditure in transportation might negatively impact the people (Matsumaru, Nagami, & Takeya, 2012).

Beneficiaries who worked as fishermen mostly left or sold their houses and moved back to their previous settlement.

"I got a house in Neuheun but as I tried to save my money for buying land in Ule Luee and apply for Rumah Duafa. It is easier to find jobs in Ule Luee. I can go fishing or work as a labour at the port"(anonymous, male resident of Neuheun relocation site).

This finding implies the importance of adequate connectivity to their previous sources of income. Both of the sites were given similar types of houses and facilities; however, those who were living in Pante Riek were luckier than their fellows in Neuheun in terms of finding jobs due to their proximity to the city centre. Beneficiaries in Neuheun might be not experienced finding jobs as a primary challenges if they are provided with adequate access to the city centre, as well as those in Pante Riek.

Providing adequate facilities such as infrastructure for transportation for a completely new relocation site in developing countries, particularly in a post-disaster reconstruction timeframe might be impossible (Matsumaru, Nagami, & Takeya, 2012). However, integrating those relocation sites into development programmes and allowing a longer timeframe for the provision of infrastructure could help the community from being abandoned.

Another challenge of living in Neuheun is insufficient access to health and entertainment facilities, which also makes it difficult to sustain the wellbeing of family members. This is mainly due to a lack of infrastructure such as adequate transportation and water supply. Despite having been provided with a deeply-drilled well, water provision in this village is still an issue. Operation and maintenance costs for the water distribution system are shared equally among the community. Whenever some of them are reluctant or postpone paying their contribution, the collected fund is not enough to cover the operational costs, therefore leading to the termination of their water supply. This displays the importance of collective action for a relocated community.

"I really hope that the government could provide "PAM"(drinking water service) so we don't have to deal with stoppage of water supply due to arrears" (anonymous, female resident of Neuheun relocation site).

It implies the importance of collective action for a relocated community. Long-term recovery depends on developing and supporting the capacity and skills for collective action in the affected communities (Thorburn, 2007). With a strong bond amongst them, collective action in the community could help them strive against this disturbance, even force the government to provide a better service for the community. An example of this situation was experienced by the people in The Fourth of February settlements, in Guatemala City. These settlements stand as an example of relocated communities' natural coping mechanism by using effective internal organisation to deal with difficulties in the aftermath of the disaster, even in poverty (Oliver-Smith, 1991). The lesson that could be learnt from this is the recognizing of the importance of building community collective action by the stakeholders involved in post-disaster relocation.

Livelihood recovery support received by the relocated people

The primary objective of relocation as defined by the World Bank, is to guarantee an affordable, economic opportunity for achieving self-sustainability in the shortest possible period and also to enable a responsibility transfer from agencies to settlers (Oliver-Smith, 1991). Some aids programmes had been implemented in the Pante Riek and Neuheun relocation sites.

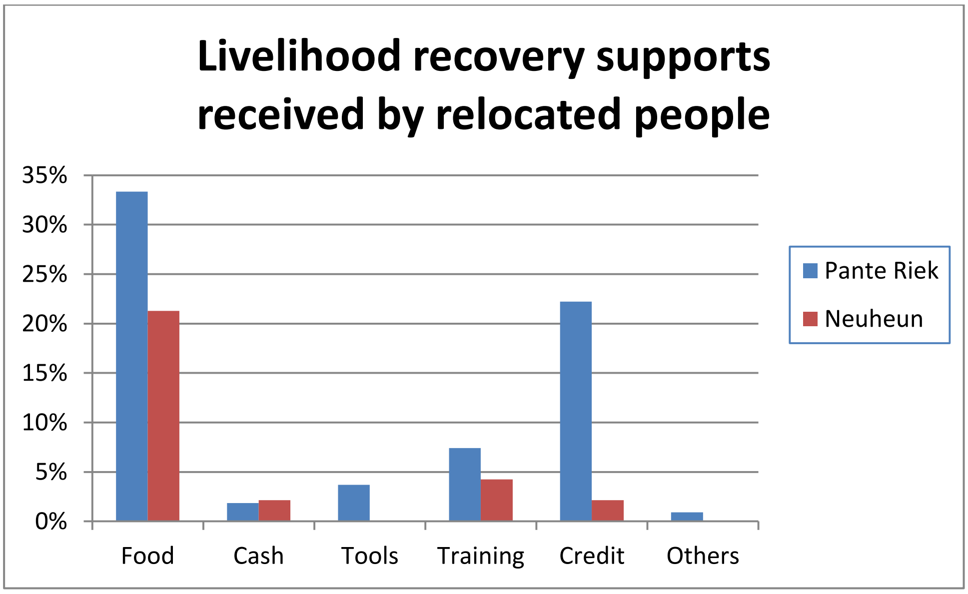

Figure 3: Livelihood recovery supports received by relocated people

Figure 3 depicts the livelihood recovery support received by relocated people. On the one hand, it shows that food or in-kind aid is scored as the highest aid received. On the other hand, support for self-sustained livelihood recovery, particularly for establishment of income generation such as working tools, vocational training or credit for business enhancement is almost absent. It implies that income generating activity support for creating livelihood resilience has not been well integrated into the post-disaster reconstruction policies. Interventions often rely on providing food and replacing physical assets (Pomeroy, Ratner, Hall, Pimoljinda, & Vivekanandan, 2006). This might be the cause of many challenges that have been faced by the beneficiaries in Neuheun.

Previous research found that closer proximity to employment, social network and services are important for success of resettlement (Molin Valdes, Patel, & Hastak, 2013). However, a lack in these areas might be compromised in supporting the community with the capacity and skills to create income-generating activities such as small enterprises. Rural people could make a living by many different activities, rather than depending on one single job (Fosse, 2006). Appropriate skills training and support, combined with routine follow-up and monitoring to prevent the misuse of funds to purchase consumable goods rather than productive assets (Thorburn∗, 2009) might be more effective to be implemented.

CONCLUSION

Post-disaster relocation is a complex task as the beneficiaries have to deal with challenges such as lack of access to job opportunities, and difficulties in sustaining the well-being of family members due to the inadequacy of basic infrastructure and social services such as transportation or water supply systems. Due to a lack of reliable transportation to the economic centre, people in Neuheun experienced job prospects as the primary challenge in recovering their livelihood. This did not happen in Pante Riek, which is located near the city of Banda Aceh.

To help these relocated communities in recovering their livelihood, recovery support programs have been implemented in both relocation sites. However, they were mainly focused on providing food or in-kind donations. Income-generating activities such as providing training, working tools or business support credit have not been given enough importance.

This study highlights the importance of providing access to job opportunities for relocated people either by introduction of reliable transportation infrastructure, which enables them to connect to their previous economic activities, or by implementing livelihood recovery support to create some income-generating activities at the relocation sites. Another issue of concern is the importance of increasing community cohesiveness to encourage participation in collective action and awareness of self-reliance.

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GOVERNANCE OF CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION INTEGRATION: STRATEGIES, POLICIES, AND PLANS IN AUSTRALIAN LOCAL GOVERNMENTS

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Abstract

In Australia, governing the integration of Climate Change Adaptation (CCA) into Disaster Risk Reduction (DRR) is becoming a pressing field of action. This governance is shaped by normative elements such as strategies, policies, and plans (SPPs), which set goals for coping with climate change-related risks. This paper investigates CCA and DRR as integrated into SPPs by Local Governments of Newcastle, Singleton, and Lake Macquarie, NSW. A content analysis of documents publicly available on City Councils' websites has been performed. The analysis found: i) differences between urban and rural Local Governments in terms of climate change-related risks consideration; ii) a convergence of common topics and milestones for some of the SPPs; iii) the necessity to target vulnerabilities and resilience for some specific subgroups of local communities; iv) land-use and development as common topics; and, v) a required focus on drought and on the inclusion of CCA into disaster response. The paper recommends exploring governance of CCA&DRR integration at the local level in order to advance the current state of the art.

Key words: Climate Change Adaptation; Disaster Risk Reduction; Governance; Australia; Local Governments

Introduction

The Intergovernmental Panel on Climate Change (IPCC) calls for a risk perspective able to assess climate change-related risks (Field et al., 2012; Field and Van Aalst, 2014). Climate change and associated processes are in fact embedded within disaster-related efforts; this poses a prudent place for considering climate change adaptation (CCA) as a subset within disaster risk reduction (DRR) (Kelman, 2015). In social systems, CCA is "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (Field et al., 2012, p.

556); DRR is "a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk, reducing existing exposure, hazard, or vulnerability, and improving resilience" (Field et al., 2012, p. 558). Both CCA and DRR manage hydro-meteorological hazards by reducing vulnerability and exposure, increasing resilience, and by transferring and sharing risks (Field et al., 2012); reduce the impacts of climate-related hazards; and promote pro-active, holistic, and long-term approaches for disaster management (Thomalla et al., 2006). Different organisations plan, implement, and fund CCA and DRR through different approaches and languages (Birkmann and von Teichman, 2010; Djalante and Thomalla, 2012; Field et al., 2012). Additionally, institutional, financial, and political barriers inhibit collaboration among these organizations (Field et al., 2012; Gero et al., 2011; Howes et al., 2015). A coherent integration of CCA and DRR is therefore required for ending separation and targeting common goals, (Begum et al., 2014; Kelman et al., 2015). For Rivera and Wamsler (2014), integration is a mainstreaming process which modifies specific core operations in order to incorporate and indirectly act upon new topics. In this case, CCA has to be integrated into DRR. This paper discusses CCA&DRR integration according to a disaster risk governance perspective (Field et al., 2012; UNISDR, 2015b). Disaster risk governance refers to the institutional context and the specific arrangements societies put in place to manage disaster risk (Renn, 2008; UNISDR, 2015a). In CCA&DRR integration, governance has a complex and porous nature which depends from site- and context- specific variables (Forino et al., 2015). The paper analyses governance of CCA&DRR integration in Australia through two connected topics. The first relates to the role of Local Governments in CCA&DRR integration. Local Governments support cooperation and mutual learning for CCA and DRR operations through managing related information and financing and connecting national programs with local instances (Field et al., 2012; Field et al., 2014; Renn, 2008; UNISDR, 2015a). The second relates to SPPs as normative elements informing actors about how to deal with potential climate change-related risks (Forino et al., 2015). SPPs are among the principal ways multi-level governments promote CCA&DRR integration (Forino et al., 2015). The paper investigates the extent to which CCA and DRR are integrated into SPPs by three Local Governments in Australia, and performs a content analysis of publicly available documents.

METHODOLOGY

Three Local Governments, namely Singleton, Newcastle, and Lake Macquarie, have been selected. Research data have been obtained, managed, and interpreted through three sequential research steps: data collection, selection, and analysis. Documents were retrieved through electronic search engines in February 2016 on the websites of the Coty Councils representing the three selected Local Governments. Keywords associated with climate and disaster research were used to cover all the potentially emerging topics. Once collected documents, their epistemic and functional values were assessed (Wang and Soergel, 1998). After, all the selected documents were classified into three groups of Strategies, Policies, and Plans, according to their overall goals and title, although a net distinction was not always practicable. A content analysis was then performed using the nVivo software and through a specific code dictionary for CCA and DRR, adapted from Rivera and Wamsler (2014). Codes for CCA were "climate", "change", "adaptation", and "mitigation"; for DRR, codes were "disaster", "risk", "reduction", and "vulnerability". CCA and DRR nodes were assigned to the section containing the respective code(s).

RESULTS, AND THEIR IMPLICATIONS FOR GOVERNANCE OF CCA&DRR INTEGRATION

Urban-rural dichotomy

From content analysis, differences results between urban and coastal Local Governments in tackling climate change-related issues. This supports results by Fallon and Sullivan (2014) on NSW, for which such differences are related to differences in available resources, among others. For both Newcastle and Lake Macquarie, classified as urban, SPPs target specific climate change-related risks or link them to broader socio-environmental goals. Some SPPs for Newcastle address CCA or focus on floods, bushfires, and coastal DRR. Meanwhile, some SPPs for Lake Macquarie target DRR for specific hazards or establish adaptive measures for specific areas. Conversely, for Singleton (classified as rural) there are no SPPs n specifically targeting CCA and a lower number of SPPs contain CCA or DRR nodes. While the number and foci of SPPs cannot be considered indicators able to assess the commitment by each Local Government, they can however proxy describe the trend undertaken by each Local Government. Therefore, efforts are required in Singleton for preparing SPPs able to establish targets and priorities on a par with close and more densely populated areas of Newcastle and Lake Macquarie.

Common visions and issues

A further emerging topic is a common and shared vision among some of the SPPs which implies addressing common goals and priorities (Howes et al., 2012; 2015). Through SPPs, each Local Government should be able to identify common milestones towards targeting common goals, priorities, and related trajectories. SPPs for Newcastle and Lake Macquarie report some common visions and goals, while SPPs for Singleton result still fragmented. Efforts are also necessary to increase the dialogue among departments within LGs, particularly towards improving synergies between diverse and diverging focus (e.g., environment, economy, social issues). Additionally, all the three Local Governments extensively linked land-use and new development to CCA and DRR. For example, the three Local Governments recommend improving regulations for new development, incorporating CCA and DRR in development design, and avoiding or minimising risk in development areas through a more adaptable land-use. This aligns to results for Australian, which found that regulations for development and land-use planning allow maximizing synergies between climate change and disaster risk issues by targeting common issues and goals (Serrao-Neumann et al., 2015). However, supporting new development and land-use in areas subject to climate change-related risks may also imply an indirect support to factors increasing exposure. For example, the NSW government recently presented for consultation two drafted plans for the Hunter Valley, which propose building 60,000 new dwellings between 2016 and 2036 to sustain expected population growth and to promote the expansion of extractive industries (NSW, 2015a, 2015b). This makes necessary understanding how these projections support efforts of coping with local climate change-related risks, and analysing the extent for which governance of CCA&DRR integration can be altered by particular interests which may emerge from these expectations and diverge from public goals and benefits.

Local communities, vulnerability and resilience

According to regulations set by State governments, the inclusion of local communities within public decision-making is mandatory in Australia (Serrao-Neumann et al., 2014). In governance of CCA&DRR integration, different degrees of inclusion exist at the local level, but their effectiveness has been often limited as an accomplishment of such top-down requirements (Serrao-Neumann et al., 2014). Both SPPs for Newcastle and Lake Macquarie stressed the importance of local communities along the decision-making process or developed different forms of inclusion. However, these communities are often considered as homogeneous, while some subgroups with specific characteristics may exist according to location and experiences (e.g., youth, ethnic groups, and elder people) (Howes et al., 2013). These subgroups often experience issues related to non-climatic factors such as social exclusion, marginalization, and unemployment, which may converge affecting those groups with less access to resources for dealing with climate change-related challenges (Forino et al., 2015; Kelman, 2015). SPPs by all the three Local Governments focused on groups which show specific vulnerabilities to climate change-related risks (e.g. people with disability, elders, young and unemployed people, or Aboriginal groups) (Field et al., 2012; Forino et al., 2015). Some Plans for Lake Macquarie recognized adaptive capacities by local communities may decrease due to current demographic ageing trends, but needs and potential of elder population in light of climate change-related risks were not accounted. Similarly, some SPPs targeted youth and children, but did not provide indications about climate change-related risks or potential actions these groups can undertake. Additionally, some SPPs targeted Aboriginal groups but did not address specific climate change-related risks. This overall lack of focus for specific subgroups within local communities aligns to e.g. an overall underestimation of youth's role in CCA&DRR integration (Forino et al., 2015) as well as to a lack of full acknowledgement of Aboriginal groups within the Australian society, usually precluding them from a full social inclusion. A further topic connected to a vulnerability discourse is related to CCA&DRR integration as supportive of building resilience. Scholars (O'Brien et al., 2006; Heazle et al., 2013; Begum et al., 2014), international agreements (Robert et al., 2015), and experiences in Australia (Serrao-Neumann et al., 2015) highlight the multiple ways through which CCA&DRR integration contributes to building resilience. However, similarly to vulnerability, different subgroups experience different levels and types of resilience (Howes et al., 2013), which still require investigation. SPPs at the local level should therefore be able to drive governance not just through investigating generic vulnerabilities and resilience, but also analysing specific related issues for specific subgroups within local communities. This would allow considering and suggesting ways to intervene also on a range of non-climatic issues which contribute to shape everyday life of different groups affecting also their coping capacities (Field et al., 2012; Forino et al., 2015; Kelman et al., 2015).

Drought, and inclusion of CCA into disaster response

Contents analysis reports two topics which require more investigation. The first is drought risk. The Hunter Valley experienced severe droughts in the past; increased climate change-related stresses can occur on water resources and facilities (HCCREMS, 2010; Reisinger et al., 2014). Nevertheless, just one Plan for Singleton considers drought risk and the potential climate change-related impacts in water supply. Efforts are required to include drought as a potential hazard affecting crucial resources such as water and soils. The second is the inclusion of CCA into disaster response. Surveys on a number of countries (Birkmann and von Teichman, 2010; Schipper et al., 2016) and for Australia (Howes et al., 2015; Serrao-Neumann et al., 2015) find that the disaster response phase is still a main challenging step for CCA&DRR integration. For example, the disaster Plans by all the three selected Local Governments do not report CCA nodes, confirming a lack of awareness of climate change-related issues within post-disaster response and recovery.

CONCLUSIONS

This paper focused on SPPs by Australian Local Governments in coping with climate change-related risks. It analysed the whole body of SPPs for Singleton, Newcastle, and Lake Macquarie, NSW. It performed an analysis of contents related to climate change and disaster risk within documents publicly available on LGs' websites. Findings revealed a different commitment in tacking climate change-related issues between urban and rural LGs. Findings also reported that SPPs for Newcastle and Lake Macquarie address common topics and milestones. Findings also reported that SPPs consider the involvement and inclusion of local communities as important within the decision-making process; however, specific vulnerabilities and resilience for specific subgroups (e.g., aged people, Aboriginal) have to be considered for increasing the effectiveness of these SPPs. Additionally, development and land-use have been found as common topics within SPPs; however, deep reflection is required about how planning new development and land use for urban sprawl and polluting industries can contribute to the effectiveness of SPPs in tackling climate change-related risks. Finally, drought risk and the inclusion of CCA into disaster response agenda are still shortcomings to be more clearly addressed. In terms of governance of CCA&DRR integration, findings demonstrate that efforts are still required for including climate change-related-risks within the whole body of SPPs by Newcastle, Singleton, and Lake Macquarie. These efforts would be crucial for strengthening the capacities of Local Governments in providing more comprehensive and inclusive perspectives about climate change-related risks. It is clear that Local Governments are not the exclusive actors in governance of CCA&DRR integration, as well as such governance cannot be managed without support from other government levels and organizations. However, the paper ought to demonstrate that disaggregated studies for a single Local Government or a group of Local Governments are necessary for exploring CCA&DRR integration at the very local level. This can provide insightful findings about challenges and opportunities of normative elements such as SPPs at the local level within governance of CCA&DRR integration. Further steps of this research will focus on the experiences of specific local actors in terms of climate change-related risks in the analysed Local Governments (e.g., City Councils, industries, communities), and on their role within governance of CCA&DRR integration. Together with the presented findings, this would allow providing a clearer picture, although not exhaustive, of CCA&DRR integration and of its related governance at the local level.

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EXPLORING HOW VISUAL INFORMATION SUPPORTS COMMUNITY RESILIENCE PLANNING AND ASSESSMENT

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ABSTRACT

Problem Statement: Community resilience consists of interactions between diverse human and non-human systems. The complexity of these interactions, and their effects on emergency management contexts, make it challenging to plan, assess and adjust relevant interventions.

Purpose and Scope: This paper aims to illustrate how diagrammatic approaches to planning and assessing community resilience interventions can improve shared decision-making in this domain. The paper specifically focuses on how a visually rich, diagrammatic approach called visual monitoring and evaluation planning can help to improve pre-emptive community resilience interventions in a New Zealand emergency management context.

Methods: Two recent studies are outlined in brief. The first concerns action research with a group of New Zealand based emergency managers and a group of academic experts. A diagram-based process was used to facilitate these groups' collaborations towards improving a programme of regional community resilience interventions. The second study used an experiment to compare responses to a diagram produced during study one with responses to a text-based table of the same information.

Conclusions: Content analysis of accounts from participants in the first study suggested that the diagram based process supported a shared focus on pragmatic objectives. The second study suggested that the diagrams produced by this process can improve situation awareness during emergency management decision-making. Further research may help challenge a current status quo, of using mainly text-based information to make shared decisions in the community resilience domain and other decisions concerning emergency management complexity.

Key words: Strategic Emergency Management, Community Resilience, Visual Cognition, Situation Awareness

INTRODUCTION

Community resilience generally concerns the "ability to resist, recover from, or adapt to the effects of a shock or a change" (Mitchell & Harris, 2012, p.2). This ability results from interactions between a diverse range of systems, including social, economic, institutional, infrastructural, and environmental aspects (Cutter, Burton & Ermlich, 2010; Birkmann, Changseng, Wolfertz, Setiadi, Karanci & İizer et al., 2012). It can be useful to understand these multiple interactions using the concept of *aggregate complexity*. This form of complexity occurs when two or more dynamic systems interact and is characterised by: constant change and evolution; fluid interactions with the surrounding environment; learning and memory within the system; changes effected by systematic structures; learning and memory; and hard to predict, *emergent* outcomes (Manson, 2001).

The concept of aggregate complexity helps to highlight challenges faced by emergency managers working with community resilience. Relevant decisions need to appreciate patterns of chance, or *trends*, resulting from interactions between aspects of a community and of their surrounding environments. For example, coastal development may be gradually slowing over time, as communities become more sensitive to risks of rising sea levels and erosion affecting their geographic area. Community resilience interventions need to consider these ongoing patterns of change. They also need to consider the emergence of surprising events and sudden changes brought about by surprising events. For example, a single house or business could suddenly slip into the sea. This event could cause an abrupt decline in demand for coastal property. Community members may even abandon nearby dwellings, making a profound change to the community being considered.

The current paper uses two studies to illustrate how information displays using a range of visual cues can help emergency managers and their collaborators respond to the dual challenges of complex trends and emergent outcomes. Elements of these responses are important for people working with the aggregate complexity of community resilience because longer term trends can otherwise be neglected - in what behavioural and cognitive researchers have called temporal discounting (see Rachlin, 1989). When decision-makers do focus on these trends, the ubiquity of confirmation bias (see: Lord, Ross & Lepper, 1979; Nickerson, 1998) means that exceptions to those trends are often neglected. Visual information may help emergency managers to consider both slow and faster-paced change because, as outlined by Cairo (2012), visual information such as diagrams can highlight broadly systematic trends alongside finer-grained exceptions. As outlined in the remainder of this paper, this is only one of several benefits of using visual information to help plan and assess community resilience interventions.

Two sets of research discussed in the current paper focused on how visual information was used to support community resilience planning and assessment in the Wellington region of New Zealand. In study one, the authors worked alongside the Wellington Region Emergency Management Office (WREMO) to explore how a diagrammatic approach to planning and assessing community resilience interventions could help improve the WREMO Community Resilience Strategy (WREMO, 2012). Apparent benefits of this diagrammatic approach were then assessed, using an experimental protocol in the second study. Together, the two studies help illustrate the potential benefits of using this diagrammatic approach to improve a regional community resilience strategy.

STUDY ONE: A VISUAL APPROACH TO FACILITATING RESEARCH-PRACTICE COLLABORATIONS

In addition to benefits outlined by Cairo (2012), a combination of visual cues may also help avoid overly simplistic assumptions about systematic change. For example, participants in Kessel and Tversky (2009) did not appreciate the cyclical nature of a system flowing from component A through B to C to D and back to component A, until they were presented with a circular diagram of these relationships. Participants in research by Huggins and Jones (2012) reported that a diagram used to assess and adjust human-environment interactions. It appears that national conservation planning and assessments of that planning were achieved by considering a greater range of relationships between components of environmental conservation, compared to the use of text based alternatives.

As outlined above, community resilience also involves a range of relationships between human and environmental components. A diagram based approach to assessing and adjusting the WREMO community resilience strategic had the potential to highlight this complexity, rather than simplicity, of relevant community resilience dynamics. It was assumed that this approach would help highlight the need for WREMO to harness the power of many minds (Huggins, Peace, Hill, Johnston & Cuevas Muñiz, 2015a) by collaborating with a range of academic experts. It was also assumed that, by co-constructing a diagram based on WREMO’s actual community resilience strategy, academic experts would engage in collaborative research with practical, rather than mainly theoretical, objectives (Huggins et al., 2015a).

An antecedent study by Huggins, Peace, Hill, Johnston and Cuevas Muñiz (2015b) analysed relevant patterns of opinion among WREMO emergency managers and a comparable group of collaborating researchers. This analysis highlighted researchers’ relatively traditional, science-led approach to analysing the WREMO community resilience strategy. Huggins et al. (2015b) concluded that pragmatically-focused research collaborations were unlikely to occur between these groups as a matter of course and that their collaborations would therefore require an innovative form of facilitation.

It was hypothesised that there would be no change in strong differences in opinion held between researchers and practitioners, identified in the antecedent research by Huggins et al. (2015b). It was nonetheless also hypothesised that the diagrammatic approach would be a useful part of improving the WREMO (2012) community resilience strategy.

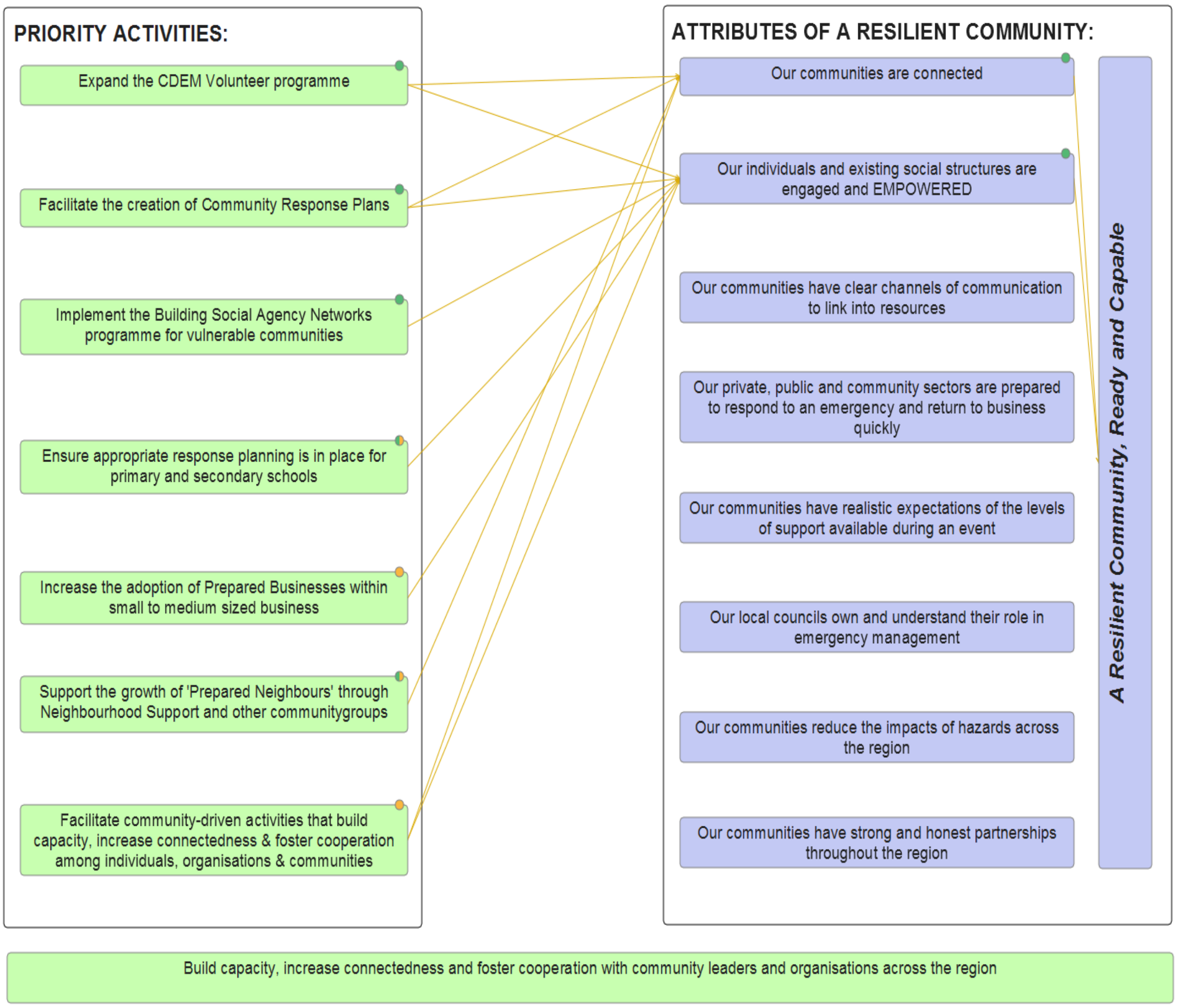

Figure 1. Diagram used to plan collaborative research into community resilience.

Method

Action research was carried out by adapting the visual monitoring and evaluation planning (VMEP) (Duignan, 2012) process into four steps for planning collaborative research: (1) drawing an initial diagram of intended outcomes and the steps required to achieve those outcomes; (2) marking the relative priority of outcomes and steps and drawing linkages between them; (3) identifying indicators that can help gauge performance towards intended outcomes; and (4) developing relevant research projects (Huggins et al., 2015a). Main components of the diagram developed during steps one and two is shown in figure 1. The fourth step of the action research process involved plotting research questions onto a further iteration of this diagram, complete with a draft set of overarching ethical principles.

Semi-structured interviews were carried out with most of the researchers (n = 5 of 7) and practitioners (*n* = 5 of 7) who participated in the action research outlined above. These interviews focused on participants' experiences of the modified VMEP process. Interview data was then analysed using a combination of qualitative thematic analysis and quantitative content analysis, outlined by Marks and Yardley (2004). The majority of this analysis was based on factors identified in antecedent research by Huggins et al. (2015b) and surrounding literature outlined in Huggins et al (2015a), before checking all content analysis codes for inter-rater reliability.

Results and Discussion

A number of content analysis codes concerned what occurred while using the VMEP diagram to facilitate step four of the action research. Excerpts from interviews relating to this stage the modified VMEP process were most frequently coded against four key themes: considering diverse groups and individuals (229 excerpts); constructive focus on WREMO activities (179 excerpts); supporting professional collaborations (171 excerpts); and need for scientist leadership (155 excerpts). The prevalence of the former three codes supported the second hypothesis, that the diagrammatic approach would form a useful part of improving the WREMO (2012) strategy. The latter code highlighted the continuing importance of a relatively technical approach to analysing WREMO interventions. This appeared to support the first hypothesis, that strong differences in opinion between researchers and practitioners would not change during the action research.

However, this support for the first hypothesis was negated by other results of the content analysis. Although an equivalent pattern of opinions had previously applied almost exclusively to WREMO practitioners (reference withheld), the code 'constructive focus on WREMO activities' now applied fairly evenly across both researchers' and practitioners' interview text. Differences between researcher ($M = 21$, $SD = 11.64$) and practitioner ($M = 32$, $SD = 14.86$) groups did not significantly exceed differences within each group for this code ($F(1,8) = 1.76$, $p = .22$). This result contradicted the second hypothesis, that strong patterns of opinion would not change during study one.

Huggins et al. (2015a) concluded that this contradiction, combined with the prevalent code of 'considering diverse groups and individuals' illustrated how the VMEP process could accommodate different positions from diverse emergency management stakeholders. Huggins et al. (2015a) suggested that these results also marked how a VMEP type diagram can help create new modes of shared thinking at group and subgroup levels. Schraagen, Klein and Hoffman (2008) referred to these types of processes as *macrocognition*: the study of cognitive adaptations occurring amongst groups of individuals attempting to work with the challenges of complexity. Study one provides an example of how a VMEP process can help normally disparate groups to change their ways of thinking about complexity, through effectively thinking together.

The VMEP process outlined above produced a detailed list of 35 different research prompts which could improve the WREMO community resilience strategy. WREMO expanded on efforts made during the action research outlined above with broader set of stakeholders, using an approach which was heavily dependent on text-based summaries. As outlined by Doyle, Becker, Neely, Johnston & Pepperell (2015), this approach was promoted by WREMO alongside several high profile collaborators. Their insistence on using largely text-based formats appeared to be comparable to document formats used to develop the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015) and other large-scale initiatives focused on resilience to disasters and other shocks such as the 100 Resilient Cities initiative (100 Resilient Cities, 2016). Despite their recent, largely text-based efforts, WREMO and their collaborators do not appear to have developed any substantive programme of programme-focused, collaborative research concerning the regional community resilience strategy. We may have observed a very different outcome if the VMEP process received continuing support from WREMO and collaborating researchers.

STUDY TWO: ASSESSING HOW VISUAL INFORMATION HELPS ADJUST COMMUNITY RESILIENCE INTERVENTIONS

Study two aimed to examine the way information formats affect individuals participating in macrocognition. This presented a challenge for collecting and analysing relevant data. Instruments used to measure differences in the quality of emergency management decision-making are usually focused on very rapid decisions, concerning emergency response with relatively short term implications (Huggins, Hill, Peace & Johnston, 2015). By contrast, study two assessed decisions concerning community resilience which were not restricted to a time limit. These decisions had implications which could extend well beyond the short term, into timeframes measured in years or even decades. It was therefore hypothesised that only a limited number of established situation awareness indicators could be used to reliably gauge performance in an experimental scenario for study two (Huggins et al., 2015).

Certain information formats may enhance decision-making performance by sharing information (Cooke & Gorman, 2010; Owen, Bearman, Brooks, Chapman, Paton & Hossain, 2013) among other aspects of cognitive processing (Hutchins, 1995, 2000) between members of a collaborating group. As outlined by Huggins et al. (2015), a range of research and theoretical precedents suggested that these benefits were more likely to be produced by information displays which augment text with a range of other visual cues. It was therefore hypothesised that responses to diagram based information would achieve higher levels of expert-rated situation awareness, when compared with responses to a mainly text-based equivalent.

Method

Invitations to participate were sent to all New Zealand based emergency managers working on a named community resilience programme. This included a total of six offices with a total of 20 community resilience personnel. Their experience of the experimental protocol was varied by being introduced to either diagram or table based displays of performance within a regional community resilience strategy (Huggins et al., 2015). The former display was based on the diagram shown in figure 1, with the addition of indicators being used to gauge progress on prioritised objectives. The latter display was a text-based table based on the table being used to monitor performance within the same community resilience programme.

Participating emergency managers accessed the research protocol from their workplace computers. They were asked for informed consent before progressing through a series of screens including the following: (1) an email request for advice about KPI results, providing an introduction to the experimental scenario; (2) a basic introduction to interpreting either the diagram or text-based table format, as randomly assigned to each participant; (3) the diagram or text-based information, displaying performance over a six month period.

Each new screen included a continuation of the original email request, guiding participants through the protocol. The email message asked participants to respond to screen number three, by asking: “Please tell me what you think is going wrong.” They were asked to type their responses into text entry boxes that were not restricted by any word or character count.

Results and Discussion

Three of four situation awareness components were rated with a large degree of inter-rater reliability: current situation awareness (CSA) ($\rho = .76$, $p = .003$); prospective information seeking quality (PISQ) ($\rho = .58$, $p = .03$); and prospective amendment quality (PAQ) ($\rho = .53$, $p = .05$). This finding supported hypothesis one, that some but not all situation awareness scales could be applied to decisions concerning pre-emptive community resilience (Huggins et al., 2015).

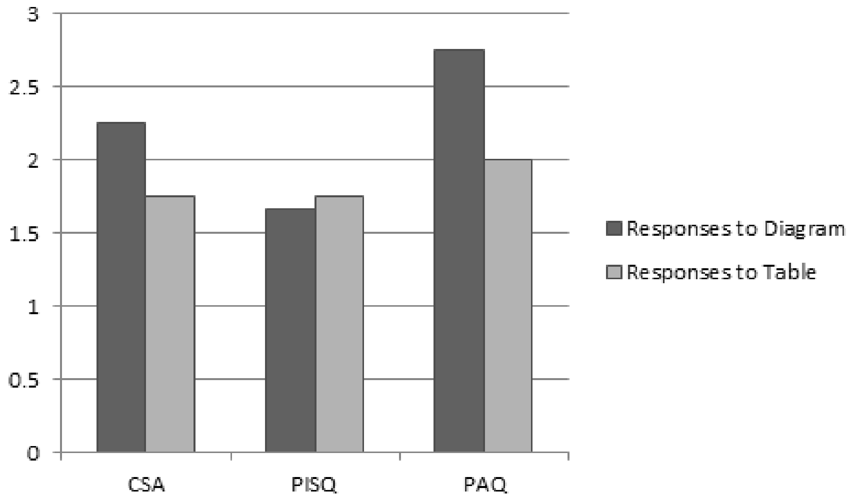

Figure 2. Expert ratings for current situation awareness, prospective information seeking quality and prospective amendment quality

As shown in figure 2, responses to the diagram condition received higher expert ratings for CSA and PAQ. This result provided tentative support for hypothesis two, that responses to the diagram display would achieve higher levels of expert-rated situation awareness (Huggins et al., 2015).

CONCLUSION

The current paper has outlined and discussed two sets of research into how information formats support complex community resilience planning and assessment. Diagram based information displays were developed using an adaptation of the VMEP process in study one. These displays were subjected to experimental testing in study two. Both sets of research were carried to explore how diagram based information may help emergency managers to meet challenges posed by the aggregate complexity of community resilience.

Study one highlighted how the visually rich information displayed in diagrams can be used to highlight collaborative research opportunities which could otherwise be neglected. A shift in researchers' focus, towards more directly pragmatic aspects of research collaborations, appears to have been facilitated through applying the VMEP process. This marks interplay between the use of information formats and surrounding cultural norms.

However, the change observed appears to have only been a temporary exception to prevailing cultural tendencies (Huggins et al., 2015). Collaborating emergency managers and researchers soon reverted to largely text-based modes of interacting. The persistence of text-based approaches to community resilience helps to illustrate how, as outlined by Hutchins (2008), shared thinking processes constitute cultural patterns of behaviour and beliefs within particular groups. The VMEP process can be thought of as a cultural microcosm for participating stakeholders in favour of using particular information formats. In the absence of continued facilitation and organisational support, this microcosm was rapidly subsumed.

Results from study two tentatively suggest that group decision-making using text based information may be a less effective way to meet the challenges of community resilience complexity. However, study two was largely a pilot experiment, focused on developing methods rather than generalizable results. Much more data needs to be generated, collected and analysed to inform a more profoundly cultural shift in emergency management practice.

More generic experimental conditions or a repeated procedure would help generate more data for analysis and help test whether the current findings can be statistically generalised to a wider range of emergency managers and emergency management contexts. Scales used to measure CSA, PISQ and PAQ aspects of situation awareness could form a valuable part of this further research into how diagram based information supports emergency management decisions concerning complex interactions between diverse systems.

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THE EFFECTS OF THE CONSTRUCTION INDUSTRY ON SAMOA'S ARCHITECTURAL RESILIENCE

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ABSTRACT

As the threat of Climate Change looms, extreme weather events, such as cyclones are becoming more common for the Pacific Islands. With 70% of the Samoan population living across their coastline, the country is identified as one of the most vulnerable Pacific Islands. It is prone to high waves and storm surges, along with tropical cyclones, which destroy livelihoods, housing and claim lives.

The traditional architecture of Samoa was originally built to withstand such weather events, but is not built for the increased cyclone intensity and rising sea levels. On the other hand Western building practices can achieve better longevity through material selection but can be found lacking in many tropical weather conditions, which are not faced in the countries they originate from. This contrast remains unresolved, with unsuitable housing remaining one of the largest dilemmas currently faced by Samoan inhabitants.

Samoa is currently considered to be a Least Developed Country, but is soon to graduate to become a Developing Country. This places Samoa as one of the more developed nations of the Pacific, therefore encouraging Samoa to take the lead in resilience to the ever imposing effects of Climate Change. Samoa has a close relationship with both New Zealand and Australia and therefore has access to building expertise, education and materials. Why then, is Samoa so lacking in architectural resilience against the effects of Climate Change?

This paper endeavours to determine the cause for this lack of action and to, in turn, provide potential solutions. These solutions could aid similar problems being faced in other Pacific countries as well as encouraging further architectural resilience that can then be mirrored by the remaining, vulnerable countries of the Pacific.

Key Words: Samoa, Climate Change, Architecture, Construction

INTRODUCTION

The climate problems that Pacific Islands are currently facing require immediate attention, with Samoa as one of the most vulnerable of the island nations. If changes are not soon made, Samoa's rising population could find itself displaced. With predominantly coastal living, the architecture of Samoa is required to have some level of resilience against these weather events. While traditional architecture was developed to deal with the unique climate of the Pacific, it cannot stand up to the extreme weather events being incensed by Climate Change

While Samoa is one of the further developed Pacific Islands, its built resilience is severely lacking, which is preventing the country from reaching self-sufficiency. This lack of action is leading to the nation's loss of livelihood, culture and most importantly, lives. Due to a close relationship with New Zealand, the country has access to high levels of construction education and materials. However, the amount of architectural damages caused by recent weather events, implies that construction education is not being provided with these materials.

The purpose of this paper is to determine the reasons for Samoa's lack of architectural resilience against Climate Change.

LITERATURE REVIEW

In the paper 'Acting on Climate Change & Disaster Risk for the Pacific', World Bank highlights several important points, each reinforcing the point that Samoa, as well as other Pacific countries, must soon develop their architecture and daily living in response to Climate Change (World Bank, 2016).

"Vulnerability is exuberated by poor socioeconomic development planning, which has increased exposure and disaster losses, and by climate change, which is predicted to amplify the magnitude of cyclones, droughts and flooding"

It is shown, in Figure One, that tropical cyclones are the most damaging in terms of economic loss. As Climate Change is set to increase the intensity of tropical cyclones, this loss will only increase. This perpetuates the cycle of Samoan inhabitants losing their housing and then rebuilding in the same style as

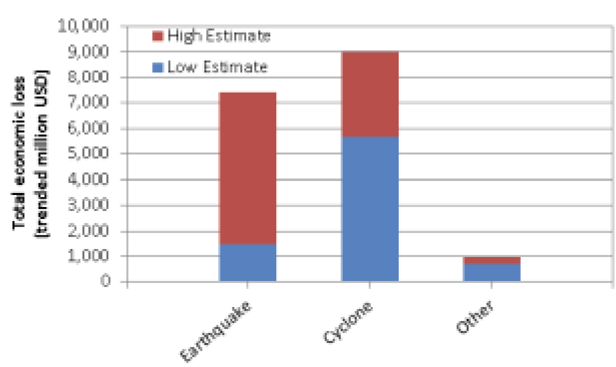

Figure 1: Economic loss due to natural hazards in 15 Pacific countries (World Bank, 2013)

before, only to lose their home once again.

This World Bank paper specifically warns against a continuation of the current way the world is treating the changing climate. The current approach is one that focuses on disaster relief, rather than focusing on mitigating the damages these disasters cause in the first place by focusing on adaptation methods.

A key point investigated during interviews within Samoa, revolved around the difficulties of collaboration between outside countries and Samoa. This difficulty is described by World Bank as a recurring problem, laced with good intentions, that needs to be managed.

“Weak coordination between institutions limits the impact of interventions, and the institutional rigidity of donor organizations can make cooperation and partnership still more difficult”

In these situations, outside organisations come to Samoa to provide relief in the way they see most effective, rather than what the people of Samoa view as effective. This issue is further discussed in Section 3.4.

The World Bank paper is in sync with this paper’s focus that Climate Change is a present and increasing threat on the inhabitants of Samoa. It encourages the implementation of measures to reduce the damage that these weather events can cause.

While World Bank, like many other reports, reinforces the idea that Samoa needs to develop its current way of living, it does not suggest why the country is struggling to make these much needed changes. The position Samoa currently stands in remains relatively undocumented and it is this issue that this building resilience paper plans to deconstruct.

METHODOLOGY

The main methodology followed for this paper was through a narrative approach, which has resulted in qualitative data. This research was carried out over ten days during a research trip to Samoa’s main island, Upolu, in June 2016. The first half of this trip was dedicated to interviews with experts within the varying fields of architecture, urban planning and humanitarian work in Apia, Samoa. The second half of this trip involved collaboration with the Samoan Red Cross Association, including trips to various villages across the island of Upolu. Due to time limitations, expert interview subjects were chosen from those available and working in Apia within the construction/architecture industry, ranging from Urban Designers to Quantity Surveyors. Local interview subjects consisted of those who volunteered, from several villages, all located within Upolu.

This methodology allowed the research to include the personal opinions of people who had experienced disasters, such as Cyclone Evan, first hand. This therefore allows a depth that cannot be achieved through online fact checking.

Field observations were also made as well as research into the focus topics: Samoa and Climate Change. Field observations were most beneficial when inhabitants from small villages were interviewed. With a background knowledge of architecture and construction, the replies given during an interview could be analysed in comparison to the surrounding housing.

A downfall of this methodology is that the information has come from individual interpretations of information and therefore may have been influenced by personal opinions in some cases. However, as all information was gained from residents of Samoa, this allows a uniqueness to this paper where the information is based off a Samoan point of view. It should be understood that due to the nature of this methodology, the bulk of the information is subjective.

Each interview subject for this research signed a consent form, allowing their answers to be shared. A condition of this consent is that the interviewee is not to be named, nor will any information be released that could identify them. Therefore, references used in these interviews identify the subject by their job title only.

EXPERT NARRATIVE

land ownership

Within Samoa there are three forms of land ownership, these are customary, freehold and public land. Public land is owned by the government and makes up 7% of Samoa's land, while freehold is privately owned land and makes up 12% of Samoa. The most common land type is customary land, which is owned communally in accordance to the traditional customs of the Samoan people (Ye, 2010). With 81% of Samoa's land labelled as customary land, any government driven projects to move residents inland is confronted with immediate issues. This is that the bulk of the land is not owned by the government, specifically the Land Titles Investigation Commission, and so cannot be handed out, "the Commission has no authority to make any determination or order if it finds that land in issue is customary land" (Ye, 2010).

With the land lying in the ownership of the *matai* (chief), residents often find themselves with no land to move too. Therefore they are forced to remain by the coast in threatened areas. This is a key issue preventing Samoa from developing resilience as this lack of land choice restricts many changes that could be made.

The building code

Code compliance is another significant issue that was uncovered during the interviews with experts in the building industry. One reason is affordability, this was described by a Climate Consultant, "people can't afford it, they can't afford those materials" (Consultant, Climate Change, 2016). Nor can families afford the labour required to construct buildings up to code compliance. Samoa has minimal resource production facilities and so many materials are shipped in from overseas, hence their exorbitant price.

Gaining a building permit involves applying to Planning and Urban Management Agency (PUMA), this is a Ministry of Natural Resources and Environment division begun in 2002. This area of construction generally works well, although at a minimal speed. The main issues discussed arise after the permit has been approved and the house has been built. Samoa currently has no law enforced that these buildings are then inspected. This means that after gaining a permit, residents can essentially build as they please, to the level of compliance they chose. This issue was outlined by a Quantity Surveyor working within Apia, "lots of residential housing just gets constructed and no one comes and checks what's happening. They don't check the foundations, the structure" (Surveyor, Quantity, 2016).

Both of these issues could be largely improved if there was better construction education available readily within Samoa. Again, this problem was identified by a Climate Consultant interviewed, "your average carpenter on the ground know nothing about it [the building code]" (Consultant, Climate Change, 2016). With a lack of skilled builders Samoa is set to consistently continue the pattern of 'building back the same', rather than the encouraged, 'build back better'.

Hazard identification

While the Ministry of Natural Resources and Environment has worked to produce a map of Samoa displaying the various sites prone to hazards, this has not yet emptied the identified sites. This is due to many issues, one of which has been discussed in Section 3.1, surrounding land ownership. Another issue is generally that communities feel a strong tie to their land, especially to the proximity of the sea. "Our cultural and ancestral ties to the land makes it hard to move away" (Consultant, Climate Change, 2016). A case study of this is expanded upon in Section 4.2.

This is not only seen in the more isolated communities of Samoa, where less options are made available, but is seen in the capital, Apia. Formerly known as

Aggie Greys, the Sheraton Hotel chain has rebuilt this 5 star hotel, right on the coastline, beside a river, well within a flooding zone.

These cases demonstrate how the need for housing land can dominate the long term safety of any land. This is not an issue seen only in Less Developed Countries, but is a problem exuberated within Samoa due to the combination of housing needs and cultural ties to the land.

Collaboration issues

Currently, the main way Samoa gains assistance from outside countries is from humanitarian organisations providing aid. While these organisations have only good intentions, time can often become the most important factor, with cultural and climate understanding taking a back seat.

An example of good intentions gone wrong is the intervention of Architects in Emergencies, an Australian organization (IPA, 2009). Their design strived to provide sanitation as well as shelter, options that are often provided one without the other. Unfortunately, the company's final design consisted of a *fale* shelter with the latrine built right up against the shelter, a copy of this design is shown in Figure Two.

While this design was aimed to be of a great help to victims, the building could not be used, as the intimacy between the sanitation building and the shelter was against traditions generally followed in Samoa. This meant that these designs ended up being used as storage, something not necessary in the case of an emergency.

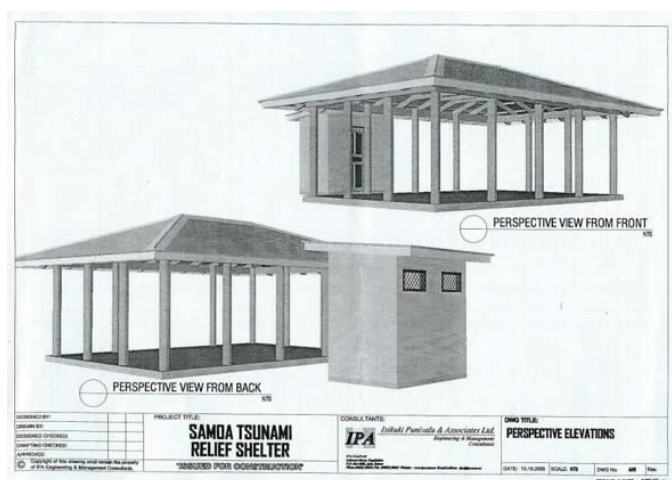

Figure 2: Architects in Emergencies *Fale* Design (IPA, 2009).

While these organisations provide a lot of valuable support, it is plain to see that those who know best are the community themselves. This is why a higher standard of self-sufficiency should be aimed for within the Samoan community so that many repairs can be made internally. Where help is required from external parties, collaborations must be enforced to ensure that a design will be beneficial, rather than a hindrance. An interview with an Urban Design Advisor, working within Apia, reinforced this idea "You need to collaborate with the locals and the villagers for so long before you can even come up with a good design" (Urban Design Advisor, 2016).

LOCAL NARRATIVE

The local people of Samoa have a far more succinct knowledge of Climate Change than even the average New Zealander. The likely reason for this is that most Samoan inhabitants have seen the effects themselves over the past years. This puts them in an optimum position, where building resilience in regards to the changing climate will not be resisted. Interviews conducted with local residents provided insider knowledge as to how inhabitants are already resisting the effects of Climate Change.

This area of the report contains information from several inhabitants from villages across Upolu. The villager's full names are not given, which was agreed upon before the interviews. Further information has been sourced from online research.

The tsunami house

Located on the southern coast of Upolu are a stretch of villages, from Lepa to Lalomanu, which were some of the worst affected in the 2009 tsunami (Pacific Coastal and Marine Science Center, 2009). The typography of Lepa's village layout consisted of a sea coastline and stretch of land backed by a towering cliff. The residents had minutes to react and with a severe lack of preparation, the resultant fatalities were the highest across Samoa (Pacific Coastal and Marine Science Center, 2009). The people of Lepa had chosen to live along the coast line due to the reasons previously stated in Section 3.3, as well as the fact that the resorts dotting the coastline brought in much of the village's income.

While the majority of housing was destroyed by the 10m waves, one design was predominant in the surviving architecture. This was the design which has now been developed into the Tsunami House (Figure Three). This design was then adapted by the Samoan government and was offered to families who had lost their homes. The design follows the basic principles of a traditional *fale* with its open spaces, allowing weather to pass through. Seven years on from the tsunami these designs could still be seen across the island of Upolu. Demonstrating the adaptability of Samoan people, many of the tsunami houses now have add on structures. These are generally in the design of a *fale palangi*, allowing the household some enclosed spaces for security.

The tsunami house itself has proved its performance in the case of extreme weather, but it is unlikely that the attached enclosed housing would fare as well. Residents also stated that they could not remain in this housing during times of extreme weather as it did not offer protection to inhabitants (Resident, 2016). The development of this design displays how traditional housing is most likely the most appropriate, whereas the need for the inhabitants protection, perhaps calls for a hybrid design. However, the issues covered within the Expert Narrative are preventing the people of Samoa from moving forwards with these ideas.

Figure 3: Remaining, abandoned Tsunami houses in Lepa (Image Author's Own)

Relocation

Since the 2009 tragedy, the southern coast villages have been relocated to the top of the cliffs, where the residents now live amongst their plantations. However, while this elevated land is clearly the safer options, many families are still moving back to the coast line and rebuilding. In the case of the subjects interviewed from these areas, the reasons included an innate wish to be near the ocean as well as the hotter climate that comes from living further inland. Interviewed residents also commented that they had to return daily to the base of the cliff to collect water from reservoirs, because rain was not common enough for their rainwater tanks to suffice (Resident2, 2016). A final reason was that the majority of their deceased had been buried on the foreshore, and tradition dictates that they reside nearby. While adaptations have been made, such as the construction of escape routes snaking up the cliff, the people moving back to the coast are still in an immensely dangerous position.

In these situations, it is not necessarily construction problems standing in the way of the inhabitant's safety, but rather, tradition. The prevalence of traditions in countries similar to Samoa is not something to be ignored as it is certainly an aspect of daily lives that built resilience will have to construct any adaptations around.

Community resilience

While the prescribed immediate response after a disaster is Emergency Services, the actual first responders come from within the community. Family ties are important, with extended families generally living within the same villages. This means that families are very rarely left to their own devices and there is always an abundance of help available a few doors down.

Figure 4: Home belonging to interviewee in the village of Aleisa (Image, Author's Own).

This is no different in times of disaster. This was revealed in Samoa following an interview with a family living in the village of Aleisa. This family lived in traditional designed housing, constructed out of western materials, most of which was found material. This house had very little disaster resilience and the family was aware of this. When Cyclone Evan hit, the family evacuated themselves, with no outside help. They relocated down the road to their relative's house, who lived in a concrete block home, designed to resist high wind speeds. After the cyclone this family returned to find their home destroyed. Again, with no humanitarian help, they rebuilt with help from labourers within the village (Resident3, 2016). While the final product, as pictured in Figure Four, is by no means cyclone resilient, the family is not worried for their safety, as they have their relatives just down the road.

This displays just how capable the people of Samoa can be, even without the aid of any outside organisations. While not all residents have a stronger shelter to escape to, those without simply need the education and means to create their own safe shelter. With such a strong sense of community and a willingness to adapt, the local people of Samoa display that with less blockades within the construction industry, Samoa could easily become one of the leaders in Climate Change resilience.

DISCUSSION:

The interviews conducted within Samoa highlighted several clear issues that are preventing Samoa from developing its architectural resilience against Climate Change. The key reason being, a severe lack of education within the construction industry. This issue is increased by a lack of enforced building regulations and a lack of understanding of the building code.

During this narrative research, the people of Samoa clearly demonstrated their own inherent resilience in the face of climate change. The people met with from villages showed a clear interest in learning and improving, they had simply been given no opportunity to do so. Those working within the architecture industry expressed frustration with the current construction normalities. These discussions revealed that the problems with Samoa's resilience does not lie within inhabitants of Samoa, but within the practises that have been insufficient from the day they were implemented.

Samoa has a strong relationship with developed countries such as New Zealand and Australia to the point where Samoa's own building code is roughly based off the two countries building codes. Although the provision of a code to follow, it is of little use if no education is provided concerning how to enforce this code. While these countries provide Samoa with a lot of support, especially post disaster, it is clear that more focus could be focused on disaster mitigation, through education. It is also important that this building code be revised to suit the extreme climate of Samoa and to implement a specialised construction education.

Another issue surrounding the building code is not just that the materials are often too expensive, but that the builders do not have adequate knowledge to use appropriate alternate materials for the climate. This means that low cost architecture is being built well below compliance without the house owner's knowledge. With the implementation of a specialised construction education, climate responsive building techniques could be enforced. These could include basic measures to reduce wind loads as well as elevated structures in flood prone areas. These simple measures being taught to local builders could significantly decrease damage during extreme weather events.

Many of Samoa's current issues do come down to government regulations, a political minefield that cannot be addressed with ease, especially from outside of Samoa. Small changes could be made within the construction industry through the provision of education. Many Samoan students are already choosing to study within New Zealand, by encouraging a career in construction, a higher level of knowledge may soon be the norm within Samoa. By providing further incentives for Pacific students studying within the construction industry, changes could be made beginning from the newest generations.

CONCLUSIONS

Samoa currently sits on the cusp of becoming one of the most influential countries in resilience against climate change. The people of this nation have shown all the attributes of being open to adapting to the World's changing environment. The reason for Samoa's lack of architectural resilience can be sourced to the issues surrounding construction education and regulations.

With Samoa's growing development and close connection to New Zealand it is in a strong position to begin promoting education surrounding code compliance to increase the skill levels within the country. This increased focus on education coming from a country in such a vulnerable position would influence and provide opportunities for other threatened countries within the Pacific. This could allow Samoa to take the lead in developing built resilience against Climate Change.

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EVALUATE HOMES IN PUBLIC HOUSES USING QUALITY OF LIFE TOOL, TALK TO THE BUILDING AND SPACE SYNTAX

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ABSTRACT

Public housing is often stigmatized due to its utilitarian look, repetitive cost effective nature and possibly poor standard of construction. The environment attracts vandalism, crime and suicidal tendencies; resulting in lower house/unit prices. Those lower valuations can defer maintenance and rents drop further till the area starts to additionally have a reputation of being sub-standard. Somewhere in amongst all of that are people constructing their 'homes' regardless of this apparently unfavourable living context. According to a study conducted by Griff Tester and Adia Harvey Wingfield, "….Our findings suggest that respondents consider their public housing residences to be "home," and they construct this meaning using the dimensions of home identified in the literature. However, how respondents used these dimensions were, in some ways, different because of the context of living in public housing. Respondents emphasized the social dimension, and this dimension appeared to organize the other dimensions. As such, our findings support arguments that context matters to the meaning of "home." They also suggest that policymakers need to broaden their understandings of public housing, as places that can be 'home', and use this understanding when making decisions about housing transformations…" (2013, p. 70).

The paper proposes a methodology to evaluate the level of 'home' in current public housing to improve future public 'homes'. Tools proposed for a workable methodology includes Quality of Life Survey, Talk to the Buildings and Space Syntax. The three tools rationalize and validate results of each tool to inform the level of home. While Talk to the Buildings and Space syntax analyses the architectural and spatial aspects of home, the Quality of Life Survey (QoL) through Depression Anxiety Stress Scale (DASS) assesses resident's psychological component on their feeling with the house.

Keywords: public housing, home, Talk to the Buildings, Quality of Life, patterns

INTRODUCTION

Public housing designs are often governed by economic constraints which tend to leads to a generic outcome. As a result, public houses are designed poorly, meeting only the basic necessities of a liveable house. The generic designs are then replicated at high density for even more cost saving purposes. This is evident in past practices, especially in big cities. In Malaysia, public housing design under the People's Housing Project scheme is built across 25 projects resulting in about 24 000 same house units throughout Kuala Lumpur by the year 2020 (Bernama 2010). Modernist views on generic high rise flats as the preferable public housing solution is proven to be more of a failure. This type of public housing largely induced stigma on the building and its residents. Despite being stigmatised, residents of public housing do value their public houses as homes. In a study to define meaning of home in public houses, Griff Tester and Adia Harvey Wingfield found that public housing residents do find their public houses as home but suggested that they construct the meaning of home from the social dimension, less from the physical house itself (2013, p. 70). It is arguable that more can be improved to the physical settings through architectural strategies in initiating the meaning of home. In order to validate and support the argument, we must first gauge the level of homes in current public housing. The paper proposed a methodology consisting of Quality of Life (QoL) survey, Talk to the Buildings and Space Syntax as tools.

LITERATURE REVIEWS

The Meaning of Home in Public Housing

To understand the meaning of 'home', this paper reviewed how 'home' is interpreted in different fields namely architecture, psychology and sociology.

A study conducted by Tester and Wingfield through sociology lenses have shown that residents of public housing construct the meaning of home differently compared to those living in private housing. Literature recognises three dimensions working jointly to create a 'home' namely "material dimension (physical setting and material or personal object in the home that has practical or emotional value), activity patterns dimension (day to day process of making a home that are often connected to a person's place identity), and social dimension (social interactions involving family, friends, neighbours and co-workers) (As cited by Tester and Wingfield, 2013, p. 72). From the study, Tester and Wingfield found public housing residents relied strongly on social dimension in constructing 'home', followed by activity patterns and material dimension (2013, p. 73). Clare Cooper Marcus's conclusion from the psychology point of view that home is constructed through personalisation and movable possessions within the house (1995, p. 59) can be classified under the 'activity patterns and material dimension', which is secondary in public housing environment than it is more important in private housing (Tester and Wingfield, 2013, p. 78). While they are secondary, it is important to note that these dimensions still play a role in 'home' construction. According to Lee Cuba and David M. Hummon, a sense of home is experienced when there is "emotional ties" associated with the physical setting (1993, p.113).

The realm of architecture also supports this as Christian Norberg-Schultz pointed that a home must contain a "poetic relationship to reality" to which brings meaning to its residents (as cited by Nylander, 2002, pp. 10). Efforts of home construct through the physical dimension have been discussed and developed in architecture. Adapted from Christopher Alexander et. al 'A Pattern Language', Jacobson, Silverstein and Winslow narrowed down ten essential patterns that create a home. Each pattern represents desirable qualities of spaces and has been observed to work well within the designed environment. The way each pattern is represented is descriptive of its good quality, providing designers with possibilities of design to achieve the suggested qualities. However, due to economic constraints and legislation restrictions, public housing resident rarely have access to the resources that architecture has to offer for home construct in the physical dimension.

Another aspect considered in Tester and Wingfield's study was the three level of experience of home. Referring to Van Der Klis and Karsten, a house is experienced at three levels: "purely functional or instrumental experience, a well-known and thoroughly familiar experience, and an intimate or personal experience" with the last to identify strongly as a home (As cited by Tester and Wingfield, 2013, p. 72). In the study, Tester and Wingfield found that the social dimension of home construct was experienced by the public housing residents at the intimate and personal level signifying home exist in public housing environment. However, the ways they construct home differs from what is practiced in private houses.

SCOPE

Application of the tools to measure 'home' is limited to existing and lived in public houses. This is to include the social dimension aspect that is regarded as important to home meaning in public housing. Time is also a factor to consider when gauging level of experience. Therefore, the measurement can only be carried out after several years of settlement. This means results gained can be useful to inform design strategies to consider in future public houses and renovation and extension purposes.

METHODOLOGY

A house that encourages a 'sense of home' strengthens the relationship with its owner. Often, building resilience is viewed in the physical terms. This paper engages resilience in its physical and immaterial sense. The component that makes a different between a house and a home is the emotional bond that residents have toward their houses. This paper recognises 'home' rather than a house to be resilient. To measure the level of home, the three dimension mentioned by literature should be address in this research. Therefore, the tools Quality of Life Survey, Talk to the Buildings and Space Syntax is proposed.

Quality of Life Survey

The Quality of Life survey uses the Depression Anxiety Stress Scales (DASS) DASS contains set of 42 questions to evaluate a person's wellbeing. DASS 42 was developed by the Psychology Foundation of Australia at the University of New South Wales. According to the Psychology Foundation of Australia, DASS can also be assessed through a shorter version consisting only 21 questions (2014).

For this research, DASS's survey questions that cover emotional and psychological wellbeing will be able to inform a person's feeling towards a situation. In detail, it seeks to identify depression, anxiety and stress condition in a person. DASS's set of questions tackles the three conditions through 7 to 14 items for each condition. However, the statement for the items are general, not centred to a situation, allowing for misconstrued of results and endless possibilities of reasoning and factors contributing to the results. Therefore, it is suggested that the questions are to be tailored by narrowing down the scope to the house or home. According to Tinkler et al, the subjective well-being approach that DASS has taken assesses a person's well in terms of life satisfaction, happiness and psychology. It is subjective due to the nature that the responses are ranked according to their significance rather than providing the real accounts or information (as cited by Santosa, Potangaroa, & Siregar 2012). Evaluation on the well-being of public housing residents through DASS enables identification of characteristics that high scorers hold based on interpretation made by developer of DASS (refer to Table 2 below).

Type of scale	**Characteristics to identify**
Depression	1. self-disparaging 2. dispirited, gloomy, blue 3. convinced that life has no meaning or value 4. pessimistic about the future 5. unable to experience enjoyment or satisfaction 6. unable to become interested or involved 7. slow, lacking in initiative
Anxiety	A. apprehensive, panicky B. trembles, shaky C. aware of dryness of the mouth, breathing difficulties, pounding of the heart, sweatiness of the palms D. worried about performance and possible loss of control
	- over-aroused, tense - unable to relax - touchy, easily upset

Stress	• irritable • easily startled • nervy, jumpy, fidgety • intolerant of interruption or delay

Table 2. Characteristics to different type of scale. Source: Psychology Foundation of Australia, 2014. Web.

The Quality of Life survey has proven to be useful in research previously. DASS survey was carried out by Santosa, Potangaroa and Siregar on residents of informal settlement in Surabaya, Indonesia to assess their wellbeing. The data collected revealed the core social dimension aspects that contributed to their wellbeing. It shows that DASS is useful at measuring people's wellbeing and addresses the social dimension aspect at the same time.

- ***Advantages of DASS***

Since DASS works in numerical scale, it reduces the complexities of having to deal with and interpreting meaning behind different information. Operating on ranking scale allows one to gauge the severity extent of a problem. DASS questions the phenomenologically based such as feelings toward a space or situation, allowing psychological insight (Santosa, Potangaroa, & Siregar, 2012). Other than that, the method can be assessed at the individual or group level (Psychology Foundation of Australia, 2014). Group classifications can be formed to compare a group's wellbeing in different aspects such as housing, social dimensions related or health.

- ***Limitations of DASS***

There are limitations to using DASS for this research. While the subjective well-being approach simplifies data collection and interpretation; results from the survey cannot reveal specific cause of the problem, hence, will not point to the specific part of design that is problematic.

Talk to the Building

Talk to The Building deals with quantifying good qualitative architectural values. The approach is relevant because it recognises Alexander's pattern language as the design aspects to be looked for in a building. Regan

Potangaroa developed the approach as a means to measure the significance level of patterns that appear in a building. The levels of significance of a pattern in a building is set on a scale ranging from 0 to 1 with 0 being none existing, 1 being 'Not significant' and 4 being 'Very significant' (Jokatama, Panko, & Potangaroa, 2013, p. 5). Though a number of combinations of patterns can be chosen out of the 250 patterns for evaluation, the patterns must be chosen depending on type of building and a set of design goals to be achieved. For the research on home, Potangaroa referred to the 10 essential patterns that make a home as suggested by Jacobson. The patterns include:

- Inhabiting the site
- Creating rooms
- Sheltering roof
- Capturing light
- Parts in proportion
- Flow through rooms
- Private edges, common core
- Refuge and outlook
- Places in between
- Composing with materials

Each of the ten patterns suggested by Jacobson et. al to be a home is to be scored accordingly during a site visit with the scores recorded in a Matrix table as below (Table 1).

Village Analysis Spreadsheet

Number of houses = 109

Pattern:	outside front	porch	alleyway	outside back	lounge	kitchen	toilet	bedroom	rooftop	totals
inhabiting the site	54	46	42	78	42	28	3	23	13	329
creating rooms	33	30	32	68	15	13	2	14	7	214
sheltering roof	29	17	10	51	1	2	0	1	5	116
capturing light	10	5	5	12	8	13	5	2	1	61
parts in proportion	25	19	13	29	2	5	1	3	1	98
flow through rooms	25	28	12	40	18	3	2	3	2	133
private edges, common core	26	8	21	37	27	4	1	11	4	139
refuge and outlook	28	44	24	26	21	2	0	2	9	156
places in between	38	32	32	59	5	3	2	15	4	190
composing with materials	31	15	20	43	3	3	1	3	3	122
totals:	299	244	211	443	142	76	17	77	49	

total mods. for house= 1547

Average per house= 14.2

Table 1. Matrix used to evaluate patterns in houses in Tamil Nadu. Source: Regan Potangaroa and Vicky Feng. 2013. Web.

- ***Advantage of Talk to the Buildings***

The approach has many advantages. Firstly, it enables us to gauge the level of home based on credible qualities of home and meaning of home prescribed by theorists. The method investigates good designs evidenced by eight years of research by designers and architects (Alexander, et al., 1977, p. x). Furthermore, the method acknowledges qualitative aspect of design within numerical end results. This gives the method a rich humanistic and deeper approach to home design. Some if not all patterns have been considered on its phenomenological impact towards the sense of space. As in the pattern Parts in Proportion, it strives for a "comfortable feel" by ensuring good proportional and balanced relation between all components in a house (Jacobson, Silverstein, & Winslow, 2002, p. 129). The term comfortable feel are expressive and can only be understood at the humanistic level.

- ***Limitation of Talk to the Buildings***

One of the limitations is the different reading that different people interpret when engaging with a pattern. A person may interpret a different level of significance than another depending on their abilities to recognise the patterns. Referring to the way Jokatama, Panko, & Potangaroa use the approach in their studies, it can be established that training and experience is required prior to conducting the approach in order to gain a reliable set of results (2013, p.5).

Space Syntax

Space Syntax is a tool used to "understand the relationship between spatial design and the use of space as well as longer term social outcomes" (The Bartlett Space Syntax Laboratory, 2016). It works by outlining space into grids to be analysed. According to Potangaroa, the analysis is based on the understanding that space can be divided into smaller areas, "analysed as network of choices" then have the results mapped and graphed showing "connectedness and integration" of the grid spaces (2010, p.3). For this paper, the "isovist map" approach proposed. Benedikt described that an "isovist map" maps the areas that can be view from a certain point (As cited by Potangaroa, 2010, p. 3). The approach can identify the flow between public and private areas which relates to Alexander's pattern 127: Intimacy Gradient, Alexander et al mentioned that "Unless the spaces in a building are arranged in a sequence which corresponds to their degrees of privateness, the visits made by strangers, friends, guests, clients, family, will always be a little awkward" (1977, p. 610). The same element of design is apparent in the pattern Private Edges, Common Core. According to Potangaroa, there are three common analysis methods which includes:

- Integration which is defined by “depth”, based on the number of turn it takes for one to move between spaces. The most integrated area or public is marked in red while the least integrated or private in blue.
- Choice shows the flow of space by measuring fluidity of the space.
- Depth distance measures the relativity of depth of a space to all other spaces. This is represented by a graph and mapped numbers (1,2,3,4,...) according to level of depths of the spaces.

(2010, p.3)

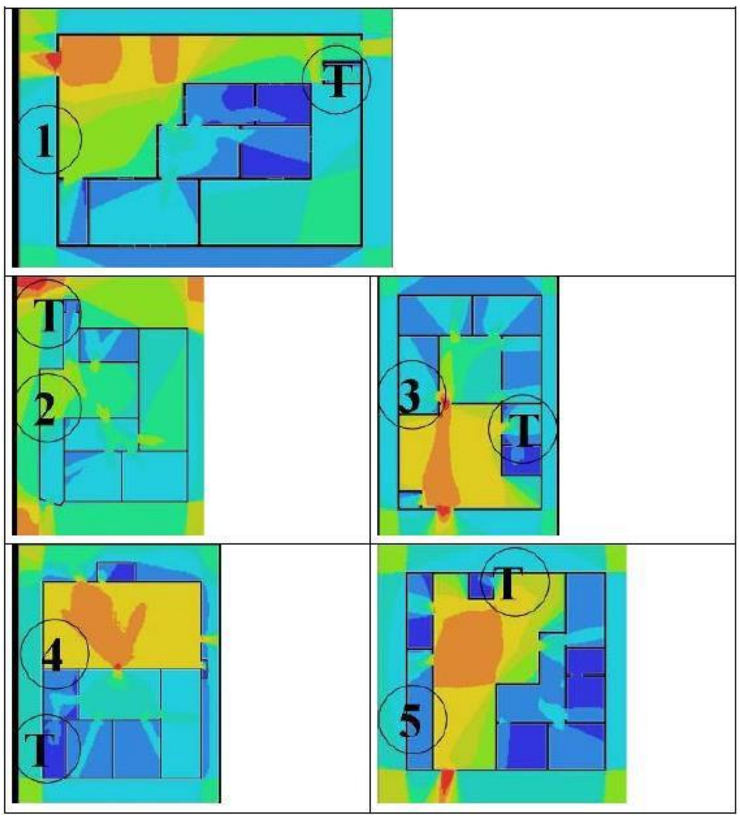

Diagram 1. Isovist maps of the 5 Iraqi houses. Source: Regan Potangaroa. 2013. Web.

A study using DepthMap software to carry out Space Syntax analysis has been carried out by Potangaroa. The research observed and measured spatial configuration of five houses at El Hop camp in Syria (refer to Diagram 1). Similar with the purpose of this paper, the research also enquires home vs house within the five households.

- ***Advantages***

Space Syntax is able to measure and map spatial configurations that allows an understanding on how the space will work socially. Thus, it addresses the concern of social, physical and activity patterns dimensions that is required to measure level of home in public housing.

- ***Disadvantages***

The degree of accuracy of space syntax analysis depends on how the space plan is modelled. A more detailed plan will produce more accurate outcomes. However, it needs to be noted that windows and openings other than doors are not considered in the analysis. It is suggested that researchers takes this into consideration when analysing or adopt a reasonable substitute openings representing windows.

CONCLUSION (Summary and Recommendation)

Conclusively, the QoL, Talk to the Buildings and Space Syntax covers the investigation of the social, physical and activity patterns dimension suggested to be the key constructs for a home. By utilizing the methods together, a comprehensive evaluation can be achieved to evaluate homes. The methods can bring us forward to understanding the link between people's wellbeing of the mind with space and how we are affected by certain spaces. DASS has been used internationally in different languages to identify emotions of depression, anxiety and stress. This shows the large extent of coverage that the tool can serve including for home evaluation in public housing. The second part of the methodology called Talk to the Buildings heavily assesses the architectural side of housing but evaluate its human side. Thus, this tool mediates well with the DASS survey. Space syntax measures the physical dimension in terms of intimacy gradient which can suggest how the activity patterns will work. The case studies in Tamil Nadu and Iraq have displayed the usefulness of QoL (DASS) and Space Syntax respectively. Due to the in depth analysis needed for each tool, it is recommended that the evaluations are carried out by an experienced and trained person for reliable set of results.

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A SURVEY ON ECONOMIC VULNERABILITY AND RESILIENCE TO NATURAL HAZARDS

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ABSTRACT

With the successful shift from a hazard-centered disaster paradigm to one that places emphasis on the influence of vulnerability and resilience, disasters triggered by natural hazards have since been perceived as un-natural occurrences. To date, the theoretical conceptualization and empirical measures of vulnerability and resilience remain subjects of contentions. This survey of the economic literature aims to describe the progress made in the conceptualization, and measurement of the economic dimensions of vulnerability and resilience in the context of natural hazards, and to provide useful insights for policy-making. Economic vulnerability and economic resilience, interacting with the hazard itself and the exposure of populations and physical assets, are considered critical determinants of the resulting impacts of disaster – be they direct or indirect. The empirical evidence provides systematic support for the hypothesis that apart from the characteristics of the hazards, the potential for people and economies to avoid adverse impacts and their capacity to withstand and rebound from a disaster are influenced by a confluence of socio-economic factors. Vulnerability is predominantly a pre-disaster concern, while resilience is mainly considered post-disaster. Hence, vulnerability is typically linked to prevention, preparedness and mitigation; while resilience, to response, rehabilitation, reconstruction, and recovery. A high level of socio-economic development, whether at the country or at the household level, reduce vulnerability and improve resilience. Noteworthy is that social conditions matter more than the level of income in reducing vulnerability. Policies that are most effective in minimizing indirect impacts and spillover effects are along the provision of adequate access to funds to hasten macroeconomic, as well as household-level recovery.

Keywords: Disaster, disaster risk reduction, economic resilience, economic vulnerability, natural hazard

BACKGROUND

With the successful shift from a hazard-centered disaster paradigm to one that places emphasis on the influence of vulnerability and resilience, disasters triggered by natural hazards have since been perceived as un-natural occurrences. Consequent to this paradigm shift is the heightened interest by a multiplicity of disciplines in gaining a deeper understanding of the important underlying vulnerability factors that allow hazards to become disasters. From this increasing understanding of vulnerability emerged a likewise increasing appreciation of the distinct role of resilience in shaping the consequences that follow from the resulting direct disaster impacts.

A number of comprehensive reviews reveal the distinct conceptualization of vulnerability and resilience in each of the disciplines and communities involved in the natural hazards discourse (Birkmann, 2006; Gaillard, 2010; Thywissen, 2006; Villagran de Leon, 2006). To date, the theoretical conceptualization and empirical measures of vulnerability and resilience remain as subjects of contentions. A seemingly dominant view is that vulnerability is the component of disaster risk that explains the varying impacts on elements that have the same level of exposure to a given hazard. Resilience is what enables the exposed elements to withstand, cope and recover from disaster impacts. Economic vulnerability and economic resilience, interacting with the hazard itself and the exposure of populations and physical assets, are considered critical determinants of the resulting impacts of disaster – be they direct or indirect. Indeed, disasters are largely influenced by economic forces so that "the very occurrence of disasters is an economic event" (Cavallo & Noy, 2011).

Against this backdrop, this quick survey of literature aims to describe, in the context of natural hazards, the progress made in the conceptualization, measurement, and identification of the determinants of the economic dimensions of vulnerability and resilience using econometric methods. Further, this aims to synthesize the relevant empirical work to provide broad insights for policy decision-making.

CONCEPTUALIZATION OF ECONOMIC VULNERABILITY AND ECONOMIC RESILIENCE

Apart from the separate efforts of the various academic disciplines (e.g. sociology, geography, economics or public health), the definitions and frameworks relating to vulnerability and resilience continue to evolve by their usage within the disaster risk reduction (DRR) community, and the climate change community. The year 2014 saw the harmonization of frameworks between these two communities. The IPCC's Fifth Assessment Report (IPCC, 2014) presented a risk framework that mirrors that of the DRR community's risk equation: *Risk = Hazard x Exposure x Vulnerability* (UNDP-UNDRO, 1992; UNDRO, 1979).

The UNISDR (2009) defines these variables: *Risk* is "The combination of the probability of an event and its negative consequences"; *Hazard* is "A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage"; *Exposure* refers to "People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses"; and, *Vulnerability* refers to "The characteristics and circumstances of a community, system or assets that make it susceptible to the damaging effects of a hazard". Recent developments include frameworks that add resilience as a separate and distinct component of disaster risk. The UNISDR (2009) defines *Resilience* as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."

In Economics, the concept of vulnerability is typically applied to four areas of interest, other than disasters: poverty, food security, asset vulnerability, and sustainable development (Alwang, Siegel, & Jorgensen, 2001; Moret, 2014). Most often, vulnerability is analyzed in the study of the dynamics of poverty, focusing on the "risk of falling into poverty or deeper into poverty" (Moret, 2014). Likewise, resilience is used in three research strands: economic shocks; sustainability; and, institutions (Rose, 2009).

In a review of the economic literature on natural hazards and disasters, Rose (2009) presents a list of suggestions for integration into the existing conceptualizations of economic resilience. Foremost is the need to distinguish between damages to stocks (i.e. property damages), and damages to flows (i.e. damages to production of goods and services). While the former are incurred all at once at the time of the shock, the latter, however, will continue to be incurred until full recovery is achieved. Thus, as argued, damages to flows are more relevant to the economic resilience concern. Further, behavioral and policy dimensions also need to be duly considered as these affect the pace of recovery. Furthermore, there is also a need to consider the temporal aspects of resilience: static vs. dynamic resilience, and shorter vs. longer-term. Likewise, context, capability, market, cost, process and fairness dimensions need to be integrated into the definition (Rose, 2009).

Considering all of the above, Rose (2009) defines economic resilience as "The process by which a community develops and efficiently implements its capacity to absorb an initial shock through mitigation and to respond and adapt afterward so as to maintain function and hasten recovery, as well as to be in a better position to reduce losses from future disasters". In terms of interventions, preventative actions or mitigation measures reduce the magnitude of the hazard and/or the probability of a disaster to occur, and reduce vulnerability (Rose, 2004, 2007). Alternatively, disaster impacts can be reduced through resilience, particularly through ingenuity, resourcefulness, and speedy repair and reconstruction (Rose, 2004, 2007).

Similarly, Hallegatte (2014) adds economic resilience as a fourth component, along with hazard, exposure and vulnerability, thereby extending the typical disaster risk equation into an "economic welfare disaster risk". Here, resilience refers to the economy's ability to minimize people's welfare losses from a disaster. As argued, the direct damages to assets do not fully capture the adverse impacts on people's welfare. These asset losses (i.e. reduction in the value of the *stock* of assets) lead to consequent output losses (i.e. reduction in the income *flow)*, and consumption, which, together with asset losses, better captures the welfare losses resulting from a disaster (Hallegatte, 2014).

An important feature of this framework is the consideration of both macroeconomic and microeconomic aspects of resilience. On one hand, resilience at the macro level is determined by the economy's ability to limit the immediate losses in income resulting from losses in assets (or the economy's instantaneous resilience), and by the economy's ability to "reconstruct and recover quickly" (or the economy's dynamic resilience) (Hallegatte, 2014). On the other hand, resilience at the micro level is influenced by the distribution of the losses incurred across the affected households, the household's ability to smooth their consumption and their access to risk sharing schemes (Hallegatte, 2014). As proposed, there are two approaches to reduce 'economic disaster welfare risk'. The first is to reduce the direct impacts of disasters on assets, and the second is to reduce the output losses resulting from the asset losses. The former entails reducing vulnerability and exposure, while the latter entails increasing the resilience, both at the macro and micro levels.

DETERMINANTS OF ECONOMIC VULNERABILITY AND RESILIENCE

In many disciplines, a commonly used method to assess vulnerability and resilience to natural hazards is the index method. Within Economics, econometric methods are typically used, although other quantitative algorithms are also being used. This section focuses on the results of econometric studies, which can be categorized into two strands according to the research question posed. The first strand seeks to identify the factors affecting the direct impacts of disasters on people (i.e. deaths and affected persons) and assets (i.e. damage to properties). The models generally take the following form: $_{it} = {}_0 + {}_1 az_{it} + {}_2 xp_{it} + {}_2 Vul_{it} + \varepsilon_{it}$; where *i refers to* spatial unit *i* at time *t*; *and Y*, *Haz*, *Exp*, *Vul* correspond to Risk, Hazard, Exposure and Vulnerability in the standard risk equation discussed earlier.

By controlling for hazard characteristics and exposure of people or assets, these empirical models generate insights about the determinants and extent of vulnerability of the exposed.

There is a general consensus among existing cross-country empirical studies that a country's level of economic development is inversely related to its vulnerability to disasters (Anbarci, Escaleras, & Register, 2005; Kahn, 2005; Peduzzi, 2006; Raschky, 2008; Toya & Skidmore, 2007). As Kahn (2005) asserts, economic development serves as an "implicit insurance" that cushions the adverse disaster impacts on people. Social conditions, particularly education, matter more than the level of income in reducing disaster deaths in less affluent countries (Toya & Skidmore, 2007), and unplanned and mismanaged urbanization either create or enhance people's vulnerabilities to disaster impacts (Kellenberg & Mobarak, 2008). Likewise, there are fewer fatalities among countries with better institutions because inequality is lower, resource allocation is better, and laws and legislations are in place and are effectively enforced (Adger, 1999; Kahn, 2005; Raschky, 2008). In a sub-national panel econometric study along this strand of research, Yonson, Gaillard, and Noy (2016) found that in the context of the Philippine provinces, poverty and people's exposure matter more than the hazard itself in determining deaths from tropical cyclone disasters.

The second strand of econometric studies aims to measure the indirect or follow-on economic impacts of disasters typically in either the short-run (months to several years) or long-run (at least 3 to 5 years). These studies also attempt to understand the factors that influence these follow-on impacts, thereby also providing insights on the determinants of economic resilience. As surveyed by Cavallo and Noy (2011), these models generally take the following form: $_{it} = + \, _{it} + \, S_{it} + \varepsilon_{it}$, where Y_{it} is the economic indirect impact for a spatial unit *i* at time *t*. These indirect impacts may include GDP (or growth), GDP per capita, human development index, poverty and employment, among others. DIS_{it} is the immediate disaster impact to assets and/or to population. In some studies, this includes the hazard characteristics. X_{it} is the vector of control variables affecting Y_{it} (Cavallo & Noy, 2011).

Using a panel dataset for 109 countries covering 1970 – 2003, Noy (2009) aimed to quantify the short-run impacts of disasters on the macro-economy, and to examine the determinants of these impacts. The results reveal that countries with higher income per capita, greater trade openness, and literacy rate, higher levels of public spending, and better institutions are able to withstand the initial impacts of disasters, and are also able to prevent spillovers. Noy (2009) attributes this to the capacity for resource mobilization to implement the necessary reconstruction.

Like Noy (2009), Hochrainer (2009) finds evidence of the negative consequences of the direct disaster impacts on capital stock to macroeconomic output, though the focus of the latter is on the medium-term and long-term (five years). Results further show that the inflows of remittances and aid significantly reduce the adverse macroeconomic consequences. Overall, while the direct impacts on capital stock have a strong influence on the follow-on impacts of disasters on output, external funds also have influence on post-disaster dynamics (Hochrainer, 2009).

In a similar attempt, Mechler (2009) measures the corresponding changes in consumption to determine welfare changes due to the occurrences of disasters. Results for the global sample of countries show that asset losses do not cause significant changes in consumption. However, using a smaller sample with low-income countries only, it is found that asset losses do adversely alter consumption. Moreover, the results reveal that inflows of regular and post disaster aid result to improvements in consumption among low-income countries.

Noy and Vu (2010) undertook one of the earliest sub-national empirical inquiry using the provinces of Vietnam for 1995-2006. Areas with higher level of development, and have better access to funds for reconstruction from the central government experience the 'creative destruction' dynamics, and a consequent short-run growth spurt in the disaster aftermath. The authors claim that this provides support for an earlier observation by Cuaresma, Hlouskova, and Obersteiner (2008) that areas with high level of development benefit from capital upgrading for assets damaged during a disaster.

The household level micro-econometric study of Antilla-Hughes and Hsiang (2013) examines tropical cyclones and study the Philippines. Results reveal that consequent to the sharp drop in household income due to disasters are alterations in investment, expenditure and consumption patterns. There is reduction in investments in human capital, and a reduction in household expenditures on medicine and nutritious foods. Several other papers report similar findings for other case studies (surveyed in Karim and Noy, 2013); but neither of these examines whether these short-term patterns of impact on investment in health and education have any long-term impacts. An exception is Caruso and Miller (2015) that find that these impacts on education persist even in the second generation after a catastrophic event (in their case, an earthquake in Peru in 1970).

Arouri, Nguyen, and Youssef (2015) undertook a household level study on Vietnam to determine the effects of floods, storms and droughts on household welfare, and to identify the factors shaping resilience. It is argued that resilient households experience relatively less adverse disaster impacts on their welfare, as proxied by income per capita, per capita consumption expenditure, poverty status of households, and share of income of alternative sources of income (Arouri et al., 2015).

For storm-related disasters, households with either fewer working-age members, those with more members, or those belonging to the ethnic minority groups are less resilient. Access to finance—such as microfinancing, internal remittances, international remittances and social allowances – and education positively affect resilience. Households in communes with either more equal distribution of expenditure or higher level of average per capita expenditure are found to be more resilient.

SYNTHESIS AND IMPLICATIONS FOR POLICY

The empirical evidence provides systematic support for the hypothesis that apart from the characteristics of the hazards, the potential for people and economies to avoid adverse impacts and their capacity to withstand and rebound from a disaster are influenced by a confluence of socio-economic factors. Hence, DRR measures must include an appropriate mix of structural and non-structural measures that aim to affect these factors. Further, the findings depict the interrelatedness of vulnerability and resilience. Vulnerability is predominantly a pre-disaster concern, while resilience is mainly considered post-disaster. This implies that in terms of DRR priorities, vulnerability is typically linked to prevention, preparedness and mitigation; while resilience, to response, rehabilitation, reconstruction, and recovery

A high level of socio-economic development, whether at the country or at the household level, reduce vulnerability and improve resilience. What this means in practical terms is that assistance and investments in development will yield the greatest benefits if less affluent countries and poor households, particularly those with high exposure, are favored. A notable finding is that social conditions may matter more than the level of income in reducing the direct disaster impacts thereby pointing to the kind of interventions needed to effectively address vulnerability.

The findings consistently suggest that policies that are most effective in minimizing indirect impacts and spillover effects at the macroeconomic level are mainly about the provision of adequate access to funds, including aid, to speed up the reconstruction, rehabilitation, and subsequent economic recovery. External and internal sources of funds are likewise critical for household-level recovery. With the apparent critical role of credit and access to funding, more research on financial risk-transfer tools, such as insurance, as a tool for building resilience is still required.

Results of the global and country-level studies provide general indications on what broadly determines vulnerability and resilience across countries, and how each country fares against others. Sub-national and household level assessments are better able to capture context-specific concerns; hence, their findings have greater practical usefulness to any country.

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SEISMIC RESILANCE OF INDONESIAN VERNACULAR ACHITECTURE IN A NEW ZEALAND CONTEXT

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ABSTRACT

Innovative solutions to improve seismic resilience of New Zealand buildings can be found in the exploration of traditional Indonesian construction techniques. Currently, Indonesia's vernacular architecture sits on the verge of extinction after a cultural shift towards the masonry bungalow forced a rapid decline in their occupation and construction. The 2004 Indian Ocean earthquake and tsunami illustrated the bungalows poor performance in the face of catastrophic seismic activity, outperformed by traditional structures. This has been particularly evident of the *Rumah Aceh* in Aceh province in Northern Sumatra. Although there have been attempts to adopt a semi-modern concept between the two styles, the majority of vernacular modernisations are an imitation of form. This negates any construction techniques beneficial to the buildings resilience which has ensured their structural integrity for generations. Within a New Zealand context, an adaptation and modernisation of Indonesian vernacular construction will generate an architectural response not currently accepted under the scope of NZS 3604:2011. The standards most recent revision arose from discussion of timber-based seismic performance following the Canterbury earthquake of 2010. This exploration will further address light timber structures and their components, sustainability and seismic resilience. Improving new builds durability as New Zealand move away from our own, previously promoted bungalow model.

Key words: Indonesia, NZS 3604, Seismic resilience, vernacular

Building Codes are continually amended and refined to improve seismic resilience of New Zealand buildings. Historically, amendments are made following a natural disaster, which has highlighted the shortcomings of current building practises when collapse or severe damage to buildings result.

This pattern has occurred repeatedly since regulated building practises were implemented across New Zealand in 1935. A direct result of the 7.9 (M_L) earthquake that devastated much of Napier in 1931 (Wolfe, 2013). At this time many countries upon realising various imported typologies' inability to response to similar seismic events, due to their construction methods, had already begun to develop modern earthquake designs (King) (Gutierrez, 2004).

More recently, significant developments to the New Zealand Standards were made following the 2010 Christchurch 6.3 (M_L) earthquake. Resulting in the latest adaptation of NZS: 3604 regarding 'non-specifically engineered timber framed structures'. Amended to better reflect the natural environment and locations on which we build (Standards New Zealand, 2011). This included improved earthquake hazard maps, earthquake zone classifications and the introduction of soil classification considerations, as some soil profiles are likely to amplify the seismic waves by several orders of magnitude which drastically affects the structures intensity of shaking during a seismic event (King).

These amendments further improved the seismic resilience of New Zealand timber framed housing. However, they are firstly over 80 years old and based on a sparse number of seismic events: and secondly appear to adopt (perhaps understandably) the need to anchor the building to the ground. They focus on 'force reduction factors' rather than designing for earthquake forces in their entirety (Langenbach, 2010) assuming a level of inelastic behaviour to dissipate seismic energy.

While logic prepares us to think that modern construction techniques should be regarded as preferable (Ortiz-Palacio, Ibanez, Lopez-Ausin, & Porres) previous papers have argued, with convincing evidence, that there could be lessons taken from vernacular architecture, as selected vernacular buildings have reportedly out performed current ones (Sassu) (Langenbach, 2010) (Gutierrez, 2004) (Gautam, Prajapati, Paterno, Bhetwal, & Neupane, 2016)

Vernacular buildings have been around much longer and have, just like their contemporary cousin, been developed after disasters but instead over hundreds of years and many more seismic events.

Moreover, they demonstrate a wide variety of approaches rather than a singular tactic.

This longevity inherently links the built context with the social and religious strata of the culture as much as the physical requirements posed by the environment (Gutierrez, 2004). The resulting vernaculars can be a highly developed response praised by architects, engineers and cultural anthropologists as being extremely effective solutions to the needs of their dwellers. Only modified as a result of persistent and extraordinary circumstances. (Gutierrez, 2004) The question 'Could selected vernacular seismic exemplars be used and adapted to the current New Zealand context?' should be considered as a viable exploration of building resilience.

New Zealand' seismic vernacular heritage appears to be sparse. Maori, New Zealand's Indigenous people, had little over 750 years to progress a vernacular prior to European arrival (Memmott & Davidson , 2008) (Taylor, 1966). This is a significantly shorter period then many indigenous cultures. The vernacular culminated in a variety of post and beam buildings. Smaller dwellings such as sleeping houses where typically simple in design and construction, consisting of two primary posts erected to support a singular ridgepole. The roofing and walls were a framework of saplings fastened to the primary structure with vines, overlaid with thatch and secured additionally with two horizontal poles running the length of the roof on either side. (Taylor, 1966). While forms varied and developed over time, the use of lightweight materials on rammed earthen foundations was the primary structural resilience against seismic activity[1].

In the event of an earthquake these small timber structures were ductile enough to flex and under extreme duress collapse without killing the occupant. After a collapse the structure could be easily reconstructed and elements replaced, honouring the Maori philosophy of built forms having a life cycle and respecting Ruaumoko, the Maori god of earthquakes (Gutierrez, 2004). These events ensured community engagement during reconstruction and the transfer of skills to the next generation. (Memmott & Davidson , 2008) However 'Resilience' within this framework refers to the ability to quickly and easily rebuild not longevity, as is the incentive of contemporary New Zealand building culture (Standards New Zealand, 2011)

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[1] Primary architectural forms of high importance such as *Marae*s involved larger structural elements making them heavier and less

able to benefit from the resilience installed in smaller dwellings. It is therefore perhaps more apt to explore a vernacular example that does embody our current expectation of 'resilience' such as the *Rumah Aceh* from Indonesia.

Rumah Aceh, or Aceh house, is the ingenious dwellings of Aceh Province located at the Northern most point of Sumatra, Indonesia. This paper limits the scope of Indonesian vernacular examples to the Aceh region as, much like New Zealand, Aceh is under constant threat from seismic activity. Both Regions are located at the meeting point of tectonic plates and share a recent history of devastating seismic events.

A research trip to Banda Aceh in May of 2016 allowed for the exploration of the Rumah Aceh's seismic resilience in person. With support from Syiah Kuala University, a research team was assembled and assisted a study in Lubuk, an inland settlement where many occupied examples of vernacular architecture remain. 10 Rumah Aceh's where selected to be evaluated, employing several methodologies.

At each dwelling 1:1 'semi structured interviews' (Kajornboon) were conducted with the occupants of the 10 Rumah Aches being assessed. Selected undergraduate architectural students of Syiah Kuala University carried these out. Interviews were conducted in Bahasa following an interview guide written by the lead researcher, primary author of this paper. Interviews where then translated by the students at a later date. The goal was to understand the occupant's perceptions on the Rumah Aceh and its success, in their view, as their primary dwelling whilst gaining knowledge on the structure and construction process. This was aided by visual documentation of the buildings', gathering data to visually assess the primary elements that provide the seismic resilience as understood by prior established construction principles (King).

Rumah Aceh's are timber post and beam structures which are erected on flat rocks or concrete plinths without foundations. Built typically 2.5 – 3 meters above ground with variations ranging as low as 0.5 meters. The structure consists of 4 posts across, creating 3 bays, clearly outlining front, middle and rear of the house. The middle section is typically 50 – 75 cm elevated above the back and front rooms. The length varies depending on the size requirements but is easily amended by adding additional bays.

Yet, Rumah Aceh's in Lubuk did not escape the urbanisation process and all 10 houses surveyed have incorporated various aspects of modern housing. This development began as local perception of ousing was altered with the change of living needs and improvement of amenities became available (Ly, 2012). Such modernisations often included living spaces on lower levels to accommodate older family members, modernised kitchens and bathrooms. This was accomplished by enclosing various portions of the bays underneath the original structure with clay brick construction and concrete render.

Figure 01. 'Modern addition to existing Rumah Aceh. Enclosing rear bay and extension to rear, clay brick construction with concrete render'

Earthquakes, such as the 2004 Indian Ocean Tsunami, showed that predominately housing with masonry structure was affected. It has been suggested this resulted from the limited understanding local people and builders have on how to properly create safe dwellings with new materials given their inelastic properties and new construction methods (Tuan Anh & Van Giai Phong, 2014).

Changes to the original Rumah Aceh are limited to the removal of internal columns to provide space below and above, altering the way internal spaces are divided. It is important, however, to distinguish that it is simply a variation within a given order – a manifestation of unselfconscious design. The case studies provided show that adaptations to modernize the Rumah Aceh do not involve adjustments to the construction of the original structure. Suggesting that in an earthquake the primary structure, due to its unique seismic resilience, would continue to survive even if the newer addition were to fail and collapsed below it.

Figure 02. ‘structural column from below removed to great more space in the interior’

The Rumah Aceh’s surveyed, date from the early to mid 20th Century and has typically been occupied by a single family for generations, often built by parents or grandparents of the current residents. This gave weight to individual’s accounts of seismic experience within their Rumah Aceh’s and their knowledge of the buildings history. Of those interviewed, the 2004 Earthquake was the most recalled seismic event experienced. While many admit to fleeing their homes, they all returned stating they felt safer in their Rumah Aceh’s which suffered no structural damage but were weary of their brick and concrete addition where cracking was visible.

Ignoring the modern brick additions, the Rumah Aceh’s show the same construction techniques as documented by Dr. Hurgronje during his research in 1891, ‘The Archenese’ (Hurgronje, 1906). This suggests the construction methods have been deemed sufficient by those who have occupied them for generations. This is supported by the fact a new Rumah Aceh has recently been constructed in Lampulo, a riverside community outside of Banda Aceh.

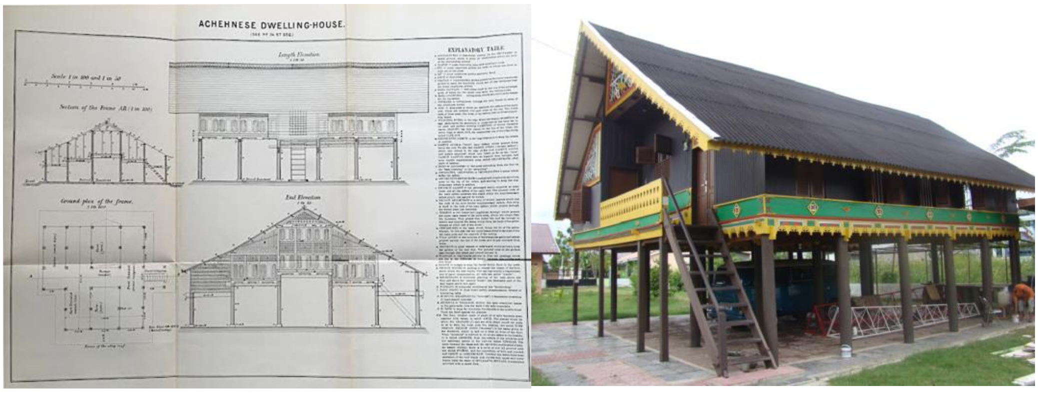

Figure 03. ‘Dr. Hurgronje documentation of Rumah Aceh in his 1906 publication in comparison with a new Rumah Aceh in Lampulo constructed c.2015’

This illustrates two elements that are crucial to the Rumah Aceh's seismic resilience: The lack of foundations and the construction joints that form the frames of the post and beam structure which generates a shape of ideal proportions to resist lateral force of seismic events.

The primary construction joints between the posts and beams are made entirely from wood and without nails. While other wood construction details have often promoted the need to create a ridged joint. The Rumah Aceh beams slide into the post with ease. The joint is then packed with a wooden wedge to create a sufficiently stiff structure. In the event of a sizable earthquake the forces acting on the structure will force the wedges to loosen allowing greater elasticity between individual members of the joint. This in turn dampens the vibrations and dissipating the energy through regular lateral force distribution.

Although timber and similar organic materials are valuable for seismic resistance as they have the capacity to resist high tensile forces, they are especially vulnerable to fungi and xylophagous insects (King). Whilst raising the building of the ground gives a level of protection its ability to easily replace individual elements as they rot or come to harm make the Rumah Aceh particularly resilient.

Figure 04. 'Construction joints with wooden wedges that loosen during an earthquake to increase elasticity'

This is only achievable because the joints facilitate an easy disconnection between its various elements. Allowing post and beams to be removed and replaced with little disruption to the rest of the structure. Aided by the building not being tied to its foundations, the building is easily lifted and supported by bamboo scaffolding when primary elements are temporally removed.

Employing construction joints that operate in this way in a New Zealand context would drastically improve the elasticity of current timber framed housing. Furthermore, the ability has far reaching implications past surviving the initial seismic force; The 2011 Christchurch earthquake (6.3 M LM), centred 10 kilometres South-East of Central Christchurch caused substantial liquefaction in residential areas where most houses are constructed of light timber framing on concrete slab or timber piled foundations, designed and built in accordance with NZS3604:(1999) (Buchanan & Newcombe). Liquefaction caused large forces of lateral spreading beneath foundations which were often greater than could be resisted. This led to damage of the timber structure above and in some cases resulted in soft-storey failures. Houses that where constructed with short pile foundations performed significantly better then concrete slab although many still required piles to be replaced after significant movement (Buchanan & Newcombe). If New Zealand were to adopt a system that replicated the Rumah Aceh's ability to easily replace damaged structural elements, the recovery process to assure the structural integrity of a dwelling following damages, such as those presented in Christchurch, would be significantly faster and easier. Going forward, an adaptation of the Rumah Aceh's construction could see the redevelopment of suburbs in Christchurch whose soils are current deemed unsafe to rebuild with current acceptable solutions as the amplification of vibrations would be too great. A resolution to this issue would allow a large population from the eastern suburbs to re-establish their community.

Figure 05. 'lack of foundations - posts resting on concrete plinths'

The Rumah Aceh is easy constructed on various soil type due to its lack of foundations. Despite the Rumah Aceh not being tied to the ground, it is able to resist lateral wind force by the sheer weight of the structure. The lack of foundations also helps dissipate lateral seismic forces by being able to shift when under extreme seismic stress and in the most extreme circumstances slide off the plinths, drastically damping vibrations. Following this, the structure can be quickly corrected through community engagement or 'Gotong royong' in a similar aspect of Maori resilience, however, this only happen as a last resort rather than a primary defence

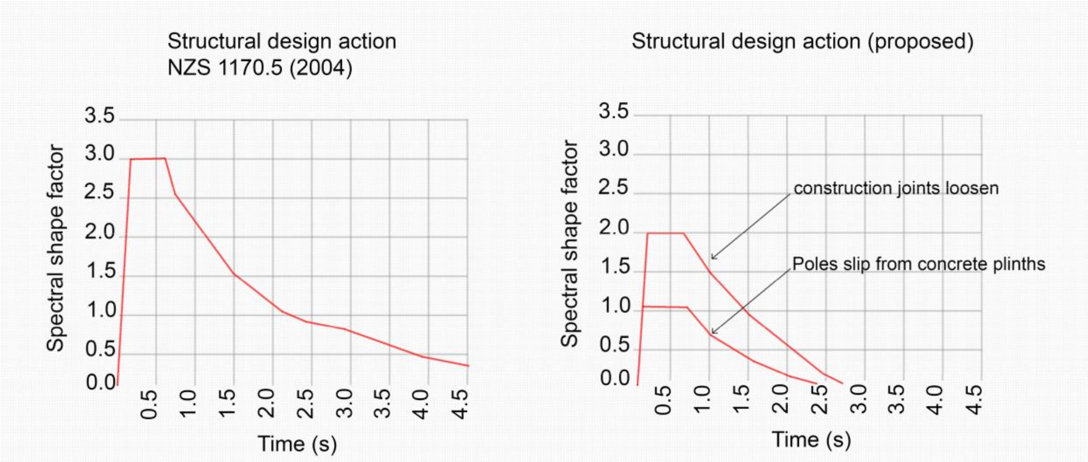

Figure 06 'Structural design action graph for soft soils Type 'D' as currently shown in NZS 1170.5 (2004) compared with theorised damping of vibrations with the introduction of Rumah Aceh key seismic resilience's'

The overall shape is a direct result from the physical properties of the timber posts and beams assembled into the replicated bays, which obtain full advantage of their major strengths by retaining structural symmetry. This is a key element that is essential for proper earthquake behaviour (King). The Bays can be classified into two categories. The earlier style, where the middle section is raised and the later style, where the floor is level across the front, middle and rear of the house called '*santeut*'. One of the houses included in this study adapted their Rumah Aceh to the later style to create more spacious interiors. While this effects the way the post and beams fits together across the front, middle and rear of the house, it does not appear to have an adverse effect on the seismic resilience. This suggests that the construction joints can be use in a multitude of ways to develop variance in form.

Figure 07. 'Comparison of early and late style of bay compositions'

This paper presents the initial stages of research for the author's master thesis and shows the analysis of the key seismic resilience principles of the primary case study, the Rumah Aceh. The next step is to explore how these identified principles can be applied to expand upon the current acceptable solutions of non-specifically engineered timber framed construction in New Zealand to not only provide 'force reduction solutions' but resolutions of true seismic resilience. This will involve adapting established New Zealand housing typologies using these methods of construction though massing studies and digital modelling to determine if the principles are cross-cultural. Furthermore, establishing a toolbox of construction joints will be paramount to allow exploration of a full design resolution, creating a unique design that both fits within a New Zealand culture and responds aptly to the physical environment and in doing so provide research that proves it's possible to have housing that is prepared to face all measures of seismic disruption.

The resulting implications from this research will facilitate greater resilience within New Zealand's buildings by building back better through the employment and adaptation of established techniques of seismic construction from a highly resilient case study. Ensuring not only greater building response during an earthquake but facilitating a faster recovery by reducing risk to communities.

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TWENTY YEARS OF RESILIENCE RESEARCH: FROM MODELS TO MEASUREMENT

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ABSTRACT

While all disasters create extensive physical loss and destruction, with consequent social and psychological disruption, some people and communities cope with, adapt to and recover from disaster consequences better than others. That is, some people and groups are more resilient than others. The importance of understanding resilience extends beyond minimising the loss and suffering of affected populations. It also becomes important in a context in which the risk faced by society is constantly increasing. Our involvement in over twenty years of community resilience research across a range of hazards and in different countries shows that there are a number of individual, community and societal/institutional factors that play interdependent roles in influencing resilience. This work has culminated in integrating these findings to represent an overall model of resilience. These factors need to be considered and accounted for when developing effective risk communication and community empowerment strategies. Such strategies should include a variety of activities (e.g., effective messaging, community meetings, scenario-building, school and work activities, drills and exercises, training, etc.) to target and build on different resilience factors and to account for the differing stages of readiness of people. The model is designed to allow its constituent variables to be operationalised in ways that fit the needs of agencies needing a framework for assessing and developing resilience. Thus, the factors influencing resilience can be used as measurable indicators, and can be used to evaluate the effectiveness of resilience-building activities.

Key words: adaption, community, communication, disaster, resilience

INTRODUCTION: WHAT IS RESILIENCE?

While all disasters can create extensive loss and destruction with consequent social and psychological disruption, some people and communities cope with, adapt to and recover from disaster consequences better than others. That is, some people and groups are more resilient than others. The definition of resilience proposed here is derived from Paton's

(2006) discussion of a need for it to encompass resilience and adaptation. Strictly speaking, resilience describes a capacity to return to a previous state. This reflects its derivation from its Latin root, 'resiliere', meaning "to jump back" (Paton, 2006). Paton argued that "bouncing back" or coping could describe experience of hazard events that fall at the lower end of the magnitude spectrum, or the experience of those at the periphery of large scale events.

However, this conceptualization must expand if it is to capture post-disaster response and recovery experiences that present those affected with a new reality that people must adapt to (Eiser et al. 2012). This was evident following the Christchurch earthquake; with those residing in more badly affected areas having to develop new ways of dealing with significant loss of infrastructure and resources and, for some, having to deal with resettlement. Thus, some people had to adapt to new realities rather than being able to return to a previous state. The latter embodies the notion of adaptive capacity (Paton, 2006).

Hence, in this paper, "resilience" is used in a way that captures how, for example, those at the periphery of an event may be able to bounce back (cope), while those facing more catastrophic losses will have to adapt (Paton et al., 2015). It follows from this view that developing resilience involves understanding what people could have to contend with and identifying the factors that influence how well they will be able to respond to hazard consequences.

Resilience can be defined as comprising four general components (Paton & Johnston, 2006). Firstly, communities, their members, businesses and societal institutions must possess the resources (e.g., household emergency plans, business continuity plans) required to ensure, as far as possible, their safety and the continuity of core functions in a context defined by disruption from hazards consequences (e.g., ground shaking, volcanic ash fall, flood inundation). Secondly, communities must possess the competencies (e.g., self-efficacy, community competence, trained staff, disaster management procedures) required to mobilize, organize and use these resources to confront the problems encountered and cope with and, if necessary, adapt to the novel (and catastrophic) reality created by large-scale hazard activity. Thirdly, the planning and development strategies used to facilitate resilience must include mechanisms designed to integrate the resources available at each level to ensure the existence of a coherent societal capacity, and one capable of realising the potential to capitalize on opportunities for change, growth and the enhancement of quality of life. Finally, strategies adopted must be designed to ensure the sustained availability of these resources and the competencies required to use them over time.

Understanding how interdependencies between people, their families, their communities, and societal institutions and organisations influence adaptive capacity thus becomes important. That is, it is necessary to describe resilience, or adaptive capacity, within the context of the interdependencies that exist. For example, at one level the ability of a community to adapt to adverse or challenging circumstances and recover using its own resources requires that attention be directed to safeguarding the physical integrity of the built environment (e.g., land use planning, design standards, building codes, lifeline engineering, retrofitting buildings).

At another level, resilience can be conceptualised as a social resource (e.g., facilitating community members' commitment to reduction and readiness activities) whose existence is sustained by ensuring an equitable distribution of the costs and benefits associated with hazard reduction and readiness activities. Resilience also comprises a behavioural level concerned with encouraging the sustained adoption of preparatory adjustments and the ability to respond to and adapt to adverse hazard effects.

The importance of adopting a multi-level approach has been reinforced by work on people's experiences of response and recovery to events such as the 2011 Christchurch earthquake (McClure et al., 2015; Paton, Jang and Irons, 2016). Those affected were asked about the consequences they had to contend with and what they thought contributed to their being resilient when faced with these significant, enduring consequences. Data were collected from areas where people experienced significant disruption and thus were being called upon to adapt to novel circumstances. This work identified that (a) people had to adapt to deal with significant and enduring changes over the response and recovery period, and (b) how well they did so was a function of their ability to draw on personal, household/family, community and societal resources (adaptive capacities). The analysis offered support for the validity of variables used in pre-event studies. These are discussed next.

FACTORS THAT INFLUENCE RESILIENCE

Research across diverse hazards (e.g., earthquakes, volcanoes, pandemic, drought, tsunami, bushfire) and in different countries (e.g., New Zealand, Australia, Japan, Taiwan, Portugal, USA) has confirmed how adaptive capacity results from interaction between individual/personal (e.g., self-efficacy, critical awareness, outcome expectancy, action coping, responsibility, planning); family (e.g., shared views on preparing), community (e.g., articulation of problems, community participation, sense of community, place attachment, collective efficacy, social responsibility); and societal/institutional (e.g., empowerment, trust) factors (See Paton & McClure, 2013 for a review). The factors described above, and their interactions are depicted in a model of resilience (Figure 2).

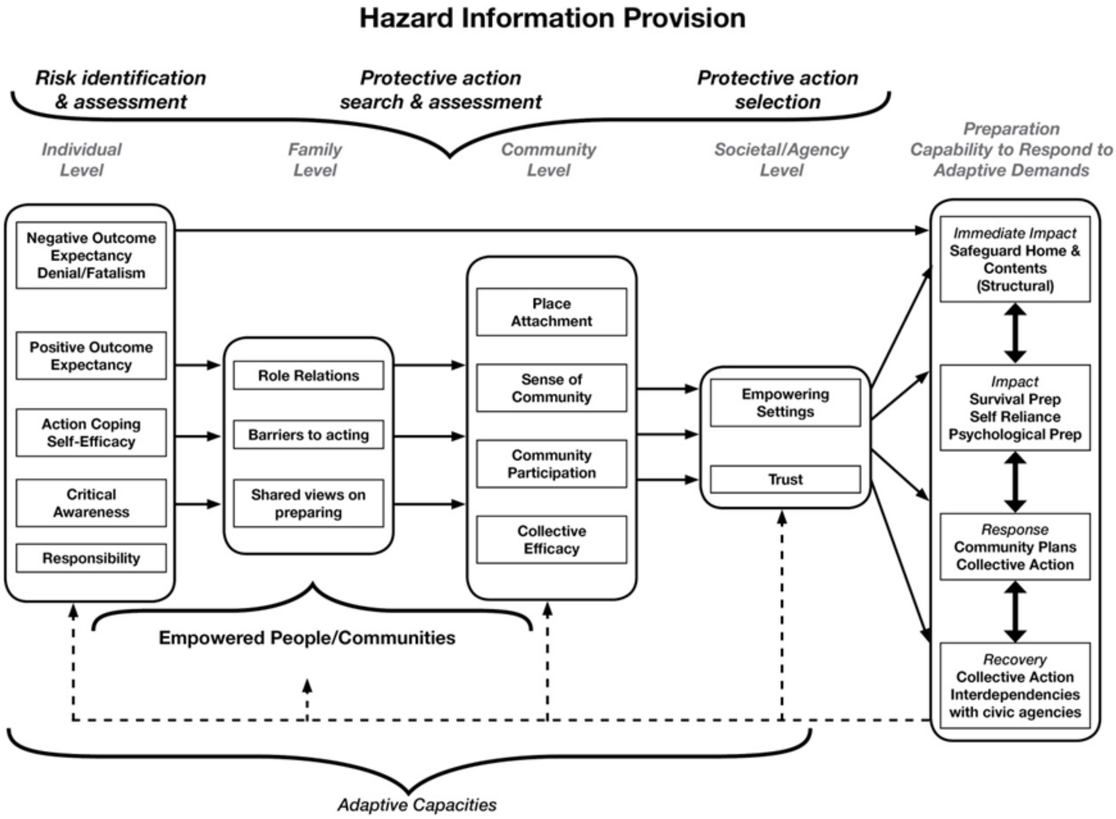

Figure 2 Model of community resilience (Paton & McClure, 2013, p 205).

MEASURING RESILIENCE

As well as contributing to the development of an overall model of resilience, the factors can be used as on-going indicators of resilience within communities. To date, these indicators have been measured using quantitative surveys. When analysing the surveys it is possible to tell which are the most critical resilience factors (indicators) for each community; that is, which of the personal, community and institutional factors are most strongly affecting resilience in that community (Becker et al., 2011). An understanding of the nature and level of current resilience factors in a community enables agencies to direct effort into enhancing factors that may not be present at high levels.

Research in Hawkes Bay provides an excellent example of how the identified factors can be used as on-going measures of resilience over time. Since 1995, seven resilience studies in the Hawke’s Bay region have explored, modelled and measured resilience for volcanoes, earthquakes and tsunami (Becker et al., 2012; Johnston et al., 1999; Johnston et al., 2003; McIvor & Paton, 2007; Mclvor et al., 2009; Paton, 2008; Paton & Johnston, 2008; Paton, et al., 2005; Paton et al., 2010; Ronan, et al., 2001). The dependent variable used in the Hawke’s Bay studies (a proxy measure of resilience) comprised questions on the structural integrity of the home, relationships with neighbours/community members to discuss and develop hazard preparedness and response, and relationships with civic agencies. Questions on these topics were then combined into a single measure.

New understandings from the Christchurch experience have highlighted that future measures should also include psychological and livelihood factors that those experiencing a disaster identified as important influences on their resilience (Paton, Anderson, Becker and Petersen, 2015; Spittal et al., 2006).

It is possible to use data such as these to rank levels of predictors and to use this to identify where limited risk management resources could most profitably be employed. An example from Auckland (Paton, 2007) is described in Table 2.

Table 2 Indicator variables measured in the Auckland resilience study, with their associated ranking (N=400)[12].

Indicator	Range	Mean	Standard Deviation	Ranking
Intention to prepare	5-15	7.63	2.79	L
Action coping	4-20	15.63	3.06	H
Negative outcome expectancy	4-20	10.87	3.20	M
Positive outcome expectancy	3-15	9.35	2.61	M
Community participation	5-20	11.97	3.49	M
Articulating problems	4-20	14.70	2.36	H
Empowerment	4-20	11.51	3.33	M
Trust	5-25	16.72	3.83	M

BUILDING RESILIENCE

The indicators discussed above were selected because they could be operationalized and used to inform practical intervention development. It is recommended that agencies work to develop the resilience factors in their communities in a holistic way. Specific recommendations for developing the various resilient factors are outlined in Table 3.

Table 3 Factors or 'indicators' of resilience and recommendations for developing resilience in communities (after Becker et al., 2015).

[12] In Paton (2007a, p. 26) "a ranking of low (L) reflects a mean score that was more than one standard deviation below the median; medium (M) reflects a high similarity between the mean and median values; and high (H) reflects a mean score more than one standard deviation above the median."

Resilience factor/indicator	**Recommendation for developing factors in communities**
Self-efficacy *"I can do something to mitigate the effects of a disaster"*	• Encourage people to personalise information in relation what they will have to do. • Provide practical information about 'how to prepare' and why it is effective and do so in small chunks rather than in large, comprehensive formats (e.g., booklets). • Start with easy to adopt items (e.g., emergency kits) and progressively introduce more complex/expensive items (e.g., structural changes to houses). • Develop separate strategies for owners and renters
Critical awareness *"Hazards are important, and I think and talk about hazards regularly"*	• Encourage thought and discussion amongst community members through provision of appropriate forums and formats (e.g., community members to review hazard scenarios, community to share experiences of disasters, community leaders to lead discussions, discussion and participation through community group events, etc.). • Ensure that people start talking about the benefits of being prepared.
Positive outcome expectancy *"I can do something to deal with hazards and as a result my actions will improve my safety/lead to a good outcome"*	• Outline the complex nature of hazards, rather than focussing on damage and destruction. • Develop belief in people that mitigation for disasters can be effective. • Show that losses are avoidable, and ways people can practically avoid the loss. • Describe the immediate utility and/or benefits of mitigation. • Use comprehensive communication strategies to relay information, as well as participation and empowerment.
Negative outcome expectancy *"Whatever I do, disasters are too catastrophic and nothing can be done to make a difference"*	• Reduce negative outcome expectancy by focussing on the realities of a disaster, rather than damage from an event being universal and total. • Show that the distribution of losses is not evenly spread (i.e., that more at risk or vulnerable communities are impacted more). • Show that people have control over disasters, i.e. that the choices they make over mitigation etc. can help them become more resilient to disasters. • Ensure communications are balanced (e.g., showing potential effects of a realistic disaster, but also showing how to cope). • Encourage people to think about what they might do to help the more vulnerable people in their neighbourhood/ community
Action coping *"I deal with problems by undertaking action directly (rather than worrying)"*	• Include active problem solving as part of community education, participation and empowerment strategies. • Ask people to reflect on significant events in their past and on how they coped with these events.
Community participation *"I actively and regularly participate in community activities"*	• Integrate any resilience-based Civil Defence Emergency Management (CDEM) work with community development planning and intervention. • Make use of existing groups to develop discussion and participation in hazard issues. • Encourage individual involvement in general community activities and functions. • Involve community leaders in resilience activities. • Identify, discuss and address salient issues within communities (these may be hazard-related or related to other issues e.g., crime). • Choose some hazard-related community-based activities to undertake (in association with other parts of the organisation of other agencies if necessary), e.g., hazard mapping exercises, community response planning, drills, door-knocking, emergency training. • Work with schools as part of an integrated community resilience-building programme.

Resilience factor/indicator	Recommendation for developing factors in communities
Articulating problems *"I discuss and define problems, and help determine solutions for those problems with others in my community"*	• Make use of participation and empowerment strategies as vehicles for articulating problems. • Ensure participatory activities include a specific focus on defining problems related to hazards, and how the community might solve those problems. • Assist the community in defining their own problems and coming up with their own solutions, rather than doing it for them. • Choose activities to undertake that assist with articulating problems, e.g. directed discussions about what to prepare for and how to prepare (individually and as a community as a whole); developing response and/or evacuation plans, undertaking drills and exercises; undertaking evaluation. • Involve community leaders in resilience activities, so that they can help the community discuss hazard problems and solutions.
Empowerment *"I can call upon personal and external resources, and deal with issues that arise"*	• Ensure community members have the ability to consider issues and implement solutions (e.g., by ensuring adequate resourcing is available, by building skills though training, by undertaking community development). • Integrate any resilience-based CDEM work with community development. • Ensure development undertaken at all levels (e.g., individual, community, etc.). • Target at-risk groups. • Work with existing groups that have community influence. • Enable community-led risk reduction, rather than institution-led.

Social norms
 	
"Other people think preparing is important, or are prepared, so I should too"
	• Development of attitudinal and behavioural norms that support preparedness are influenced by:
	    ○ participating in an interactive group situation or activity; being exposed to frequent information which stimulates critical awareness;
	    ○ active practice of hazards and preparedness activities;
	    ○ learning from an early age about hazards and preparedness and encouraging children to discuss school-based activities with their parents; and framing preparedness.

Trust *"I trust individuals, groups and organisations"*	• Ensure people have positive (empowering) experiences with providers of information to increases their trust in hazard and preparedness information i.e. ensure information is accurate, clear, is available from multiple sources, messages are consistent, and help people deal with their local issues, concerns and needs. • Build trust around hazard mitigation expenditure, and ensure a fair and just spread of hazard mitigation actions. • Make use of community participation and empowerment strategies to assess and meet local needs. • Build trust with the CDEM sector, and wider associated institutions.
Planning *"I know what I am likely to experience and can anticipate what I need to do to develop ways of responding"*	• Ensure people can identify the implications hazard events will have for their community. • Facilitate people's ability to personalise the implications of hazard events and their consequences for them (e.g., impact on family, impact on livelihood). • Integrate with community participation (see above) to develop neighbourhood/community plans to accommodate diversity of needs and interests, develop plans and how they will be put into action.
Personal responsibility *"I understand my role in how risk will be managed and how it contributes to community safety"*	• Develop the belief that people and emergency management and response agencies play complementary roles in preparedness and response. • Clearly identify and distinguish what agencies will do and what people and households should do to contribute to community safety.
Social responsibility *"I know we are all in the same boat and need to develop ways we can respond"*	• Identify hazard issues in terms of shared fate (i.e., it's everybody's problem). • Identify interdependencies between people and groups (e.g., need to be able to care for one another if cut off from normal resources, identifying more vulnerable members of the community and how their needs can be met). • Clearly identify and distinguish what agencies will do and what neighbourhoods/communities can do to contribute to community safety.

Resilience factor/indicator	Recommendation for developing factors in communities
Sense of community *"I will have to rely on other people and they will be relying on me"*	• Identify hazard issues in terms of shared fate and the benefits of collective action to manage hazard events. • Encourage maintenance of interdependence by giving to and doing for others (e.g., in conjunction with community participation activities). • Encourage the perception that people are part of a larger, stable and dependable community. • Develop mechanisms such as Neighbourhood Emergency Response Teams.
Leadership *"It is important to ensure that our actions are guided and coordinated by someone who knows our community"*	• Identify people in neighbourhood/communities with general (e.g., management experience) and specific (e.g., skills such as building) leadership skills. • Identify from this list people willing to assume leadership responsibility to support planning and plan implementation (including skills such as planning, problem solving, decision making, conflict management). • Include issues such as leadership and succession planning (e.g., rotating leaders to deal with specific issues, minimising burnout during response and recovery.
Collective efficacy *"We know how to work together to deal with issues that arise"*	• Encourage identification of neighbourhood impacts and consequences and how these could be dealt with within group settings. • This may require facilitation and mentoring for groups that lack appropriate planning and problem solving skills. • Group meetings should be designed to integrate the provision of information/actions with the development of planning and problem solving skills in the group.
Place attachment *"This is a great place to live and I want to do what I can to maintain my lifestyle here"*	• Encourage a sense belonging in the physical location through identifying, for example, local (e.g., heritage, symbols such as art deco architecture) and natural amenities to increase people's sense of emotional investment in their community. This, in turn, increases motivation to take action to prepare to sustain attachment.
Experience *"Being prepared helped me respond to a hazard event"*	• If possible, identify people within communities that have had direct or indirect hazard experience and that can testify to the benefits/effectiveness of being prepared and able to take action. • Involve them in developing and delivering risk and preparedness messages/actions to increase the ability of other community members to identify with the issues identified.
Resourcing *"We know who can do what in our community"*	• Use participatory planning to identify the resources available within communities. • In conjunction with participatory planning, identify the additional resources communities will need to develop, implement and action plans. • Identify external (e.g. agency, community and government) sources communities can contact to discuss resource needs should a hazard event occur.

Psychological preparedness
 	
"Having thought about what I might experience helped me cope"
	• Psychological preparedness is enhanced by helping people:
	  ○ to anticipate the anxiety and concerns that will arise (e.g., what makes an event threatening, what would happen if you had to evacuate and be temporarily re-settled; what would happen to your job?);
	  ○ to identify uncomfortable or distressing thoughts and emotions that may cause further anxiety; and
	  ○ to find ways of managing the responses so that one's coping capacity remains as effective as possible (this step can be integrated with the developing of coping and planning discussed above).

WHERE TO FROM HERE? – FUTURE RESEARCH DIRECTIONS

The factors or indicators that contribute to community resilience provide a basis for communities to assess their current levels of, and track their progress towards, resilience. As communities invest an increasing amount of time and money into resilience programmes, it is essential to baseline resilience levels across different communities so that gaps can be identified and resilience progress can be evaluated. New research is being conducted by Kwok and his colleagues (Kwok, Becker, & Johnston, 2016) to translate a subset of baseline resilience indicators of communities, or BRIC indicators, for the Wellington region (Cutter et al., 2010, 2014). This type of generalised resilience assessment offers a broad overview of regional resilience levels and helps inform regional resilience policies and practices. However, with the bulk of resilience activities conducted at sub-regional and sub-city levels, such efforts need to be community- or context-specific. That is, the dynamics of local communities should guide how resilience enhancing actions are carried out in order to meet the needs of local stakeholders. Thus, another area of research into understanding resilience from the perspectives of local practitioners and stakeholders is currently being carried out in Wellington, New Zealand by Kwok and his colleagues (Kwok, Doyle, Becker, Johnston, & Paton, 2016). They have examined how local emergency practitioners, policymakers, and researchers evaluate what resilience means to them, and their perspectives on the key factors that contribute to the resilience of Wellington's communities. Research is also underway to identify community-specific factors that facilitate or hinder local resilience through soliciting the perspectives of local residents (Kwok, Paton, Becker, Doyle, & Johnston, 2016). Such research helps contextualise the resilience factors in the model so that resulting actions are more locally relevant.

Further work has also been initiated to explore the role of "Citizen Science" in building community resilience (Orchiston et al., 2016). This can be either community-based initiated citizen science projects or agency initiated projects. Recent tsunami projects in Orewa, New Zealand illustrate both types (Johnston et al. 2016) and give insights into the opportunities and challenges both have.

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ANALYSING THE CONSEQUENCES OF POST CONFLICT RECONSTRUCTION

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ABSTRACT

The period after conflict is characterised with large-scale destruction that necessitates investments in post conflict reconstruction (PCR). It is important that the PCR strategy take a holistic approach to rebuild the economic, social and political structures while taking measures to prevent future conflict. On the other hand, individual PCR interventions may focus on reconstruction of a particular sector with specific objectives. Nevertheless, it is important to account for the consequences of these PCR interventions as negative consequences may fuel the conflicts. This paper is an analysis of the potential consequences of PCR interventions and the significance of understanding them prior to intervention. The purpose of this paper is to introduce a conceptual framework on consequences of PCR interventions that has been developed as part of a long-term study on PCR consequences. Using the conceptual analysis method, the framework was developed to demonstrate the causal linkages between the PCR intervention and its consequences relating them to the post conflict context and long-term outcomes.

Key words: *Consequences, Framework, Intervention, Post-conflict, Reconstruction*

INTRODUCTION

Conflicts are a form of disaster that affect the modern world on a daily basis. In addition to the large number of deaths and disabilities caused by it, the conflicts have a colossal impact on the economic, social and political structures through destruction of soft and hard infrastructures, natural environment, livelihoods of people and cultural heritage. The post conflict societies are thereby faced with a number of challenges including rebuilding infrastructures, ensuring livelihoods, poverty reduction, achieving economic recovery, and re-establishing the social and political institutions (Athukorala & Jayasuriya, 2013). On the other hand, post conflict societies have a high chance of reverting to conflict (Höglund & Orjuela, 2011). Therefore, it is important to address the root causes of the conflict and implement sustainable solutions, while ensuring the safety and security of the people. A post conflict reconstruction (PCR) intervention should not only look at rebuilding the economy through infrastructures and livelihoods, but also ensure that root causes of conflict are addressed and new conflicts are not created (Jabareen, 2013). Hence, it is important to account for the consequences of a PCR intervention at the planning stage. The PCR interventions are individual projects that focus on a defined set of objectives. These should be strategically placed within the overall PCR strategy in order to achieve economic development and prevent the recurrence of conflict. The purpose of this paper is to introduce a conceptual framework on consequences of PCR relating these consequences to the post conflict context and long-term outcomes. It adopts the conceptual analysis method in order to develop the framework and bases the analysis on previous body of knowledge.

The next section introduces the rationale behind the work presented in this paper. Section three is a discussion of the methodology adopted in developing the conceptual framework. Section four presents the conceptual framework. The final section concludes the paper and offers future research recommendations.

JUSTIFICATION

There is a vast body of literature on understanding the post conflict context and challenges faced during reconstruction. Accounting for the economic consequences of war and understanding the challenges of PCR form an important part of post conflict agenda (Arunatilake, Jayasuriya, & Kelegama, 2001; Athukorala & Jayasuriya, 2013; Ganegodage & Rambaldi, 2014; Pradhan, 2001). Since these societies are at risk of reverting back to conflict, PCR should incorporate conflict prevention strategies parallel to economic recovery (Collier, Hoeffler, & Söderbom, 2008; Cramer & Goodhand, 2002; Höglund & Orjuela, 2011). Intervention in a conflict context differs from that of non-conflict context (Rajasingham-Senanayake, 2005). PCR projects tend to fail if the local conditions and war dynamics are not taken into account (Brun & Lund, 2008; Earnest, 2015). The PCR literature provides several examples of failures due to lack of planning and clear agenda (Dale, 2015; Earnest, 2015). At the same time, some interventions may create negative consequences that were not previously accounted for (Unruh & Shalaby, 2012). Thus, it is important that any intervention takes in to account potential negative and positive consequences at the initial planning stage.

In previous studies, very little attention has been paid to analysing the consequences of a PCR intervention. Although consequences are discussed in isolation or as a group of related consequences, they are not comprehensively analysed relating to the larger context and long term outcomes. Also, existing frameworks in the PCR literature do not necessarily highlight the consequences of PCR intervention. Therefore, this paper analyses the potential consequences of PCR intervention, relating them to the context and long-term outcomes.

There is a considerable amount of research on post-war recovery studies (PRS), that discusses development in the post conflict context. Peace and conflict impact assessment is a measure introduced by Bush (1998) to anticipate, monitor and evaluate the impact that interventions has on dynamics of peace and conflict. Barakat and Zyck (2009) suggest that PRS should be free from politicisation and should be strongly structured and theoretically grounded. Barakat and Chard (2002) also examines the limitations and barriers in implementing PCR projects. The studies by Mac Ginty (2010)are mainly concerned with comparing the traditional, indigenous approaches to peacebuilding with western, liberal approaches while identifying the strengths and weaknesses of each approach. However, the present research is concerned with consequences of PCR interventions, not limiting them to peace and conflict aspects. Thus, the framework introduced in this paper is different from PRS, as it discusses the consequences related to economic, environmental, social and political aspects.

METHODOLOGY

This study uses the conceptual analysis method in developing the conceptual framework. This method was previously used by Jabareen (2013) to develop a framework of concepts generally related to PCR, aiming at better understanding concepts related to PCR and the relationships among them. Jabareen discusses these concepts in general through a holistic approach. Since this study specifically focuses on consequences of PCR, it differs from Jabareen's framework.

CONCEPTUAL FRAMEWORK

Context

In addition to the large number of deaths and disabilities, conflicts cause large scale damages to infrastructure, disturbing the production process and thereby restraining development (Oji, Eme, & Nwoba, 2015; Smith, Houser, Leeson, & Ostad, 2014). Therefore, it is necessary to focus on economic recovery during the post conflict period, while maintaining political stability and general security. Negative peace, failed state, poverty, corruption and prevalence of war economies are some of the conditions that can be typically seen in post conflict societies (Cole, 2014; Cramer & Goodhand, 2002; Earnest, 2015; Jabareen, 2013; Zabyelina, 2013). The society is also in the danger of reverting back to conflicts(Collier et al., 2008). It is within this context that the PCR intervention takes place in the form of soft or/and hard infrastructure.

PCR intervention

Reconstruction is defined as an innovative approach to solve development issues (Brun & Lund, 2008). Successful PCR solutions can be yielded through planned coordination among different policy interventions and stakeholders (Anand, 2005). There are mainly three types of actors involved in PCR: local government, foreign donors and NGOs. Democracy and strong state are to central post conflict development and peacebuilding (Cramer & Goodhand, 2002; Lappin, 2010). The lack of private investments in post conflict societies necessitates state intervention to provide essential infrastructure (Schwartz & Halkyard, 2006). Due to the lack of institutional capacity and high level of uncertainty of post conflict states, the foreign intervention plays a crucial role in reconstruction (Earnest, 2015). Foreign donors can contribute to conflict prevention and peace building through promoting sustainable recovery (Toh & Kasturi, 2012). NGOs can also contribute to peacebuilding through promoting local participation (Anand, 2005; Dale, 2015). Their role is instrumental in capacity building and empowering communities in the post war context (Gellman, 2010).

Soft and hard infrastructure

The above mentioned actors are mainly involved in PCR interventions by way of providing soft and hard infrastructure that contributes to the restoration of people's livelihoods (Anand, 2005). While PCR strategy should take a holistic approach to integrate the economic, political and social reconstruction (Jabareen, 2013), the individual PCR interventions may address a specified set of objectives within a PCR strategy. Generally, there is a trend to focus more on hard infrastructure provision and soft interventions are postponed to later stages (Stewart, 2005). The lack of attention to soft infrastructure demonstrate the failure to understand the social, political and cultural dynamics of the post conflict context (Jones, 2014). Timely infrastructure provision is key in the PCR agenda. Although quick solutions are necessary, ad hoc interventions that lack planning may cause PCR failures (Dale, 2015).

Consequences

The consequences that results from PCR intervention can be put in to four broad categories as economic, environmental, social and political consequences.

Economic development is a major focus of most infrastructure projects, which can be achieved through integration of development policies with reconstruction (Jones, 2014). Countries tend to achieve high levels of growth soon after conflict due to the inflow of foreign aid, but many fail to sustain it (Athukorala & Jayasuriya, 2013). To achieve sustainable growth, it is necessary to support development with a clear vision for infrastructure (Brown, 2005). Infrastructure reconstruction has causal linkages with reducing poverty, improving investments and creating livelihoods (Anand, 2005; Collinson, 2003). While it improves access to markets (Dale, 2015), a potential negative impact of PCR is relocation of industrial activities from poorer areas to urban areas (Chandra & Thompson, 2000).

Certain PCR interventions cause horizontal inequity (HI) in the society, making it a significant social consequence of PCR. HI occurs when vulnerable communities further experience unequal resource allocation after the conflict (Stewart, 2005). Increased HI can result in the re-emergence of conflict or create new conflict (Anand, 2005). On the contrary, equitable delivery of infrastructure can contribute to sustainable peace (Zabyelina, 2013). At the same time, infrastructure can be used as a tool to enhance social capital and promote community participation (Handrahan, 2004; Vervisch, Titeca, Vlassenroot, & Braeckman, 2013). Community driven reconstruction often ensures the sustainability of the projects (Brown, 2005) but if the reconstruction is centrally driven it can lead to increased mistrust (Höglund & Orjuela, 2011). However, a centralised approach to PCR is necessary at the planning level in order to align reconstruction with an agenda for sustainable development (Dale, 2015). PCR can also lead to increased social tensions through land grabbing and exploitation, which can occur due to the prevalence of violence (Unruh & Shalaby, 2012). It is necessary to account for such consequences in a context of instability and insecurity, and where violence can re-emerge at any point.

One of the significant political consequences of PCR is corruption, which intensifies during the PCR period. Corruption can occur especially when government and local elites are involved in reconstruction (Höglund & Orjuela, 2011). It is common that PCR funds are controlled by local elites as development gatekeepers, which hinders community driven reconstruction (Handrahan, 2004). Sometimes conflicts are created among local elites to gain control over funds and as a result project objectives are not achieved (Kyamusugulwa & Hilhorst, 2015). Westernization is another consequence of PCR highlighted in the literature. The external interventions often impose external models of development and foreign notions of governance, which may not be compatible with local conditions (Gellman, 2010; Hamieh & Mac Ginty, 2010; Jabareen, 2013). Rather than implementing a whole new system, PCR intervention should understand the local practices and conditions prior to implementation (Richmond, 2012).

Long-term outcomes

The aforementioned economic, environmental, social and political consequences have linkages to the long-term conditions that occur in post conflict societies. Conflict prevention should be a major focus of the long-term plan for reconstruction which also involves peacebuilding and long term stability (Höglund & Orjuela, 2011). Failing to achieve reconstruction objectives may cause poverty and instability to prevail in the society, which can lead to future conflicts (Jones, 2014). On the other hand, sustainable development achieved through PCR can be used as a tool to promote peace (Brown, 2005). Soft infrastructure interventions play a crucial role in promoting peace through governance institutions (Jones, 2014). Once the soft and hard infrastructure is in place, and political stability is achieved, political reforms can be introduced to address the root causes of the conflict (Höglund & Orjuela, 2011).

Conceptual framework

Figure 1 is a visual presentation of the framework described in the above conceptual analysis.

CONCLUSION

Using the conceptual analysis method, a conceptual framework has been developed to address a gap in the literature concerning the analysis of PCR consequences. The conceptual framework demonstrates the linkages between PCR intervention and consequences, relating them to the post conflict context and long-term outcomes. It is important to understand the potential consequences before implementing a PCR project. Future empirical work will seek to elaborate and refine the framework, including more detailed investigation into the applicability of such a framework indifferent types of 'hard' and 'soft' PCR project.

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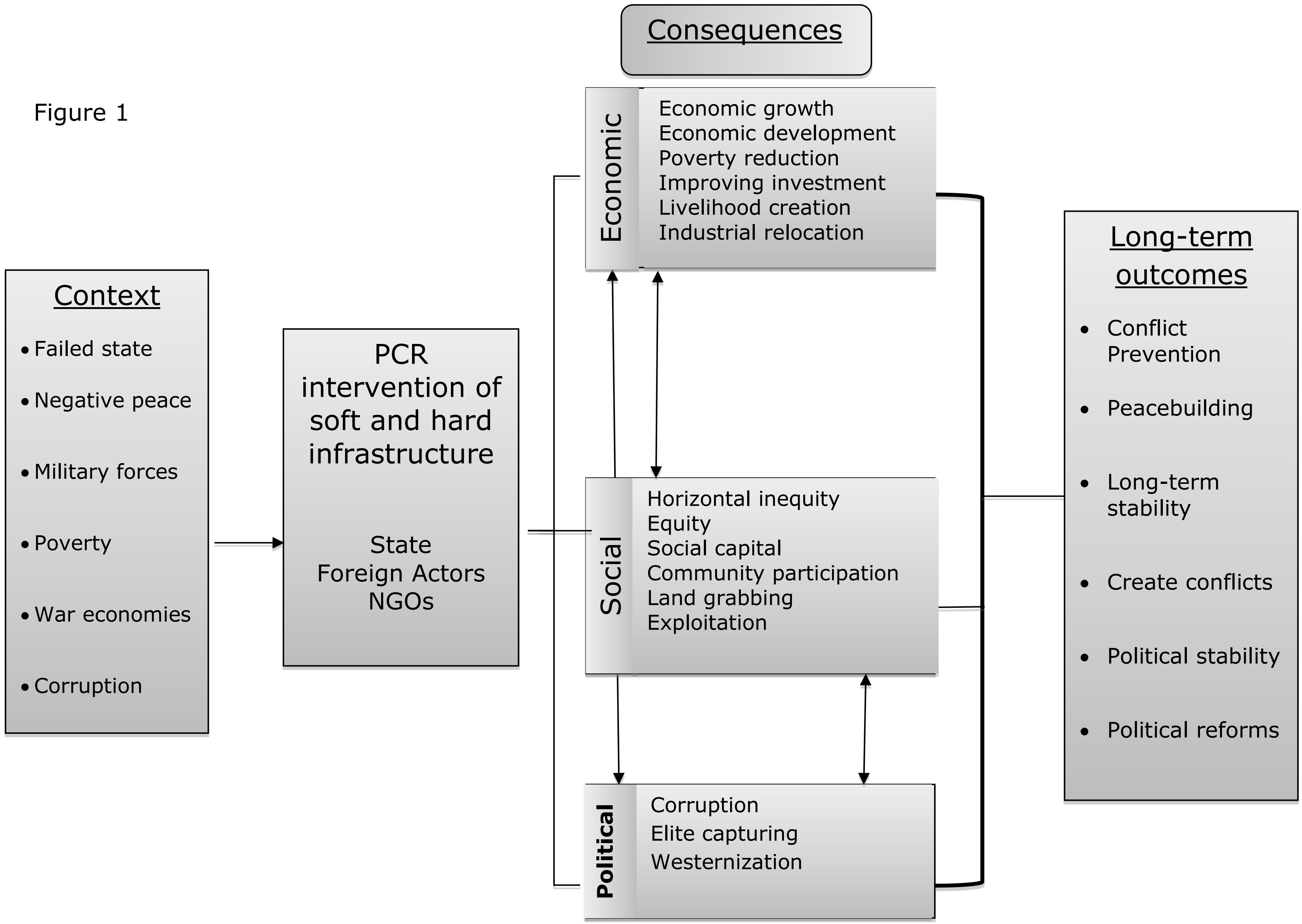
Figure 1



Consequences
Economic
Economic growth
Economic development
Poverty reduction
Improving investment
Livelihood creation
Industrial relocation
Context
Failed state
Negative peace
Military forces
Poverty
War economies
Corruption
PCR intervention of soft and hard infrastructure
State
Foreign Actors
NGOs
Social
Horizontal inequity
Equity
Social capital
Community participation
Land grabbing
Exploitation
Political
Corruption
Elite capturing
Westernization
Long-term outcomes
Conflict Prevention
Peacebuilding
Long-term stability
Create conflicts
Political stability
Political reforms

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THE USE OF PUBLIC OPEN SPACES TO ENHANCE THE COASTAL URBAN CITIES' RESILIENCE TO TSUNAMIS

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ABSTRACT

Tsunami is a rapid-onset natural hazard that can be considered as one of the extremely destructive hazards. Depending on the location of the origin of Tsunami, there can be limited time available to evacuate people to safe places and to make appropriate response decisions in timely manner. Therefore, it is imperative to increase the inherent capacity of a city to respond this type of a natural hazard.

Planning and designing spatial elements are one of the directives to increase the inherent capacity of a city to resist, absorb, accommodate and recover from the effects of a Tsunami. Accordingly, this research paper emphasizes the importance of public open spaces as one of the key spatial elements of a city which can be used as a strategy to enhance the coastal urban cities' resilience to Tsunamis, as an agent of recovery, as a mode to provide essential life support, as a primary place to rescue, shelters and potential for adaptive response.

Moreover, this ongoing research study analyses the current literature on use of public open spaces for Tsunami resilience and also the current problems and issues associated with it. Finally, the analysis suggests set of recommendations to enhance the use of public open spaces to increase the coastal urban cities' resilience to Tsunamis.

Key words: Coastal Urban Cities, Disaster Resilience, Planning and Designing, Public Open Spaces, Tsunami Resilience

INTRODUCTION

The growth of world population and the increase of human migration towards the coastal urban cities, result rapid population growth in coastal urban cities. Therefore, these coastal urban cities will contain an increasingly large proportion of the world's human population (World Bank Group, 2016). Confirming this fact, population distribution studies indicate that half of the world's population lives within 60 km of the sea, and three-quarters of large cities are located on the coast (UNEP, 2015). However, this growing population in coastal urban cities, create significant challenges to both natural and built environments by polluting the coastal zone, putting more pressure on land and destabilizing the coastline by damaging mangroves, coral reefs, sea grass beds and sand dunes.

Further, the implications of climate change set all coastal locations at risk with the impacts of accelerated global sea-level rise, changes in storm frequency and other related coastal hazards (Neumann, Vafeidis, Zimmermann, & Nicholls, 2015). Moreover, the combined implication of the population growth in urban cities and the climate change, increase the exposure of coastal urban dwellers to natural coastal hazards such as coastal floods, storms, erosion, tsunamis, saltwater intrusion and subsidence.

Out of these coastal hazards, Tsunami is a rapid-onset coastal hazard that can be considered as ever-present threat to lives, infrastructure, and property along the coasts (Taubenböck et al., 2009). It is infrequent, but extremely destructive natural hazard. Historical records indicate that hundreds of thousands of people were killed by tsunamis worldwide (National Tsunami Hazard Mitigation Program, 2001). Further, Tsunami 2004 reminded the world to be more proactive by claiming nearly 275 000 lives and destroying billions of dollars' worth properties (Barber, 2005).

However, regardless of these threats of coastal hazards, rapid urbanization gathers more people towards coastal urban cities due to the internationalization of finance, service and products, growth of international ports and high-density developments near harbors. For instance, the estimations display that 489 cities within the Pacific states of Alaska, California, Hawaii, Oregon, and Washington are vulnerable to tsunamis and 900,000 people in these cities have the risk of being inundated by a 50-foot tsunami (National Tsunami Hazard Mitigation Program, 2001).

Therefore, it is an increasingly important, but critical task, to make coastal urban cities resilience to Tsunamis, especially with the challenges of urbanization. When making cities resilience to disasters, León and March (2014) state that urban planning and designing can play a vital role through its ability to integrate the multi-dimensional aspects affecting disaster risk reduction. Adding to this, UNISDR (2012) states that strategic planning and design of spatial elements and their influence on the natural and built environment are directives of city's capacity to absorb and recover from the effect of disasters.

While urban design and planning solutions play a vital role in creating resilient cities, public open spaces have become one of the key elements in spatial planning and designing which play an important role in urban cities. However, the use of public open spaces for disaster resilience has not been fully revealed yet to the research field (Hossain, 2014). Specifically, lack of consideration has been given to identify the role of Public open spaces to make cities resilience to Tsunamis. Accordingly, this research paper explores the potential use of public open spaces to make coastal urban cities resilience to Tsunamis and current problems associated with it, through the analysis of current literature.

RESEARCH METHOD

This paper presents the findings of an initial literature analysis based on a critical literature review and a synthesis which was conducted as part of an ongoing PhD research study. In order to ensure that the literature review is complete and comprehensive, the researcher has critically reviewed journal papers, book chapters, conference papers as well as local and international reports which discuss the current issues, problems and potentials in the subject area. At the same time, this literature review has been presented in different national and international audiences where the literature review has been critically examined and modified according to the feedback received. Accordingly, this paper presents current research need on planning designing public open spaces with a new focus on enhancing Tsunami resilience coastal urban cities.

MAKING COASTAL URBAN CITIES RESILIENCE TO TSUNAMIS

'Tsunami' is a series of long waves generated by a sudden displacement of a large volume of water (National Tsunami Hazard Mitigation Program, 2001). Tsunamis are activated mostly by submarine earthquakes, submarine volcanic eruptions, underwater landslides or slumps of large volumes of earth, meteor impacts, and even onshore slope failures that fall into the ocean or a bay. National Tsunami Hazard Mitigation Program (2001) and UNESCO (2015) state that submarine earthquakes are the most common causes for Tsunamis. Even though, Tsunami is a natural hazard, Tsunami events become a disaster when they harm people, damage properties and act beyond the ability of the communities to cope. Confirming this fact, Table 1 presents the overview of Tsunami disasters from 1980-2015.

Overview of Tsunami Disasters from 1980-2015	
No. of Events:	27
No. of People Killed:	250,471
No. of People Effected:	1,819,357
Economic Damage (US$ X1000) :	221,995,540

Table 28- Tsunami Disasters from 1980-2015, (EMDAT, 2016)

Further, table 2 describes the effect of Tsunamis on various countries which were caused by numerous tsunami events during the period of 1980 to 2015. Accordingly, it can be noted that, during the time period of 1980-2015, the most devastating tsunami event was recorded in 2004 which has taken the lives of more than 275,000 people and destroyed millions of dollars' worth of property (Prevention web UNISDR, 2008).

Year	Country	Total Deaths (No. of People)	Economic Damage (US$X1000)
2004	Indonesia	165,708	4,451,600
2004	Sri Lanka	35,399	1,316,500
2011	Japan	19,846	21,000,000
2004	India	16,389	1,022,800
2004	Thailand	8,345	No Data
1998	Papua New Guine	2,182	No Data
2006	Indonesia	802	55,000
2010	Indonesia	530	No Data
2004	Somalia	298	100,000
2004	Maldives	102	470,100
2004	Malaysia	80	500,000

Table 29-Loss of human lives and economic loss by Tsunami events 1980-2015 (EMDAT, 2016)

Further, Asian Disaster Reduction Center (2011) has stated that North Pacific Coast Tsunami in Japan 2011 has killed more than 12,000 human lives while claiming 15,000 people missing. In addition to that, one of another devastating tsunami events was the Tsunami in 2010 in Chili. Accordingly, it can be noted that the destruction caused by three major tsunamis – Indian Ocean 2004, Chile 2010 and Japan 2011 have exposed the weaknesses of capability of communities to cope with these catastrophic events.

Moreover, Tsunamis cannot be confidentially predicted as they are generated by the movements on faults in the earth's crust. Therefore, depending on the location of the tsunami's origin, there can be limited time is available to evacuate people to places of safety and to make appropriate response decisions. Thus, to plan for such events, an extra effort needs to be taken by looking at each and every aspect of a city.

Further, as it was discussed before, the rapid coastal urbanization gather more people towards the coastal urban cities generating significant challenges to both natural and built environments. Hence, the vulnerabilities and impact are extremely high on urban coastal cities. Therefore, it is an imperative task to make coastal urban cities resilient to Tsunami hazards.

When making coastal urban cities resilience to Tsunamis, the focus can be given on various elements of a city including Public awareness on actions, Preparedness, built environment elements, Technological inputs, institutional capacity and ecological integrity, etc. Out of these elements, strategic planning and design of spatial elements and their influence on the natural and built environment are directives of city's capacity to absorb and recover from disasters (UNISDR, 2012). These spatial strategies can be focused on different spatial elements such as building structures, road networks, open spaces, forests and natural reserves. In this context, this particular study specifically focuses on Public open spaces as one of the key spatial elements which can be significantly used to make coastal urban cities resilience to Tsunamis.

PUBLIC OPEN SPACES TO MAKE CITIES RESILIENCE TO TSUNAMIS

The current literature which discusses the potential use of public open spaces for disaster resilience reveal, that the public open spaces have a significant potential to be used in three main stages in disaster cycle; emergency response, recovery and mitigation.

Emergency Response and Recovery

In an event of a Tsunami, people may have very limited time to response including gathering to a safer place, sheltering and to distribute the necessary goods and services, etc. Therefore, community's ability to response and to make appropriate decision, timely manner will be highly determined by the arrangement of the spatial elements.

Accordingly, León and March (2014) emphasize the need of public open spaces with adequate location, capacity, and terrain qualities for Tsunami evacuation. They state that the most crucial two elements of Tsunami emergency are streets and Open spaces, because open spaces provide shelters for evacuees sometimes for hours to days depending on the extent of the tsunami warning or any resulting damage, while streets deliver the movement network for emergency services as well as for evacuees.

Further, Taubenböck et al. (2009), emphasize the need of identification of natural safe areas for emergency evacuation by overlapping the land use maps with tsunami hazard maps using remotely sensed data and these natural safe areas are defined as open spaces accessible by the street network and larger enough to accommodate the people in a rescue situation. Accordingly, open spaces which are accessible by the street network and have the capacity to accommodate people, are an asset for emergency evacuation in an event of a Tsunami. However, most of these literature which discuss the use of public open spaces for Tsunami resilience, do not discuss the practical implementation of this strategy to an urban context.

Allan and Brytan (2010) highlight that, recovery planners plan these open spaces, considering it as a part of the natural environment, but not as part of the built environment. They further identify that these strategies may end up with large quantities of unstructured open spaces which contradict with the strategies to achieve liveable, diverse and sustainable urban environments and also rather impractical with urban city form. Accordingly, it can be understood that to enhance use of public open spaces for emergency response and recovery, these Public open spaces need to be planned and designed to function well during both emergency and non-emergency times. Confirming this, Allan and Bryant (2010) discuss that the emergency management plans and recovery plans become more effective when it is aligned with everyday life of the city through urban planning and designing strategies. Accordingly, when these emergency management plans and recovery plans are integrated into the day to day life, the city become more resilient to disasters.

This applies even more, when making urban cities resilience disasters. Tsunami is an infrequent event, therefore, provision of large quantities of open space for the only purpose of emergency management planning is not practical. It is even more difficult to apply to an urban city where the land scarcity is a major issue. Further, Allan and Bryant (2010) state that those places will not function well in an emergency if it is not well connected with the street network and in the long run those places will become neither physically prepared and will not be identified by the public in an emergency event. Accordingly, it can be understood, the necessity of planning and designing public open spaces to function well during both emergency and non-emergency times.

Further, León and March (2014) suggest, that Tsunami rescue open spaces need to be identified with an objective of providing safe assembly spaces, basic emergency services and utilities, such as first aids, fresh water, electricity, and communication. In supporting this, Allan and Bryant (2010) state that, different types of open spaces can be used for different functions in emergency response and recovery, providing simple to complex services such as gathering, sheltering, temporary inhabitation and so on. Accordingly, the need of these public open spaces may vary according to the type varying from small squares to parks and play grounds.

At the same time, Allan and Bryant (2010) highlight the use of Open Spaces network for disaster resilience through their study on the earthquake event of San Francisco. Further, they state that after a major earthquake, city's open space network have the potential to act as a 'second city' by providing simple to complex services. Consequently, this concept of open space network can be cross compared with the previously discussed need of having different types of public open spaces for Tsunami resilience. Accordingly, in order to enhance the use of Public open spaces to make coastal urban cities resilience Tsunamis, the concept of network of public open spaces can be used as a mode to facilitate different functions of Tsunami emergency response and recovery.

Mitigation

In addition to the use of public open spaces for emergency response and recovery, current literature point out the potential use of Public open spaces as a mitigation strategy.

To mitigate the risk of Tsunami, UNESCO (2015), propose that Tsunami mitigation strategies need to be formed using the land-use planning and regulation strategies. Further, they introduce a guideline presenting the necessity of setting up development setback line through the integration of Tsunami inundation modelling into land use planning. Further, National Tsunami Hazard Mitigation Program (2001), also emphasizes the use of open spaces as an element to mitigate the Tsunami Risk. They introduce seven basic principles of planning and designing for Tsunami events. Out of these 7 principles, the second principle describes, that Tsunami hazard areas need to be allocated for open-space uses (National Tsunami Hazard Mitigation Program, 2001). However, most of these discussions, emphasize the need of acquiring Tsunami Hazard Areas for Open-Space Uses and confine the uses in conservation and preservation perspective.

Further, some of these arguments even suggest to use these open spaces for agriculture or scenic easement, but less consideration has been given on use of 'public open spaces'. Specially, in a coastal urban city where the land is a scarce resource, allocating open spaces only for the purpose of mitigation cannot be considered as the best practice. In this context, using preserved hazard areas for public open space uses of a city can be considered as a sustainable and practical solution. In supporting this view, Ardekani and Hosseini (2012), emphasize that development should be prevented in high-hazard areas wherever possible through land use regulations, nevertheless these preserved Tsunami hazard areas need to be used for open-space uses such as scenic amenity and recreational activities. However, this does not mean to promote an additional development in vulnerable areas, but it should be planned and designed to make the use of hazard-prone areas safer to the community and to get the highest and best use of the space in urban cities.

CONCLUSION

Above literature synthesis emphasizes that there is a significant potential of using Public open spaces to make coastal urban cities resilience to Tsunamis as a facilitator for emergency planning, as an agent of recovery and as an enabler for mitigation. However, most of the current studies identify the use of Public open spaces discretely in two places; 1) emergency management and recovery, 2) mitigation, but not as an interconnected system of a city. At the same time, as discussed before, the concept of public open spaces network can be potentially used for emergency response and recovery. Accordingly, amalgamating this strategy with mitigation strategy, a network of Public open spaces can be developed contributing to both emergency rescue, recovery and also to mitigation strategies. Development of this type of interconnected network of public open spaces can significantly contribute to create coastal urban cities resilience to Tsunamis.

In conclusion, this paper identifies current problems and issues, and suggest set of approaches which can be used to enhance the use of public open spaces to enhance the coastal urban cities' resilience to Tsunamis. Accordingly, these identified potentials, constrains and proposed strategies can be summarized as follows.

Potentials	Constrains	Proposed Strategies
• Emergency response and recovery – Gathering, Shelter, Distribution of goods and services	• Identification of open spaces without connecting everyday life of the cities	• Plan and design public open spaces to function well during both emergency and non-emergency times.
• The use of different typologies of Public open spaces for different functions of Tsunami resilience	• Result large quantities of unstructured open spaces contradicting to sustainable cites concept	• Develop an public Open Spaces Network contributing different functions of Tsunami resilience
• Tsunami hazard areas can be allocated for open-space uses	• Designation for the only purpose of conservation and preservation • Constrains in practical implementation to urban context	• Maximum utilization of Tsunami Hazard Prone areas for public open space uses rather than just keeping them for preservation and conservation
• Can significantly contribute to make coastal urban cities resilience to Tsunamis	• Identify the uses of Public Open spaces discretely without an interlink	• Development of Open Spaces Network which works as an interconnected system of the city

Figure 3- Summary of Discussion on current use of POS for Tsunami Resilience

Further, these initial findings will be critically evaluated at the next stage of the research where the researcher will incorporate the viewpoints of urban planners, coastal planners, disaster resilience experts and Tsunami effected communities on to these initial findings. Finally, the research findings will be used to develop a framework to plan and design public open spaces to enhance the coastal urban cities' resilience to Tsunamis.

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COMMUNITY PERCEPTIONS OF FLOOD RESILIENCE AS REPRESENTED IN COGNITIVE MAPS

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ABSTRACT

Community perceptions of flood resilience hinge upon translation of impressions of events and built environment, which thereby influence a community's ability to resist, cope with and recover from adverse impacts of flooding. Any change in the built environment with structural mitigation measures moderate community perceptions of resilience. These structures may be constructed from local or imported materials, and may involve indigenous or non-traditional methods. Particularly in developing countries, NGOs, often in collaboration with communities, design and fund non-traditional structural measures (like, brick-walls, concrete blocks revetments etc.) to enhance community resilience. Considering impacts of these measures upon communities, exploration of community reactions towards these measures is essential.

The study examines community perceptions of flood resilience in the *Haor* region of Bangladesh. The region is a mosaic of wetlands and seasonally inundated lands, and transforms during the annual monsoon season into a shallow inland sea. Here communities live on constructed islands, reinforced by indigenous or non-traditional structural measures. Wave activity places communities at significant risk, especially as the structural measures intended to increase resilience may catastrophically fail.

This paper presents findings from a community visited during late 2015 field studies, and focuses upon the use of cognitive mapping techniques. The research team facilitated small groups of community members in graphically depicting areas of risk and relative safety during flood events. Maps constructed by the community groups indicate that measures intended to enhance resilience may actually increase community perceptions of vulnerability, highlighting a need for a more nuanced understanding of community adaptation to ongoing risk.

Key words: Cognitive Mapping, Community Perception, Flood Resilience, *Haor* region, Structural Mitigation Measure

INTRODUCTION

Contemporary disaster management aims to enhance community resilience (Schelfaut et al, 2011; Klein et al, 2003; Geis, 2000). Resilience is also central to flood management, achieved through structural (e.g., embankments, revetments, wave protection walls) and non-structural (e.g., land-use planning, early warning systems, education) mitigation measures (Bosher et al, 2007). Structural measures can be further categorized as either traditional, being based on local or indigenous materials and methods, or non-traditional structural measures (e.g., brick walls or concrete block revetments). Adoption of methods reliant upon non-indigenous materials or which require extraordinary efforts to maintain, may have inadvertent consequences for communities where they are installed. Bangladesh's *Haor* communities live on constructed islands within broad riverine floodplains, and rely upon structural measures to prevent their islands from being washed away. When islands are deemed uninhabitable, owing to erosion, communities relocate to other islands, increasing density, or to larger cities, disrupting local culture and contributing to hyper-urbanization.

Communities perceive flood risk and resilience via the accumulation of translated individual sensory impressions of phenomena, compiling such into a coherent and unified view of their environment. These perceptions may be overlooked in plans to improve flood resilience as they are not easily communicated, and may not match expectations of external bodies interested in funding infrastructure. This research utilizes cognitive mapping techniques to empower *Haor* community members to effectively communicate their perceptions of risk and resilience. Subsequent interpretation of these maps allows for development of a more nuanced understanding of these perceptions, and can inform more appropriate infrastructure investments.

COGNITIVE MAPPING

Individuals store information about their environment and use that information to make spatial decisions. Downs & Stea (1973) describe cognitive mapping as a series of psychological transformations by which an individual acquires, stores, recalls, and decodes information about relative locations and attributes of phenomena in their everyday environment.

As an activity, cognitive mapping produces a visual manifestation, or graphical representation, of places and experiences perceived by an individual (Tuan, 1975), and imbued with environmental cognition (Kitchin, 1994). Embedded mental constructs, represented visually through cognitive mapping, influence decision-making behavior. Examination of a set of maps allows for exploration of spatial decision-making processes, and elucidation of motivations behind spatial behaviors can be understood (Kitchin, 1994).

Acquisition of geographical 'survival' knowledge is vital to adapt in a disaster-prone environment (Stea, 1969; Kaplan, 1973). Kaplan (1973) proposes that such knowledge gives a selective advantage in a difficult and dangerous world, and hypothesizes that cognitive maps develop as a means of quick and efficient mechanism for handling information. Better planning and design outcomes can be achieved by harnessing information about communities' spatial perceptions of their spaces (Lynch, 1976).

Cognitive maps do not necessarily display a high degree of spatial accuracy nor do they set out to achieve such. The hand-drawn maps serve not only to represent and locate significant features, but also facilitate spatially-literate verbal responses from participants. These maps may contain interesting spatial distortions and these distortions indicate the relative strength attributed to place relationships on the part of the participant (Brennan-Horley, 2010). A researcher can construct, organize, analyze, and present evidence of empirical inquiry to challenge or support concepts, theories, and models (Wagner, 2011).

COMMUNITY FLOOD RESILIENCE & STRUCTURAL MITIGATION MEASURES

Community resilience is the ability of a community to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner (Godschalk, 2003; Coles and Buckle, 2004; UNISDR, 2009; Schelfaut et al, 2011). By contrast, community vulnerability exists where the community is susceptible to the adverse effects of a hazard (UNISDR, 2009). Geis (2000, p 152) proposes that a resilient community is "the safest possible community that we have the knowledge to design and build in a natural hazard context" through minimizing its vulnerabilities.

Schelfaut and colleagues (2011) argue that enhanced resilience hinges on community perceptions of risk and resilience. Individual lived experiences provide contexts for generating perceptions of change in and of the environment (Casey, 2009). Interactions of potential mitigation measures provide a context to perceive community resilience.

Structural mitigation measures, like any change in the built environment, denote development and ideally, development intends to make change: not just any change, but a definite improvement, a change for the better (Slim, 1995). Cannon and Muller-Mahn (2010) link development and adaptation, migrating earlier theories into the sphere of disaster management. Adaptation, or the process of enhancing resilience, is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, helping to lessen adverse impacts of climatic stimuli (UNISDR, 2009). Cannon and Muller-Mahn (2010) classify adaptation as either responsive or anticipatory. Responsive adaptation is spontaneous and generally addresses every day challenges, whilst anticipatory adaptation tackles higher risk scenarios involving greater uncertainty (Cannon & Muller-Mahn, 2010). Structural mitigation measures are classified as anticipatory, and although recommendations for such measures are grounded in external experts or funders' understanding of risk, they do not eradicate uncertainty. Success of adaptation measures is never guaranteed (Cannon & Muller-Mahn, 2010). Klein and colleagues (2001) indicate technology is not a panacea, and as such communities should not solely rely upon structural mitigation measures. Such measures can be seen as adaptive answers to problems (Rammel & Van Den Bergh, 2003), especially as there are inherent uncertainties in innovations (Buenstorf, 2000). This is potentially troubling for communities, as they may expect technology to be more reliable than traditional methods in reducing vulnerabilities.

THE *HAOR* REGION

North-eastern Bangladesh's *Haor* region draws its name from its permanent waterbodies (*haor*), and exists within a tectonic depression within the floodplains of the Meghna River and its tributaries (MoEF, 2005). T. During the annual flood season, the region turns into a broad, shallow (1.8–3m) waterbody (MoEF, 2005). Flooding occurs as a result of the confluence of the region's geomorphology (Alam & Hasan, 2010), regular, extended periods of monsoon flooding (from June to September), and extreme flash floods (Salauddin & Islam, 2011). The region is large (over 24,000 km²), but only 12% of the region is habitable (Alam & Hassan, 2010).. The *Haor* region is not geopolitically defined, but rather includes all or portions of seven districts (MoWR, 2010), complicating governance.

The region supports a population of over 19 million people (MoWR, 2010) in highly concentrated settlements (Alam & Hassan, 2010). The population of the region, and specifically of the Kishoreganj district, is predominantly characterized by poverty (74% of population), with nearly 30% of the population classed as living in extreme poverty (IFAD, 2011).

Communities in the *Haor* region live in isolated settlements of 10 to 300 families (from field survey in 2015) and depend on seasonally cultivable lands (*beel*). Settlements are traditionally built on artificially raised or elevated lands to reduce risk of flooding, especially during the monsoon season.. Initially, a suitable base is located which is seasonally dry, with dredged soils added to elevate the mound 3-4 meters to accommodate construction of multiple dwellings (Figure 1). This traditional method of building settlements leaves communities at risk, as strong waves and flash floods can erode the mounds, washing away accumulated soils and potentially resulting in catastrophic collapse of the mound (Anik & Khan, 2012).

Figure 3 A typical* Haor *region settlement during the monsoon season (Karim, 2014)

Protection of the islands from erosive activities is difficult. Traditional fortifications of bamboo poles, reeds, mats, actively rooting *choila* grass (*Hemarthria compressa*), sand bags or bags of water hyacinth (*Ichhornia crassipes*) have been found to be ineffective (Alam & Hasan, 2010). Several nongovernmental organizations (NGOs) provide financial and technical support to fortify the settlements with structural mitigation measures, often reliant on non-traditional methods of construction.

RESEARCH DESIGN

This study presents preliminary results from the first author's thesis, relying primarily on the cognitive mapping, bookended at the start and finish by focus group discussions, and supported by a transect walk. This method has been applied to the settlement of Concernpara, geopolitically located within the Itna sub-district of the Kishoreganj district within Bangladesh's *Haor* region (Figure 2). Field surveys conducted in 2015 indicate that the settlement accommodates 220 to 230 families in a very dense condition on approximately 1.5 acres. This community was selected as primary contacts indicated that it had a nontraditional structural measure (concrete block revetment) in place, however limited information on the structure, or its impacts on the community, was available. A more detailed narrative of the history of the revetment, constructed from conversations with study participants, is included in the results below.

A base map (see Figure 3) (with indicative locations around the settlement boundary) was prepared to frame cognitive mapping activities. Although use of a base map does place some limits on cognitive mapping activities, doing so imparted a relative scale which was necessary to allow for cumulative analyses of maps as described in the data analyses section.

- **Participant Recruitment and Diversity**

An open invitation, introductory meeting was convened to share the aims and objectives of the research with potential adult (18 and over) participants from the Concernpara settlement, and to communicate logistics regarding participation, namely time involved. Economic diversity of the study participants roughly matches that of the Kishoreganj district, with 33% and 50% of the community living in extreme poverty and poverty, respectively.

- **Data Collection Methods**

Data collection was undertaken with support from three individuals with experience working within the settlement. Participants were initially divided by gender to ensure a culturally comfortable environment. Further division was applied to differentiate those who would have been adults before the installation of the revetment and those who may not have yet reached adulthood at that time. As the date of the installation is somewhat uncertain, but known to be approximately 20 years ago, a cut-off of 40 years of age was established to differentiate between junior (18-40) and senior (40+) groups. Additionally, there is significant migration between communities for marriage, such that not all of the junior women participants would have lived in the settlement prior to the installation of the revetment. Even amongst those who grew up in the community, perceptions of conditions among junior men or women of conditions prior to the revetment may have been based on previously collected oral history.

These divisions formed five small focus groups of 3-4 members - two groups of junior and one group of senior women, and one each of junior and senior men's groups. Following group formation, the research team facilitated initial discussions with each group about the development of their settlement and their perceived flood resilience.

Each group was given two copies of the base map of the Concernpara settlement (Figure 3). They were tasked with identifying locations of four types of features (Table 1) on their cognitive maps, using one map to identify features under current condition (with the latest structural flood mitigation measure) and the other to represent previous conditions (before installation of the latest structural flood mitigation measure). Owing to reasoning above, maps created by the junior groups of conditions before revetment construction were set aside for use in a future project.

Following mapping activities, each participant focus group was individually asked to explain features on each map to the research team, after which they undertook a transect walk to read and otherwise interpret their maps in situ. As with the initial focus group discussions, all conversations from these focus group sessions and transect walks were audio recoded.

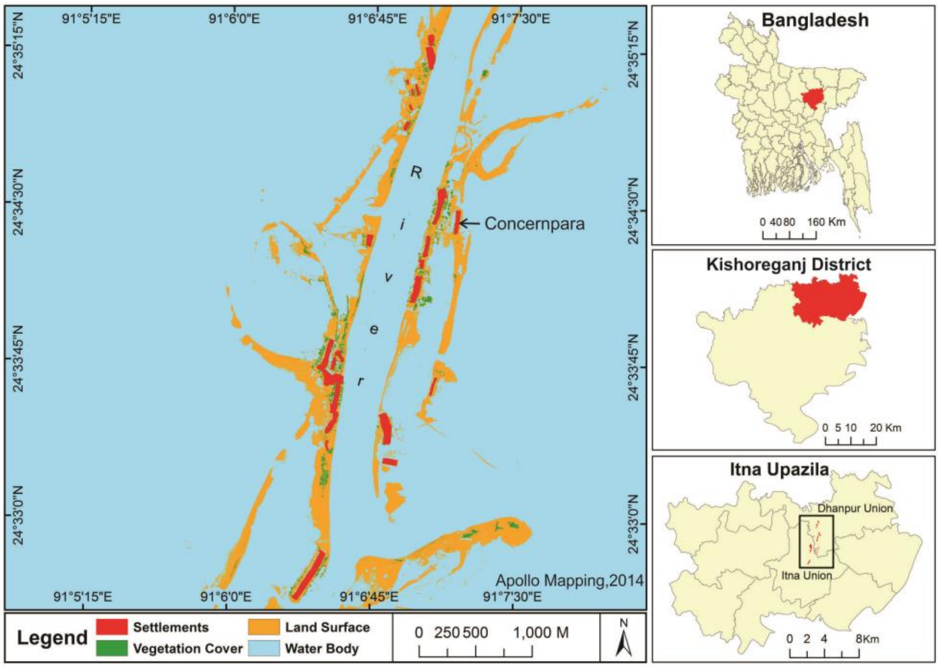


Figure 2 Location of the Concernpara settlement (Author's own figure)

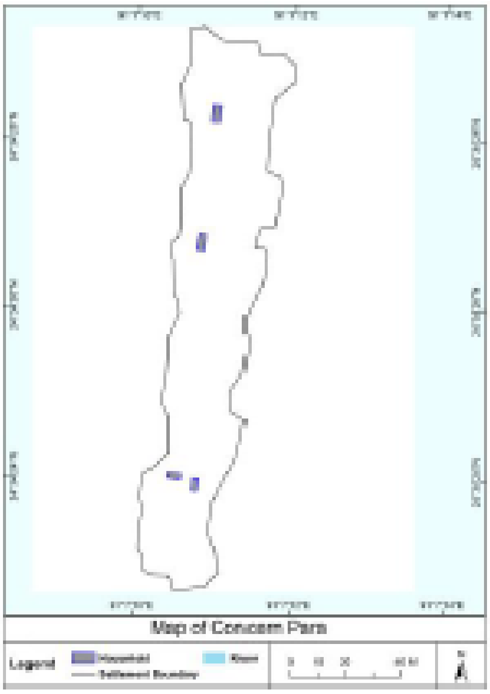


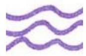
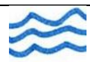
Figure 3 Base map for cognitive mapping

Following completion of field data collection activities, all audio recordings were transcribed, translated into English, and edited for clarity. All of the hand-drawn cognitive maps were scanned and electronically redrawn for clarity.

HISTORY OF THE CONCERNPARA SETTLEMENT

The following history is drawn from the cumulative narratives generated by the focus groups. The Concernpara settlement was established in or about 1990 with financial and organizational support of a nongovernmental organization (NGO). Within 5-6 years, the NGO undertook a structural mitigation project, aiming to protect the edges of the elevated mound with concrete blocks as a form of revetment on the eastern, southern, and northern sides, where wave was strongest and erosion most likely. Unknown reasons prohibited the use of wire cable or synthetic fiber rope to join individual blocks and geotextiles to allow drainage, both of which are common method to stabilize this kind of revetment structure (CDoT, 2004).

Table 1 Representation of features on cognitive maps

Features	Categories	Representations	Images
Areas of perceived risk	Low risk - somewhat prone to flood damage	Yellow Cross	
	Moderate risk - prone to flood damage	Orange Cross	
	High risk - severely prone to flood damage	Red Cross	
Depth of flood water	Up to knee-level (0.4 m)	Purple Waves	
	Up to shoulder level (head remains above water) (1.5 m)	Light Blue Waves	
	Over shoulder level (head potentially submerged) (>1.5 m)	Dark Blue Waves	
Safe area for habitation		Dark Green Hatching	
Previous land area or any previous feature		Green Line	

INTERPRETATION OF COGNITIVE MAPS

Figures 4 and 5 present cognitive maps produced by the focus groups of their settlement before the installation of the concrete block walls on the north, east and south sides (circa 1995), and current conditions. The maps reflect symbology from Table 1. The sections that follow present data collected during the focus groups and transect walks in tandem with the cognitive maps.

- **Perceived Conditions before Installation of the Revetment**

Both of the senior groups were confident in their ability to represent conditions before the installation of the walls, reflecting that they were adults prior to the installation of the walls. Junior groups were allowed to construct drawings of this period as well; however these were set aside as they reflected oral history passed down from the senior groups rather than personal lived adult experiences.

The senior groups agreed that their settlement had previously been larger, and indicated that Concernpara had lost most of its lands from the north, east and south sides of the settlement, which experience strong wave activity. Participants acknowledged that the traditional methods could not address the wave activity, and desired that an intervention of some sort occur.

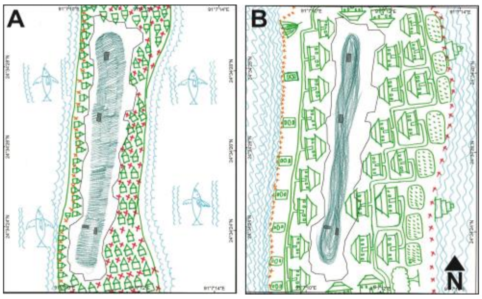


Figure 4 Cognitive maps representing perceptions of conditions before the installation of the revetment as produced by the senior groups of (A) women and (B) men.

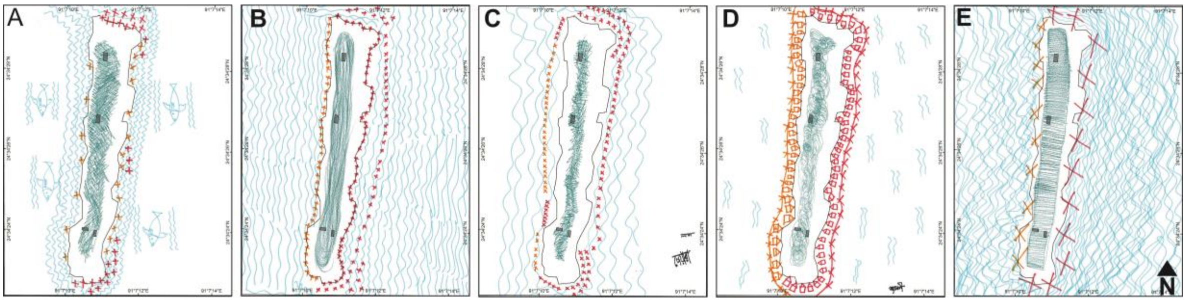


Figure 5 Cognitive maps representing perceptions of current conditions as produced by the senior groups of (A) women and (B) men, and the junior groups of (C and D) women and (E) men.

- **Perceptions of Current Conditions**

Review of the set of cognitive maps confirms that the participants perceive the settlement as flood prone along its edges, with varying levels of risk associated with particular spaces. Participants conveyed a familiarity with the intensity and direction of wave action, potentially contributing to their awareness of the settlement's vulnerability on its north east, and south sides. These sides of the settlement are reinforced by nontraditional mitigation measures - 40-50 kilogram concrete blocks formed into revetments, as verified by the transect walks. Participants in the current research remarked that it is difficult to maintain the blocks in their positions.

Three groups (Figure 5 (A, B, and C)) identified the northeast and southeast corners as presenting particularly high risk. Subsequent interviews indicated that despite the concrete block revetments, the settlement loses land and houses on the northeast and southeast corners each year. Participants reported that the concrete blocks are dislodged by waves during floods, and communicated an understanding that the arrangement of the blocks, being non-fixed nor otherwise joined together, contributes to revetment failures. Participants stated that displacement of a single block can compromise the whole revetment, as the adjacent unsupported blocks will also fall as shown in Figure 6. They reported that after revetment failures in the first year, the NGO returned and indicated that the revetment would need to be reinstalled, underpinned by geotextiles and cables. They understood that without such re-installation the revetments would continue to fail, however re-installation did not occur.

Community members patrol the walls during flood events, looking for failures. They report that they must enter the floodwaters to reset the heavy blocks as soon as possible, regardless of the severity of the current or time of day. Participants in the current research report that many people are injured during these repairs, which generally must be undertaken each year.

Perceptions of risk within the settlement varied among the groups, predominantly on the basis of age. The cognitive map produced by the senior women's group (Figure 5 (A)) communicates the greatest perceived risk amongst the groups. They assigned risk to all corners and protruding parts of the settlement, perhaps as a consequence of their longer lived experience with flooding. By contrast, one of the groups of junior women (Figure 5 (C)) drew and assigned specific risk to an embayment on the western side of the settlement, which they otherwise identify as being an area of lower risk. In follow up discussions, they described a "coiling effect" (translated) occurring in the embayment, conveying an understanding of eddying, which resulted in scour and erosion. The second group of junior women (Figure 5 (D)) assigned elevated risk to the first row of houses on all sides of the settlement, barring the west. They indicated that these areas are severely prone to flood damage and believe that the land they sit on will be washed away in coming years. Houses similarly situated close on the settlement's western edge are believed to be at lower risk, with participants indicating that limited land loss is expected in these areas. These assessments communicate an understanding of erosion dynamics, with the junior groups potentially possessing a more nuanced understanding of hazards.

Though all groups identified the central part of the settlement as the safest area to live, both senior group and the group of junior men (Figure 5 (A, B, and E)) identified the western edge as preferable and safest, communicating that wave energy is weakest on this part of the settlement. Perhaps as a consequence of the less aggressive waves, the western side of the settlement is reinforced with more traditional measures involving an inner layer of piled up sandbags covered with local water hyacinth or *choila* grass and reinforced by bamboo mats and poles. Participants indicate that building and maintaining these walls is much easier and less risky than the piling up of concrete blocks.

Figure 6 Failing concrete block wall along the north-east corner of the Concernpara settlement – community members have previously rearranged the blocks, such that the current arrangement may not match initial installation. (Author's own image, 2015)

CONCLUSIONS

This study documents the Concernpara community's perceptions of flood resilience relative to introduction of non-traditional structural mitigation measures. Residents recognize the necessity of having a suitable non-traditional structural mitigation measure to save their settlement from continued erosion. Focus group discussions indicate that the Concernpara participants perceive greater vulnerability after installation of the revetment. These perceptions may be as a result of repeated failures of the revetment and an incomplete understanding of wave and land subsidence dynamics. They may also perceive greater vulnerability because of the introduced hazard associated with maintain the revetment. Repeated revetment failures have drained community financial capacity. Gains in awareness of community capacity and understanding of flood risk and dynamics are not sufficient to offset these losses. Further, the presence of the ineffective structure reduces likelihood of receipt of external funding, as NGOs may believe that the problem has already been addressed. This study shows that where anticipatory adaptations are not appropriately installed, and more so when they introduce a new hazard, they may increase vulnerability and consequently fail to enhance overall community resilience.

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HOW RESILIENT ARE POOR HOUSEHOLDS?

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ABSTRACT

This paper empirically examines the relationship between disaster risk and hazard, exposure, vulnerability, and the responsiveness of households to cyclones. This reveals policy implications for future adaptive capacity, lessening exposure, vulnerability reduction, and resilience enhancement. This study used primary data obtained from a detailed household survey (Pam module) that was carried out in the affected islands of Tuvalu by the Tropical Cyclone Pam (TC Pam). Disasters such as cyclones, droughts, and floods were ranked the top three stressors affecting households in Tuvalu. The study confirmed that a significantly large proportion of households, particularly the poor, were badly affected and suffered monetary losses from damages from the TC Pam. Moreover, the ability of households to respond to cyclones is limited by insufficient financial resources, the absence of proper early warning mechanisms, and the lack of administrative support for training and capacity building. This resulted in further hardship on the poor who are already struggling financially. Future climate risks are likely to drive the poor deeper into poverty unless we concentrate our policies to alleviate poverty and minimize the effects on them. We employed a disaster risk model using 321 household data from the affected islands of Tuvalu. Since most of our results conform to prior literature, we further strengthened the notion that low-income and poor households in small island developing states are more vulnerable and exposed to cyclones with less ability to respond.

Keywords: Disaster risk, hazard, exposure, vulnerability, responsiveness.

INTRODUCTION

Among the Small Island Developing States (SIDS) in the Pacific, ,Tuvalu which consist of low-lying stretches of atoll islands is one of the most vulnerable countries to natural disasters in per capita terms, particularly to destructive cyclones with associated storm surges. The changes in weather patterns and the threat of rising sea levels further aggravate these threats. Given the increasing frequency and magnitude of extreme weather events in association with climate change, Tuvalu has faced challenges beyond its capacity to deal with.

Tuvalu is extremely vulnerable to disasters due to its small geographical size, insularity and remoteness, the concentration of economic activities and settlements along low-lying coastal areas, the narrow width of islands, limited natural resource base, heavy reliance on agriculture, limited disaster mitigation capabilities, and so on.

This empirical paper examines the risks in relation to hazard, exposure, vulnerability and the ability for households in Tuvalu to face cyclones, particularly its experience with the Tropical Cyclone Pam (TC Pam) in March 2015. Since most of the poorest and marginalized populations reside in high-risk areas with the minimal capacity to prepare and respond to climate disasters, special attention will be given to these households.

LITERATURE SURVEY

The literature and different organizations have their own definitions for disaster resilience. However, IPCC (2012) defined resilience as "the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions". Briguglio (1997) recognized the vulnerability of SIDS to disasters and the lack of economic resilience arising from the relative inability of these countries to face forces of these magnitudes which are out of their control.

Christenson et al. (2014) conceptualized exposure as the "likelihood that an individual in a given location is exposed to a given type of climate-related hazard event over a certain period of time". Smith and Rhiney (2015) and Lopez-Marrero and Wisner (2012) stressed that vulnerability to negative impacts of climate change is partly a function of the differential coping and adapting capabilities of various groups of people in developing countries. Smith and Rhiney (2015) pointed out that vulnerability to climatic impacts is inherently developmental as the differentiated levels of exposure and sensitivity to natural hazards are partly created by basic social and economic inequalities, and accessibility to land-based resources, assets and government support. Lopez-Marrero and Wisner (2012) stated that the vulnerability and capacities to cope with natural hazards differ due to differential accessibility to resources such as natural, physical, economic, human, social, and political.

The different terms of disaster risk, vulnerability, exposure and hazard are discussed in recent literature. Wisner et al. (2003, 2011) elaborate the framework of the 'dual-faced' character of nature that presents a set of possible opportunities and possible hazards. They emphasize that disasters are not solely natural or driven by our natural environment itself, but also influenced by human activities, i.e. the product of political, social and economic environments. Wisner et al. (2003, 2011) introduce a framework that defines and explains the relationship between risks, hazard and vulnerability. The *Pressure and Release* framework illustrate that the intersection of hazard, vulnerability, and coping and recovering capacities correspond to disaster risk. Wisner et al. (2011) reveal the framework of "progression of vulnerability" that comprise of root causes, dynamic pressures, and fragile livelihoods and unsafe locations.

ESTIMATION METHOD

Analogous frameworks were displayed by the literature. However, Wisner et al. (2011) considered disaster risk to be a function of vulnerability and hazard. World Bank (2013) and United Nations (2015) extended the disaster function by adding the exposure to the right-hand side of the equation. However, we used these functions with an extension of responsiveness variables (i.e. refers to the ability to respond or quickly react in a rightful, suitable and proper way) on the right-hand side. Our disaster impact framework should express as Equation 1.

$$Impact = Hazard \times Exposure \times Vulnerability \times Responsiveness \qquad (1)$$

In general, we estimated a regression to determine the relationship between disaster impact and hazard, exposure, vulnerability, and responsive where we used a conventional cross-sectional sample of *n independent* observations Y_i where $i = 1, ..., n$ that are linearly related to explanatory variables in a matrix of X as in Equation 2.

$$Y_i = a_i + X_i\beta_i + \varepsilon_i \qquad (2)$$

Y_i denotes the natural logarithm of the loss and damage over income caused by the disaster in household i, X_i represents a $1 \times k$ vector of covariates or explanatory variables of hazard, exposure, vulnerability, and responsiveness variables, with associated parameters β contained in a $1 \times k$ vector. Each observation has an underlying mean of $X_i\beta_i$ and ε_i is the error term. Since it is often intricate to quantify these explanatory variables, we deliberately select indicators in Table 2 as proxies based on specific considerations and circumstances related to the study.

$$Impact_i = a_i + Hazard_i\beta_1 + Exposure_i\beta_2 + Vulnerability_i\beta_3 + Responsiveness_i\beta_4 + \varepsilon_i \qquad (3)$$

$$ldam_i = a_i + linc\_cap_i)\beta_1 + hholdsize_i\beta_2 + strhouse_i\beta_3 + coastdist_i\beta_4 + elevat_i\beta_5 + cycpdist_i\beta_6 + strhou_i\beta_7 + capacity_i\beta_8 + g\_warn_i\beta_9 + \varepsilon_i \qquad (4)$$

Therefore, our disaster impact model is constructed in Equation 3 where $Impact_i$ is the natural logarithmic of the actual direct impacts on people in household i; $Hazard_i$ is a vector of the distant of the cyclone path that indicates the strength of the TC Pam that affected household i; $Exposure_i$ is a vector measuring the extent of household exposure to the TC Pam; $Vulnerability_i$ is a vector of household characteristics that measure household vulnerability to the TC Pam; and $Responsiveness_i$ is a vector that measures the ability of households to respond or react to the TC Pam. Equation 4 is the full regression specification.

DATA AND SURVEY DESIGN

The study uses primary data obtained from a detail household survey (Pam module) that I carried out from November 2015 to January 2016 in the five islands that were affected by the Tropical Cyclone Pam on March 2015. The Pam module administered household interviews of a sample size of 321 or 58% of the overall households in the affected islands, which were randomly selected. To be consistent with our Central Statistics Division, we used a systematic random sampling approach where we calculated a skip interval (i.e. household population size divided by the household sample size) before randomly selecting a starting point from our list of households, then we count down and skip by the number of the skip interval until we have your sample size.

Table 1: Description of variables and their sources

No.	Variable	Description	Source
DISASTER RISK			
1	ldam	The logarithm of loss and damage.	Authors' calculations based on primary data from the Pam survey.
VULNERABILITY			
2	linc_cap	The logarithm of income per person (in AUD dollars).	Authors' calculations based on primary data from the Pam survey.
3	hholdsize	Number of persons in the household.	
4	strhouse	Strong house structure, 1 if cement otherwise 0.	
EXPOSURE			
5	coastdist	Distant to the nearest coastline in kilometers.	Authors' calculations based on GPS locations of households using reference system UTM Zone S60 with ellipsoid WGS 84 and the Digital Elevation Model (DEM).
6	elevat	Elevation of household in meters.	
HAZARD			
7	cycpdist	Distant from household to the cyclone path in kilometers.	Authors' calculations based on GPS locations of households using reference system UTM Zone S60 with ellipsoid WGS 84 and the Digital Elevation Model (DEM).
RESPONSIVENESS			

8	strhou	Strengthen the house in preparation for the cyclone. Dummy, takes the value of 1 if the house was strengthened, otherwise 0.	Authors' calculations based on primary data from the Pam survey.
9	capacity	Have some training and capacity building experience from cyclone respond workshops by either government, NGOs, and others. Dummy, takes the value of 1 if Yes, otherwise 0.	
10	g_warn	Received cyclone warning at least 12 hrs in advance before it hit. Dummy, takes the value of 1 if Yes, otherwise 0.	

The survey was designed purposely to meet the objective of this study to garner and understand their demographic and socio-economic characteristics, and examine the exposure of households to cyclones, vulnerability of the households to direct and indirect impacts of cyclones, and their ability to respond to cyclones. The estimates obtained not only confine to understanding the vulnerability, exposure, and the ability to respond to cyclones at the micro-level, but the possibility of relocation to other safer areas to escape recurrent cyclones.

SURVEY ANALYSIS RESULTS AND DISCUSSIONS

The key focus of this paper is to analyze data, contribute and address pressing issues of development and disasters. Likewise, we encourage potential avenues to strengthen disaster risk management, and to reduce poverty and disaster risks. This section discusses the statistical results based on the primary data obtained from the Pam module survey.

Loss and Damage

Based on calculations from the Pam module, the estimated loss and damage to households in Tuvalu is 14.67% of the GDP. However, the overall loss and damage at the national level is estimated to be around 20% of the GDP. More than two-thirds of the disaster damage was physical, agriculture accounts for 5.3% of damages and losses, 14% for crops and 4.2% for livestock. The poor households dominate the percentage distribution of loss and damage standing at 78.3%. It is highly fortunate that the poor absorb most of the damages incurred from the cyclone at the household level. Three of the islands namely Funafuti, Nukufetau and Niulakita were affected, but with minor impact.

Hazard

The cyclone started on the 9th of March and lasted for five days. In the literature, hazard for panel data often use the strength of the cyclone in terms of wind speed and the magnitude of associated factors (such as sea level, waves, rainfall, etc.) that could be compared between different events. However, since we are concentrating on a single event, it seems that the strength of the event and the magnitude of associated factors are mostly the same. Therefore, we tend to use the near distant from households to the cyclone path as our hazard indicator that captures the strength and magnitude of the cyclone. The cyclone path ranges from 8,241 to 10,513 kilometers from the households. The average is around 9,841 km. The wind speed of TC Pam rose to a Category 5 at a peak of 165 miles per hour (or 265.54 km/h).

Vulnerability

Household characteristics such as income, household size and the strength of the house were used as indicators representing the vulnerability of households. Poverty was analyzed to solidify further our uncertainty of whether the poor households in small island states are more affected by cyclones or not, with evidence from the TC Pam.

Needless to say, traditional support systems and safety nets undermine the existence of absolute poverty in Tuvalu. Nevertheless, we followed Haughton and Khandker (2009) in defining and measuring poverty. A poverty line was erected to separate those who are considered poor by this standard, and whose consumption expenditure (or income) falls below that threshold. We constructed a poverty line based on the cost of basic needs approach where the cost of acquiring enough food for adequate nutrition is added to a portion of the non-food essentials. The consumption bundle of adequate food and non-food estimates the poverty line that is seen as a reasonable minimum expenditure required to satisfy both basic food and non-food needs. Hence, we refer to the poverty incidence as the percentage of those households who fall below the basic needs consumption level.

Poor household incidence is higher than non-poor households by a small margin. 81% of the income belongs to the non-poor, leaving just 19% of the income pie for the poor. Almost 34% of the expenditure pie is for the poor. Similarly, 39% income earners belong to poor households. Overall distributions of income, expenditures, and income earners are disproportionately distributed and dominated by non-poor households. This disparity in distribution is a concern in the context of poverty and inequality.

Exposure

Peoples exposure to risk is determined by their external environment, e.g.

whether a house is exposed to the risk of coastal flooding depends on its location (World Bank, 2013). Part of this study is to examine the affected islands by the TC Pam to understand the nature of exposure facing households in Tuvalu. Most of the affected households reside in areas prone to storm surges and flash floods, i.e. within coastal and low-lying areas.

The surveyed households from the affected islands reported surges from the TC Pam entering their homes. From the surveyed households, Nui reported the highest of 98% households experiencing surges from the TC Pam entering their homes. Similarly, Nanumaga, Nanumea, Niutao, and Nukulaelae reported 15%, 60%, 32% and 66%, respectively. Nanumea, Nui, and Nukulaelae were badly flooded following days of surges from TC Pam. Interestingly, poor households are less exposed to cyclones than non-poor households in terms of living in low-elevation and near-coastline areas.

Ability to Respond

It is crystal clear that the poor and low-income households are more vulnerable and absorb a heavier burden of the impacts of cyclones. Incomes of these poor households are far less than what is expected to cover monetary losses incurred from cyclone damages. However, indirect losses of essential services such as electricity, communication and transportation are disrupted and unavailable during and after the cyclone. The devastations of the cyclone worse hit the poor and low-income households who are less resilient to disasters and less access to any form of insurance and social protection. Only 10% of households have reported saving some money in the bank every month and the average amount saved is about 2% of their monthly income.

Alternatively, at the national level, there are responses regarding aid (cash and in-kind) from development partners, foreign friends, organizations, families and friends from overseas that goes through the government for its dissemination and distribution to the affected islands, communities, and households.

In general, non-poor households are more resilient to weather-related natural disasters than the poor. On average, non-poor incur more actual damages than the poor by a little margin. However, the poor suffer six times the damages in relative terms to income.

Table 2: Risk, Vulnerability and Resilience indicators

	Indicators	Poor	Non-poor
Risk	Loss (mean)	680	942
	Damage (mean)	2518	2680
	Loss and Damage (mean)	3186	3612

	Loss and Damage over income (mean)	93	15
Vulnerability	Monthly Income (mean)	97	436
	Households (%)	51.09	48.91
	Number of persons in the household (mean)	5	4
	Number of dependents i.e. children and elderly (mean)	3	3
	Household lived in concrete and wood house (%)	85	81
	Distance from the cyclone shelter in minutes (mean)	14	12
Exposure	Households live within 100 meters from the coast (%)	31	34
	Residing in low elevation (%)	13	18
Hazard	Distant from the cyclone path in kilometers (mean)	1423.07	1429.52
Respond Ability	Strengthen house in preparation for the cyclone (%)	55	45
	Shift valuable assets to safe place (%)	47	43
	Households attended cyclone respond workshops (%)	74	75
	Households received a cyclone warning (%)	63	60
	Percentage of income usually saved (%)	2.85	2.90
	Household evacuated to the cyclone shelter (%)	44.5	41.1
	Social safety net (%)	29.9	22.9
	Access to credit (%)	32.9	33.1
	Households received some form of assistance (%)	94.5	100.0
Relocation	Prefer to relocate to a safer place (%).	44	37

Source: Authors' calculations from the Pam survey.

Relocation as an Option

The impacts of recurrent cyclones portray how surveyed households react to relocation as an option. 41% of households have considered moving away from their current homes to safer places. 86% of households will consider moving if given an option of relocation by the government. Given the threats of climatic disasters, people look at options like building stronger sea walls, move away from disaster prone areas, etc.

EMPIRICAL RESULTS

Table 3 presents the estimation results explaining the log of damages. We used three regressions with the same dependent variable and explanatory variables, but with different sample groups. Regression (1) includes all households surveyed, while regressions (2) and (3) use separate samples for poor and non-poor households, respectively. The estimation results from regression (1) are all highly significant with expected negative signs. The negative signs indicate negative effectson log (damages/income) from log of income per person, household size, having a cement house, having some cyclone respond training, receiving cyclone warning at least 12 hours in advance, distant to coast in kilometers, household elevation in meters, distant to the cyclone path in kilometers, and strengthening household in response to the cyclone. For instant, moving away from the coast by a kilometer would decrease loss and damages by 0.5 percent, a one meter increase in household elevation would decrease loss and damages by 16 percent, and so on. The high values of R^2 indicate the goodness of fit of the model.

Table 3: Model estimation results explaining the log of loss and damages

	National	Poor	Non-Poor
linc_cap	-0.0375	-0.552**	0.198
	(0.114)	(0.271)	(0.223)
hholdsize	0.0679	0.0539	0.0669
	(0.0446)	(0.0648)	(0.0626)
strhouse	-0.587**	-0.547	-0.536
	(0.289)	(0.436)	(0.385)
capacity	-0.679**	-0.450	-0.733*
	(0.270)	(0.376)	(0.404)
g_warn	-0.913***	-1.043***	-0.733*
	(0.255)	(0.366)	(0.380)
coastdist	-0.00532***	-0.00301**	-0.00783***
	(0.00102)	(0.00146)	(0.00146)
elevat	-0.160***	-0.211***	-0.106**
	(0.0332)	(0.0456)	(0.0503)
cycpdist	-0.000616***	-0.000358	-0.000658**
	(0.000211)	(0.000306)	(0.000303)
strhou	-0.438*	-0.0997	-0.694**
	(0.237)	(0.366)	(0.321)
_cons	11.08***	11.99***	10.15***
	(0.824)	(1.148)	(1.523)
N	305	148	157
R^2	0.257	0.304	0.277

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Source: Authors' estimations from the Pam survey.

Higher exposure imposes higher cyclone effects on households. As expected, the effect of the cyclone tends to be lower for households with longer distance from the coast and higher elevation. This implies that households on higher elevations and further away from the coast are more resilient to cyclones. Proximity to hazard imposes higher cyclone effects on households. The effect of the cyclone tends to be lower for households with higher distance from the cyclone path. This implies that households who are further away from the coast are more resilient to cyclones.

Higher vulnerability imposes higher cyclone effects on households. As expected, higher income per capita and having a strong house reduces the effect of the cyclone. However, higher income per capita for the poor household sample reduces the effect of the cyclone. This implies that a 1 percent increase in income per capita would decrease loss and damages by 55 percent.. Households face less effects from cyclones when they strengthen and prepare their households before the cyclone hits.

Higher responsive to cyclones imposes lower cyclone effects on households. The effect of the cyclone tends to be lower for households who received cyclone warnings, cyclone respond capacity training, and strengthened their houses in preparation for the cyclone. This implies that households with the abilities to respond to cyclones are more resilient to cyclones.

CONCLUSION

Although poor households are more vulnerable in terms of loss and damages incurred, there is no solid evidence that they are more exposed to cyclones. Poor households on Funafuti are most likely to live in exposed areas to disasters such as near-coastal areas and narrow parts of the island. For the surveyed islands, one thing is for sure is that the islands of Nanumea, Nui and Nukulaelae are the most exposed and vulnerable islands which is also reflected in the huge losses and damages they incurred, and the fact that they were heavily hit by surges and flood during TC Pam.

Households are acutely vulnerable to cyclone impacts and being at the forefront facing the threats of sea-level rise, climate change and related climate disasters is a grave concern to its population. Future climate risks is forecast to worsen in the coming years. It is also critical to understand the extent of exposure of poor households to these risks, the degree of impacts on them and the ability to respond and cope to these risks.

Apart from household exposure to cyclones, many other activities and services were exposed too, e.g. offices, medical services, infrastructure, retail shops, educational institutions, public utilities and social amenities. Furthermore, there is indirect exposure associated to disruptions in services and amenities.

Households identify cyclone, flooding, droughts as the top three most important stressors followed by monetary issues. The losses and damages of poor households in relation to income are higher on average than the non-poor households. The losses and damages suffered by households are uninsured. Besides low income for poor households, they have low savings potential and less access capacity to acquire loans as well. Since the poor invest their earnings in their assets such as the house, durable goods and furnitures, their asset base was threatened by storm surges and associated floods in low-lying areas.

Financial resources, training and capacity building, responsive administration, early warning system, and preparation for cyclones are key factors that ability to respond depends upon. It is clear that the poor are the victims as they tend to have limited financial resources and access to financial facilities, thus resorting to families, friends and informal loans to cope with the impacts. These mechanisms are not fully available and has the potential to add burden to these low-income households.

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THE ARCHITECTURAL GAPS IN POST-DISASTER RECONSTRUCTION

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This paper examines the role of architecture (and potentially architects) in post-disaster reconstruction. It does this by identifying the gaps and potential barriers that are created that prevent resilience. Resilience in the field according to (Exenberger S, 2014) is "the capacity of individuals to navigate their way to resources that sustain their well-being and their capacity both individually and collectively to negotiate for these resources." What is interesting is that these architectural 'gaps' can seemingly be anywhere throughout the housing rebuilding work flow. Contrary to this, architects seem to focus solely on possible house designs for reconstruction. This is not the case and this paper explores the many other value adding roles that architects and their architecture may provide that includes engagement with the affected community, skills training, the use of vernacular materials, procurement, utilization of the existing building industry and cost planning in addition to any inherent design attributes. This paper draws on grounded theory field research and analysis of reconstruction efforts in Samoa post Category 2 Tropical Cyclone Evan (TC Evan) in 2012, the tsunami in 2009; and Fiji post Category 5 Tropical Cyclone Winston 2016 (TC Winston), and measures this against literature, research and analysis of various post-disaster reconstruction case studies.

KEY WORDS: Architects, Post-disaster, Villages, Patterns, Needs.

PLACE ATTACHMENT AND VALUE AWARENESS AS MEANS OF BUILDING RESILIENCE WITHIN A COMMUNITY

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ABSTRACT

The paper explores how architecture in a post disaster context facilitates resilience in the community it harbours. This is informed by an understanding of the affected community's values, past behaviours, activities etc. which simulates design that establishes its identity. While many studies acknowledge the need for a stronger and safer post-disaster rebuild, few attempt to address and integrate the past local context of the disaster struck communities. By reframing architecture to design buildings that have been initiated by these communities it caters not just to their basic needs but is a driver for positive change. This study looks at the ability of architecture in a post disaster context to re-establish a 'sense of place'. This is informed from the adverse effects of globalisation and mass customisation to communities driven by unique cultures and traditions. Drawing from the impact of the 2016 Cyclone Winston, Fiji on the livelihood of the communities- it explores the response to this demand for building back better. The resulting response is to break the misconstrued role of an architect - as a technician who only has work if there is a building to design – to something a lot more valuable as an artist for the community, one that fosters change and facilitates resilience.

Keywords: architecture, sense of place, place awareness, identity, 3R approach

INTRODUCTION

A critical element to the architectural design process is acknowledging the importance of place making for a community. "History is the essence of an idea of place" writes folklorist Henry Glassie (Lippard, 1997, p. 13)

A space is the end product of a chain of historical, social, technological, environmental, economic changes and other interactions. Current emergency shelters are typically blanket solutions catered to any disaster rather than responding to the unique conditions of the culture, site or climate to which they are applied nor do they engage the local community in the design process (Swete Kelly & Caldwell, 2014). The gap herein lies with the lack of a contextual relationship within the shelters provided and the site/ history.

This raises the question- how can these contextual interactions with place be measured for application to then foster resilience within a community?

This paper draws upon a recent visit to Nokonoko village, Fiji to firstly test empirical ways of measuring sense of place; then looks at how it can then be applied in post disaster reconstruction. It will also analyse existing examples of architecture and studies relevant to integrating place identity through the latter tested framework.

SENSE OF PLACE

- **What is Sense of Place?**

Sense of place is subjective in nature. The way that one experiences place and their connection to a place can be understood as a "sense of place". It is considered a romantic, nostalgic approach towards identity formation of a space (Mahyar, 1999).

The aim, in terms of design, is an architecture which is attuned to place and people environmentally, humanely and spiritually. Through identification and appreciation of our fallen site we can begin to piece a site's heritage back together again.

Observing past literature around sense of place this paper looks at contradicting philosophers like Jeff Malpas and Edward Casey and finally the key theorist for this study- Edward Relph. These philosophies discuss the varying dimensions of sense of place and whether it is a structured or limitless experience of a space. This comparison shows how a structural approach to place identity is applicable to designing architecture that integrates 'sense of place'. Whereas a phenomenological approach shows the experiential aspects of place that are hard to quantify. (Shamai & Ilatov, 2005).

For Jeff Malpas, place is discovered in the triangulated structure of the subjective (and intersubjective), the objective, and agency. Edward Casey's opinion is that place appears to the human dweller in experience due to the subject's intentionality *in* place. Casey argues that place is more accurately considered an event than a structure (Martel, 2011).

Malpas has a structured argument for place while Casey sees it as a phenomena, an event that can only be experienced, not restricted into a structure. This brings up an interesting discussion about the measurability of sense of place. How can sense of place be measured or understood if it is a limitless experience? How is it to be measured if not restricted by a quantitative structure? To further argue a structure for sense of place this study conceives and develops the philosophies of Edward Relph, which are structured and phenomenological simultaneously. As Relph writes: "Place experiences are necessarily time-deepened and memory-qualified." (Relph, Dwelling, Place and Environment: Towards a Phenomenology of Person and the World, 1985, p. 26)

While Relph advocates sense of place as a phenomenological experience he also outlines an investigative structure grounded in "a continuum that has direct experience at one extreme and abstract thought at the other…" (Relph, Place and Placelessness, 1976, p. 9) "On one hand, he identifies modes of spatial experience that are instinctive, bodily, and immediate—for example, what he calls pragmatic space, perceptual space, and existential space. On the other hand, he identifies modes of spatial experience that are more cerebral, ideal, and intangible. An example of this is planning space, cognitive space, and abstract space. Relph describes how each of these modes of spaces experienced, has varying intensities in everyday life (Seamon & Sowers, 2008).

Relph's structure of experienced and tangible spaces can be interpreted into a methodology of qualitative and quantitative aspects to then integrate into planning for architecture. However, before that, one needs to understand the impact of sense of place on our environment.

- **Impact of Sense of Place**

Kaltenborn's study of sense of place in the Arctic archipelago of Svalbard, showed that sense of place has a critical impact on the way that residents perceive environmental conditions. The study concluded that residents who have lived in a place longer are more positive about their local environment and are more likely to take action to protect it. Environmental impacts affect a range of environmental values that people hold including aesthetic, cultural, and symbolic values. This therefore affects the relationship that people have with their landscape, or their sense of place. (Kaltenborn, 1988)

The relationship between sense of place and the environment, however, is not solely rooted in the latter values. Stedman argues that the physical landscape can have an impact on the sense of place residents have. In his study of sense of place and lakes in northern Wisconsin he showed residents were happier where lakes were deeper, less public, and had less shoreline development. Residents around lakes that were more developed were more likely to base their sense of place off social values. Therefore, the physical landscape can have significant impact on the sense of place that residents have to their environment. (Stedman, et al., 2007, pp. 330-334)

MEASURING SENSE OF PLACE

Studies have shown that it is possible to measure sense of place empirically and that sense of place can be distinguished to varying degrees. (Kaltenborn, 1988; Shamai, 1991). These frameworks have been collaborated and developed including Relph's phenomenological approach to create a methodology that will test a community's value awareness and place identity. However, there are some limitations within this approach.

While sense of place has been shown to be measurable (See Appendix A for tables and exemplar interviews), there are recognisable aspects of sense of place that make it difficult to incorporate into hard science. Since there is no clear definition of sense of place, there is no defined way of measuring or organizing it on a scientific level (Kaltenborn, 1988). Moreover, there are many uncertainties that go along with sense of place with a quantitative structure of measuring. However, this framework is meant to be an opening platform inviting research into what makes a place's identity measurable. The measurement of sense of place teases out questions regarding where sense of place comes from and what contributes to it (Shamai S. , 1991).

A study illustrating the conceptual potential of Relph's Place and Placelessness is landscape architect V. Frank Chaffin's research. This focuses on Isle Brevelle, a 200-year-old river community on the Cane River of Louisiana's Natchitoches Parish (Chaffin, 1989)

> "Through an interpretive reading of the region's history and geology, in-depth interviewing of residents, and his own personal encounters with Isle Brevelle's landscape while canoeing on the Cane River, Chaffin aims to reach an empathetic insideness with this place—in other words, he attempts to find ways to be open to and thereby to understand more deeply Isle Brevelle's unique sense of place. One central aspect of Chaffin's encounter with this place is his unexpected realization that the Cane River is not an edge that separates its two banks but, rather, a seam that gathers the two sides together as one community and one place" (Shamai S. , 1991).

METHODOLOGY

Moving on from Relph's theory of an experienced space and a more quantified experience in a tangible space this research puts together a 3R framework to account for all these aspects of what makes a place. It includes questionnaires developed from previous exemplar interviews and a now commonly used survey in a post disaster context- The Talk to the Buildings approach.
The methodology employed for this study is that of qualitative and quantitative data collection to then be structured into the latter 3 R approach:

- Remembrance (Qualitative research of memory, connection, encounter, photographs of existing site to read a narrative through the site),
- Remediation (Quantitative research of physical changes, Talk to the Buildings Approach)
- and finally Reconnection (proposal for intervention that will deliver this sense of place to the inhabitants of a place to connect them back to their values)

Whilst this methodology is a useful way of measuring sense of place there are also a few limitations to it which have been discussed later in this study.

- **Qualitative research- Remembrance**

For the purposes of this research, a qualitative approach to understanding sense of place was used simultaneously with a quantitative one. While conducting interviews takes more time and reduces the number of

participants due to time restrictions, quantitative surveys alone would be less appropriate to the culture of Nokonoko.
The interviews are structured to be conversational to answer questions about "the opinions of residents on the changes of societal, environmental, cultural, and economic conditions on site; understanding of their sense of place on site; understanding of environmental issues on site; and the opinions on the role of government in post disaster reconstruction on site (Shamai S. , 1991)." However, this study was limited to those who speak English and were willing to be interviewed which made it difficult to assess the entire community's opinion. Furthermore, photographs of the site were utilised to understand the narrative behind its context.

Pattern	Definition
1. Inhabiting the site	If the form of the house doesn't begin by responding to the site, house and site may well end up in conflict with each other
2. Creating rooms, outside and in	a lively balance of indoor and outdoor rooms
3. Places in between	Places that allow you to inhabit the edge, that offer enough exposure to make you aware of your surroundings, and that provide just enough protection to make that awareness comfortable
4. Refuge and outlook	At its simplest we are inside looking out
5. Private edges, common core	A good home balances private and communal space throughout
6. The flow through rooms	Movement through a room affects the room itself
7. Composing with materials	Choosing its materials – to support, frame, fill, cover, colour and texture space – is the act of composing the home
8. Sheltering roof	More than any other single element, the form of the roof – as experienced both outside and in – carries the look and meaning of shelter, of home
9. Parts in proportion	A home is a hierarchy of parts in proportion
10. Capturing light	Good homes capture light – filter it, reflect it – in ways that, no matter the season or time of day, delight their inhabitants

Fig. 1 10 Essential Patterns that form the Talk to the Buildings Approach (Waqabaca, 2013)

- **Quantitative resea rch- Remediation**

The qualitative interviews try to tease out the issues around sense of place within the local community's personal opinions. The quantitative aspect on the other hand was utilised through the Talk to the Buildings approach to analyse patterns of what makes a house a home. This approach was developed from Christopher Alexander's Pattern language. The 'Talk to the Buildings' approach was utilised for measurable criteria for these interviews. Diverse patterns (See Fig. 1) for selected buildings erected in Fiji were to be given a score from 1(not significant) to 4(very significant). These patterns were to be mapped across three spatial areas of a house- the inside, outside and any other spatial divisions (Waqabaca, 2013)
The sample for the questionnaire was to be any male or female over 18 years of age who currently lives in Nokonoko. The resultant information from the questionnaires is detailed in section 5.1. Unfortunately, due to limited time in the village the Talk to the Buildings approach could not be utilized which could have given a measure of how the existing shelters scaled in terms of what makes a home.

CASE STUDIES

This paper deciphers a quantifiable measure for sense of place. Hence why case studies of 1- Place visited and 2- Place not visited have been explored to understand whether it is applicable to both. The two case studies looked at for this section are that of Nokonoko, Fiji and Omega Centre in Rhinebeck, New York. Nokonoko has been personally visited whilst Omega Centre has not. It can be observed that the methodology can still be applied to places that have not personally been experienced. This is because a big proportion of the qualitative approach comes from interviewing the people who are experiencing the place on a day to day basis. With a lack of this critical aspect, the study may only be loosely considered as a good indicator of value awareness.

Nokonoko Village, Fiji

Nokonoko was visited in June 2016 approximately 5 months after Tropical Cyclone had disastrous consequences on the livelihoods of the community of Nokonoko. Late February, Fiji was to experience its biggest cyclones ever seen leaving behind extensive damage and inflicting 44 deaths. Within Nokonoko the people sheltered in the church which was also damaged to a point where parts of the corrugated roof flew away in the high winds.

Fig 2. Habitat shelter inclusive of sanitation provided to Nokonoko (Author's photo)

Remembrance- In Nokonoko, through interviews with various people it is evident that post the cyclone the top three values for Nokonoko community are – Togetherness, Religion (God) and Means of Livelihood. Everyone in the village supports each other and comes together in the church on Sundays. If anyone is in need, especially the older folk in the village, then the village chief along with his '*matangali'* or ministers decides who will assist them in a group for the month. The villagers depend on agriculture, weaving and sewing as their main means of income. Every week the women and the men come together for a women's club and a men's club meeting to discuss the rebuild. Sometimes the women's club even meets to sew and weave whilst the men meet up to practice the skill of carpentry etc. There are no medical facilities within the village.

Remediation– Damage to the village seems to be limited to the physical damage of buildings as villagers appear to support each other in these desperate times.

Reconnection- Habitat Fiji has provided a couple of 'strong' shelters for this village (See Fig. 2) with a commission through European Union, however, as previously mentioned these shelters are a blanket solution to the real problem of Nokonoko. Shelter is in dire need; however, through the 3R Framework this study recognizes the need for a visiting medical clinic and an extension to their community hall -which could be utilized as a multipurpose club meeting room for all kinds of activities to help foster the community's skillset.

Fig. 3 Omega Centre being utilised as a filtration facility with educational

Omega Centre for Sustainable Living- Rhinebeck, New York

As a part of an overhaul project for the Omega Center for Sustainable Living (OCSL)'s current wastewater disposal system BNIM architects and Omega decided to showcase the system in a building that houses both the primary wastewater filtration facility and a classroom/ laboratory.

In addition to using the treated water for garden irrigation and in a greywater recovery system, Omega will use the system and building as a teaching tool in their educational program designed around the ecological impact of their campus. These classes will be offered to campus visitors, area school children, university students and other local communities (Living Future Institute, 2015).

aspects (Living Future Institute, 2015)

Analysing this case study through the 3 R Approach we find:

Remembrance- Whilst the function of the facility has merely upgraded to a more sustainable filtration facility, it is clear that adding an educational aspect to it, further reiterates the emphasis on educational value for Omega.

Remediation- The building owner has implemented a "green cleaning" program to use healthier, less toxic cleaners. The focus on the wellbeing of the user hence brings an overall positive experience in Omega which is healthy and effectively connects with the context of the educational institute.

Reconnection- Furthermore, the Omega Centre is constructed on land that was previously used as a burial spot for solid debris from years of operation with the previous owner. In addition, the original fill material was removed and sold, dating back to sometime in the 1950s. The connection with its site history is evident. What was previously a burial for debris is now a filtration facility as though following a circle of its life and purifying itself in the process.

DISCUSSION

The 3 R Approach is expected to be instrumental in advancing the study of sense of place and that in turn will lead to a greater understanding of the meaning of sense of place. This scale could serve as a standard scale to measure sense of place in different places at different times. However sense of place being a vague concept, which for some is limited to a phenomenological experience, loses its essence to some extent when quantified and developed into a data collection model. While this is a limitation it also makes room for more study in this area of research. Furthermore, constraints for this study are limited to that of time and accessibility of resources. The application of the 3R Approach was applied in Nokonoko over a period of 1 day. This period was too short to get a deep understanding of the Nokonoko culture and past associated.

Lastly, several geographers have criticized quantitative analysis of sense of place as quantitative data cannot grasp individuals' experiences (Shamai & Ilatov, 2005) so this is another limitation of the framework as it structures this experience to be restricted in some aspects.

CONCLUSION

As Shamai describes, sense of place can be measured empirically, "however, what contributes to it is not completely clear. The question remains: what creates the sense of place, the perception of physical environment or the perception of the personal and social contact and interaction in the place?" (Shamai & Ilatov, 2005)

The 3R Approach is a result of both theoretical investigation and empirical studies of sense of place. The theoretical studies of sense of place are more developed than the empirical ones, in part because some philosophical approaches defy empirical measurement and in part because of the lack of methodological tools. Filling this void is the purpose of this article as sense of place is not a phenomenon that is "useless to try measuring" (Lewis, 1979, p. 40). It is impossible to measure only if one holds a specific point of view, phenomenology, which regards it impossible to quantify any phenomenon.

This approach is a step towards teasing out these interactions and understanding what can be explained as the basis of place identity for a community. Through its focus on the physical environment in the quantitative measurement of Remediation and the social environment in the Remembrance aspect it can help engage the community. This will result in construction that allows the community to successfully build back better rather than alienate them.

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IMPACT OF INCREASED DESIGN WIND SPEEDS ON RESIDENTIAL CONSTRUCTION COSTS IN THE PHILIPPINES

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ABSTRACT

Buildings in the Philippines are designed for wind speeds of 150, 200 or 250kph depending on the region where they are located. In 2013, tropical cyclone Haiyan brought about record high wind speeds of about 307kph at landfall. It led to the collapse of 550,928 houses and partially damaged 589,404 others. Professional organizations for civil engineers and architects in the Philippines propose to modify the design wind speeds specified in the National Structural Code of the Philippines (NSCP) in order to make structures more resilient to typhoons that are both intensifying and changing direction. This research seeks to analyse the impact of such changes on the cost of constructing and/or reconstructing homes. A house model by the National Housing Authority was modelled and redesigned for increased wind speeds. Corresponding increments in the construction costs were computed. The results demonstrate considerable increase in the cost of the roof framing and sheathing in the lower wind speed ranges, and the cost of required steel reinforcements for higher wind speeds. The study contributes to the body of literature in verifying the feasibility of proposed modifications to design wind speeds in the building code.

key words: building code, construction cost, design wind speeds, structural resilience

INTRODUCTION

An average of eight to nine tropical storms make landfall in the Philippines and an additional ten that traverses at the large bodies of water surrounding the archipelago annually (Brown, 2013). These tropical storms are categorized depending on their corresponding wind speeds. Wind speeds are used as benchmark in building design coined as basic wind speed. Basic wind speeds for each province in the country are tabulated in the National Structural Code of the Philippines and they are categorized mainly on three basic wind speeds, 150kph, 200kph and 250kph (Association of Structural Engineers of the Philippines, 2010). The basic wind speed is used to determine the design wind loads on structures for different wind zones of the country. A certain limitation is indicated in the NSCP under section 207.4.3 which states that "Extreme typhoons have not been considered in developing the basic wind-speed distributions." One example of these extreme typhoons is Haiyan, which devastated the islands of Samar and Leyte with its 10-minute sustained wind speed of 230kph, also reaching wind speeds of 307kph at landfall according to the US Navy Joint Typhoon Warning Center, in Honolulu Hawaii. This cyclone, which caused the destruction of more than half a million houses and severely damaged over half a million more (National Disaster Risk Reduction and Management Council, 2014), has prompted engineering experts in the Philippines to revisit a previous proposal to amend the wind zone map of the Philippines increasing it by as much as 50kph in various parts of the country (Pacheco, Aquino, & Tanzo, 2005).

Past disasters have triggered the upgrade of building codes in various countries. For instance, a series of fires led to the development of fire provisions of the US building code, seismic events prompted the evolution of the California seismic code and other related regulations, and the Madagascar building code was adopted after the 2008 cyclone season that destroyed many public structure (World Bank, 2015).

Building codes, albeit a measure for mitigating risk, may also be a barrier for building resilience in low-income houses. The limitations on the prescribed construction materials and methods make house construction expensive (Muth & Wetzler, 1976). Codes are sometimes upgraded as a response to a disastrous event, but pressed for time, necessary analysis on its impacts are not studied. For instance, the Victorian bushfires prompted revisions in the fire code that led to a steep increase in building construction due to the hefty prices of fire suppression features and fire-rated building components (Mannakkara, Wilkinson, & Potangaroa, 2013). In the case of Madagascar, the cost of standard construction in the highlands increased by 14%. The cost of constructing traditional houses, for which the code is not mandatory but is recommended, has a markup of 24 to 104 percent (Bettencourt, et al., 2013). The Revised National Building Code of Barbados increased the cost to homeowners by approximately 15% (Phillips, 2012). Unaffordability of houses has led to the proliferation of informally built residences, houses not compliant to standards, with poor resistance against moderately high winds (Prevatt, 1994).

The Fiji National Building Code was developed after cyclone Tusi caused massive destruction in the country in 1987, prompting UK-based reinsurers to refuse insuring buildings unless a building code is adopted (Yee, 2016). This code was implemented in 1990, but that only privately owned buildings in the urban areas have actually complied. TC Winston hit the country on February 2016 and destroyed a great number of houses in the countryside (National Disaster Management Office, 2016). The cyclone prompted the revival of the Fiji Building Standards Committee, to review the standards, further awareness, and enable and register local builders to increase compliance to the code (Prasad, 2016).

This paper investigates the effect of increasing the design wind speed on the cost of constructing a single-storey house in the Philippines. A house model from the National Housing Authority is used as a case study.

This research enables a more holistic approach to evaluating the feasibility of implementing an upgrade in building code in the Philippines. This also contributes to the relatively narrow array of literature analysing the interrelationship of building regulations and socioeconomic factors.

METHOD

The structure analysed for this case study is a one-storey house with loft described in Table 30 and illustrated in Figure 4. This is among the typical models constructed by the National Housing Authority of the Philippines.

Table 30. Properties of the model house

Plan Area	22 sq. m. (4.00 x 5.50 m)
Total height	5.50 m
Roof pitch	23.5 degrees
Other description	RC framing, CHB walls with cement-plastered finish, GI roof connected by tek screws to a steel roof framing

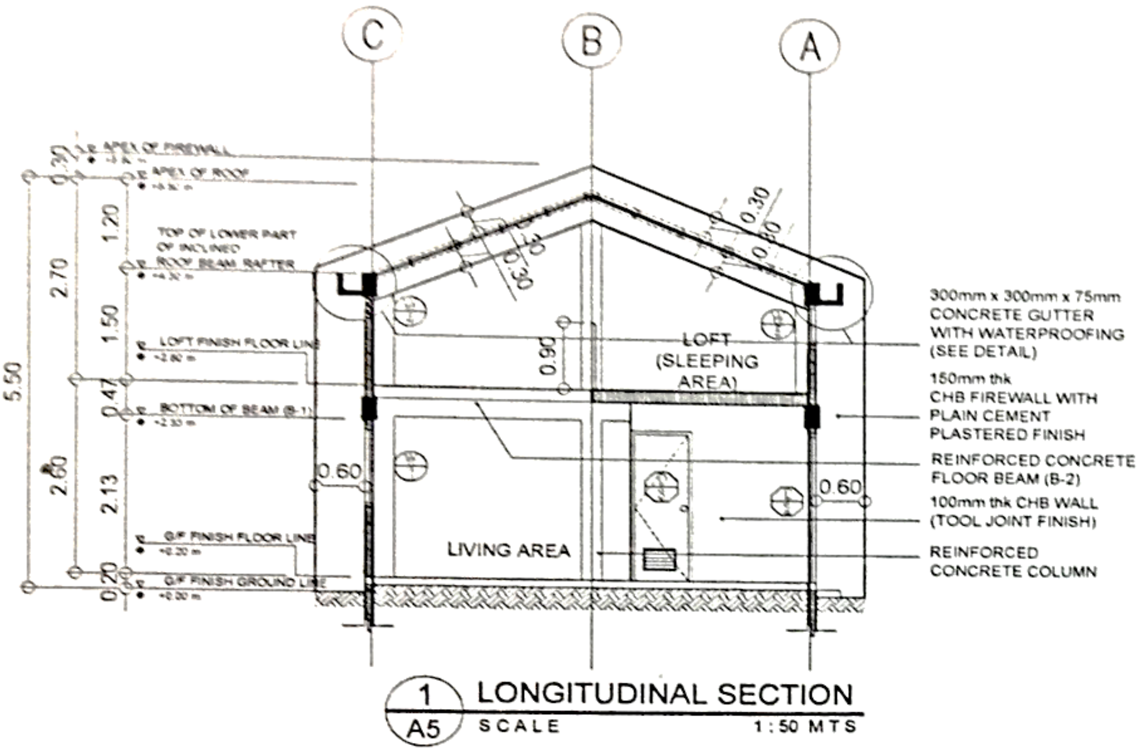

Figure 4. House model used for the case study

The structure was modelled using STAAD Pro. Wind loads were applied as prescribed in the National Structural Code of the Philippines (NSCP) 2010 version. The steel components were designed using AISC LRFD code. The roof sheathing was designed based on a maximum tek screw pullout strength of 1.26kN (Hernandez Jr, Bisa, Longalong, Suiza, & Orozco, 2015).

The house was designed for increasing wind speeds from 100kph to 325kph in increments of 25kph. The overall geometry of the house is kept constant with the change in the design wind speeds. Only the sizes and quantities of the structural members are varied in response to changing wind loads. Further, exterior walls, which are typically reinforced concrete or concrete hollow blocks, are assumed to be adequately built to withstand wind pressure.

The designs were cost-estimated using the prevalent construction materials prices in the Philippines as of May 2015. Increments in the costs were noted for various components of the building.

RESULTS

Considerable cost increments were observed in the redesign of the roofing structure and the roof sheathing for increased wind speeds. Effects were less on the reinforced concrete framing of the structure.

Roof Structure

For the rafter, the smallest commonly available steel channel section in the market is C3x4. This section is adequate for wind speeds up to 300kph. Beyond 300kph, a C3x5 section would be necessary.

Figure 5 shows that the purlins need be spaced closer as design wind speed increases as anticipated. A sharp change in the required maximum spacing occurs with an increase 150kph to 175kph in the design wind speed.

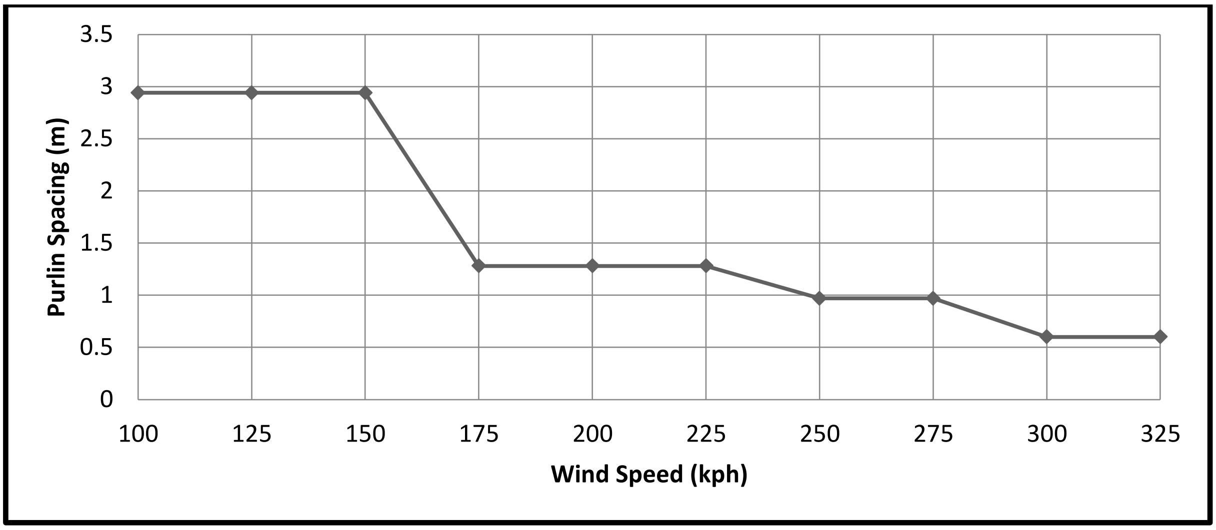

Figure 5. Purlin spacing versus design wind speed

Significant jumps in the construction cost are observed when increasing design wind speed from 150 to 175 kph, 225 to 250 kph, and 275 to 300 kph. As high as 24% increase in the cost is observed when changing the design wind load from 275 to 300 kph.

Roof Sheathing

The amount of tek screw necessary to pin the roof sheathing generally increases with the design wind speed as shown in Figure 6. The sharpest increase is observed in the 225kph to 250kph increment, entailing a 49% increase in the quantity of tek screw.

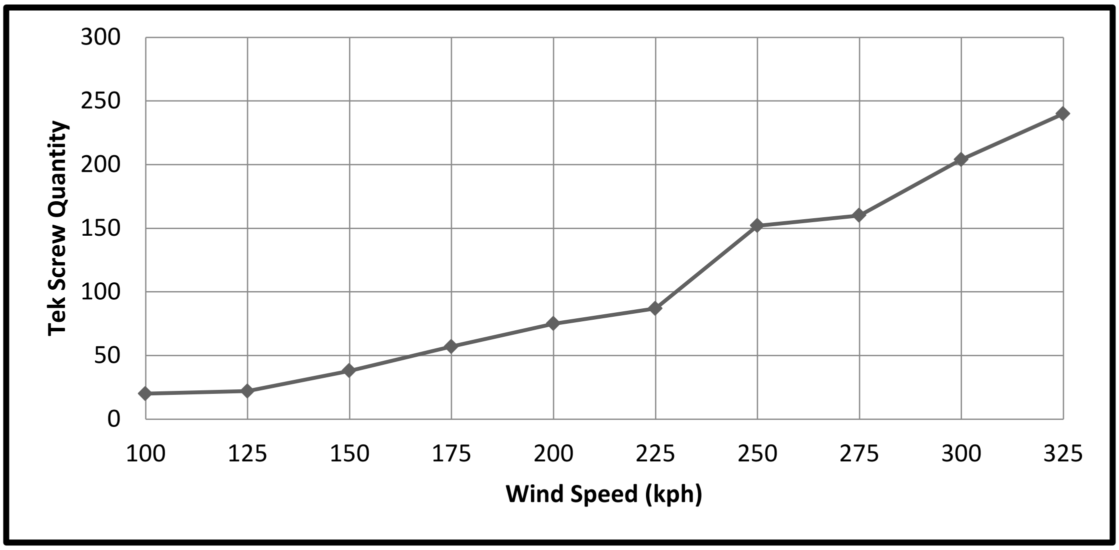

Figure 6. Tek screw quantity versus design wind speed

The gage of the corrugated GI sheets used for the sheathing is adequate. Hence, only the tek screws vary in number with the higher wind loads. While there is a steep increase in the quantity of tek screws required, it doesn't heavily affect the overall cost because of the low cost of the tek screws.

Structural Framing System

The beams and column designs appear to be insensitive to changes in the design wind speeds up to 250kph. Seismic requirements govern in these ranges. For the gable cap, the required steel rebar area, As, increases by 50% for a design wind speed of 275kph. For the columns, As, jumps by 32% at 300kph, and by another 43% at 325kph. For the beams, the design is only sensitive to wind speeds greater than 300kph.

Overall House Cost

It can be observed in the case study that the effect of changing the design wind speed in lower ranges is smaller than that in higher wind speed ranges. An increase from 150kph to 200kph results to a minimal 0.43% increase in the cost of the NHA house. It turns out to be 1.44% when increased from 200kph to 250kph, 3.38% when increased from 250kph to 300kph, and as high as 6.10% when the design wind speed is increased from 300kph to 350kph.

At the lower ranges, it is the roofing structure and sheathing that contributes largely to the increase in the prices because the seismic requirements govern the design of the framing. This means that there is an unrealised cyclone resilience for the house design due to the ductility of the reinforced concrete framing inherently brought about by the design process. Hence, the design can further be optimized.

For higher wind speeds, however, the steel reinforcements in the beams and columns contribute bigger to the cost increase as the wind design requirement begin to govern. Bigger houses with more complex roofing structures are expected to exhibit greater sensitivity to increasing design wind speeds even at lower wind speed ranges.

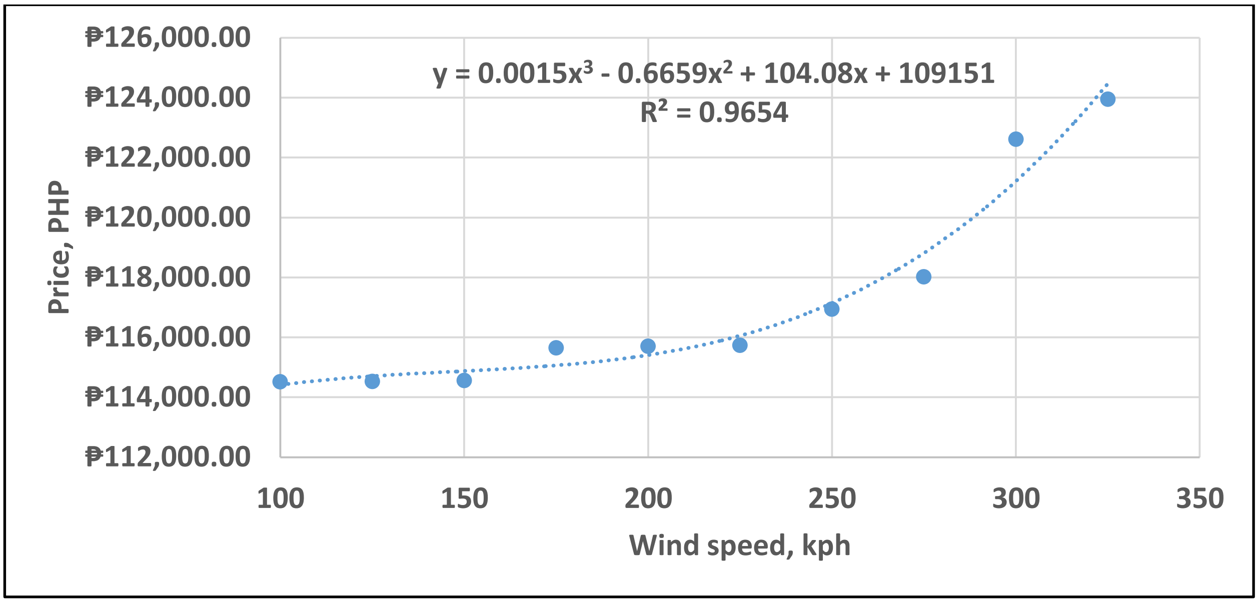

Figure 7. Construction cost of the NHA house model versus design wind speed

Looking at the actual amounts, however, shows a different perspective. Albeit the low 3.38% percent increase in the construction price when increasing the design wind speed from 250kph to 300kph, this actually translates to PHP3954.25 (USD85.75), which is equivalent to 80% of the minimum monthly wage in the province of Catanduanes, where such increase in design wind speed is proposed.

Further studies are recommended before implementing an increase in the design wind speeds for the Philippines. An upgrade in the standards does not necessarily translate to a more resilient building stock. It has to be coupled with good enforcement and should be feasibly complied with by everyone.

CONCLUSION AND FUTURE WORKS

The sensitivity of the construction cost of a house to the changes in design wind speeds was analysed for the NHA house model in the Philippines.

Results show that the cost increase ranges from 0.43% in the lower ranges to 6.10% in the higher wind speed ranges for a 50kph increment in the design wind speed. For this house, the increase in the cost is not significantly high. For a structure with more complex roof structure, the increase in the cost is anticipated to be higher even at lower wind speed range.

Future works for this study include looking at other house models in the Philippines, exploring non-traditional approaches to developing wind resilience of structures. There is also a need to verify these theoretical runs on site. The case of Fiji as it rebuilds from the aftermath of TC Winston could be looked at as well, as regards to how houses are rebuilt and how the codes and standards are upgraded and implemented.

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IMPACTS OF WATERLOGGING AND ADAPTATION MEASURES IN KHULNA, BANGLADESH

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ABSTRACT

Waterlogging is a severe problem in the southwestern coastal region of Bangladesh. This research aims at exploring the severity of waterlogging problems and the practices of as well as perceptions about adaptation in the polders situated in Khulna, Bangladesh. A survey of the households was conducted. The study finds that community people spontaneously participate in traditional adaptation methods; however, they hardly realize their own contributions toward the adaptation practices. A considerable section of the community is not aware about the institutional initiatives addressing waterlogging problem. Although the technical aspects of waterlogging and polder management are essential, the people living inside the polder perceive that the institutional and management aspects are vitally important. Post-facto nature of adaptation interventions in the region may lead to unusual losses and damages, which could be minimized through a pre-facto well mix of technology and management.

Key words: Waterlogging; Khulna; Perception; Causes; Impacts.

INTRODUCTION

Waterlogging, a chronic crisis since 1980, reduces the carrying capacity of the rivers and ultimately leads to flooding (Kibria, 2011). The causes of waterlogging include among others, insufficient drainage, deficiency in embankment management, siltation of rivers and reduced upstream river flow due to the Farakka Barrage (UNDP, 2011; Kolås, 2013). Three districts at the southwestern part of Bangladesh, namely - Jessore, Satkhira and Khulna, are highly vulnerable to waterlogging. For the last two decades, this problem has surfaced mainly due to reduced dry season flow, which further aggravates sediments deposition in the riverbeds, as well as heavy rainfall during the monsoon (Rahman and Rahman, 2011). The other causes include constructions of infrastructures, for instance, bridges, culverts, sluice gates and unauthorized encroachment of rivers. Only in Jessore and Satkhira, the waterlogged areas increased from 12,687 ha in 2003 to 22,389 ha in 2008 while number of people affected rose from 115,200 to 865,789, depicting a precarious condition (Rahman and Rahman, 2011). As a whole it has affected nearly one million people and has caused large-scale damages to national economy, especially crops, employment and livelihoods (Rahman, 1995; Ahmed et al., 1998). Bangladesh experiences various types of natural calamities. Among them flooding caused by tidal surge is a regular phenomenon in the coastal south. Although polders, low-lying land reclaimed from river or sea and protected by dikes, were constructed to overcome the threats posed by tidal surge, in many cases these are detrimental to the geo-physical and hydrological setting of the south-west coastal Bangladesh and it contributed enormously to bring another environmental havoc called waterlogging (Adri and Islam, 2012).

- **Objective and rationale of the research**

This study aims at analyzing the adaptation practices to cope with waterlogging in the coastal district of Bangladesh. The specific questions the research plan to answer are – what are the causes of waterlogging in the region and what the households perceive? What are the impacts of waterlogging? How do the individuals and institutions take initiatives to cope with the problem?

While a good number of researches are there in other countries, researches to date focusing perception of community people about adaptation measures addressing waterlogging in Bangladesh are yet to saturate (Haque et al., 2012). Because of its geographic location at the intersection of three river basins - Ganges, Brahmaputra and Meghna - on a flat deltaic topography, flood, tropical cyclone and storm surge are common phenomena to Bangladesh. In that context, this research is expected to contribute new insights on waterlogging problems from community perspectives.

- **Methodology**

Since the variables are not clearly known (for example, adaptation options for waterlogging are not clear), topic is new and unaddressed within the study areas, qualitative exploratory research has been conducted (Morse 1991, cited in Creswell, 2009, pp. 18).

A Multistage mixed sampling technique was applied for selection of the study areas, the required sample households and sluice gates for data collection following the guidelines prescribed by Dang et al. (2014). In the first stage, Khulna district was selected purposively for its geographic location. Three polders from Khulna district were then selected purposively again based on the severity of waterlogging as well as geo-physical locations. Based on the degree of proximity to the metropolis of Khulna and the Bay of Bengal, three polders, one from each of three different upazillas – Rupsha, Batiaghata and Dacope – were selected further. It is to mention that upazilla is sub-unit of district. The governance and management structure for the selected polders are different. Table 1 describes the selected polders in brief.

Table 1: Sample area and demographic information

Operated by	Polder No.	Upazilla	Union	Village	Operating starting year	Area (Ha)
LGED SSWRD	SP12027	Rupsha	Naihati	Jabusa	2000	790
BWDB IPSWAM	30	Batiaghata	Batiaghata	Fultala	1972	7209
			Gangarampur	Daotala		
BWDB non-IPSWAM	31	Dacope	Pankhali	Baroikhali	1972	3170
			Tildanag	Kaminibasi	1972	3170

Household level data were collected from five unions (lowest administrative tiers consisting of several villages) in the study area. One union from Rupsha and two unions from each of Batiaghata and Dacope under Polder No. 30 and 31, respectively were selected. Subsequently, five villages, one from each union, were randomly selected. In the last sampling step forty from each village, totaling 200 households, were arbitrarily selected for conducting the survey. Figure 1 presents a map of the study area.

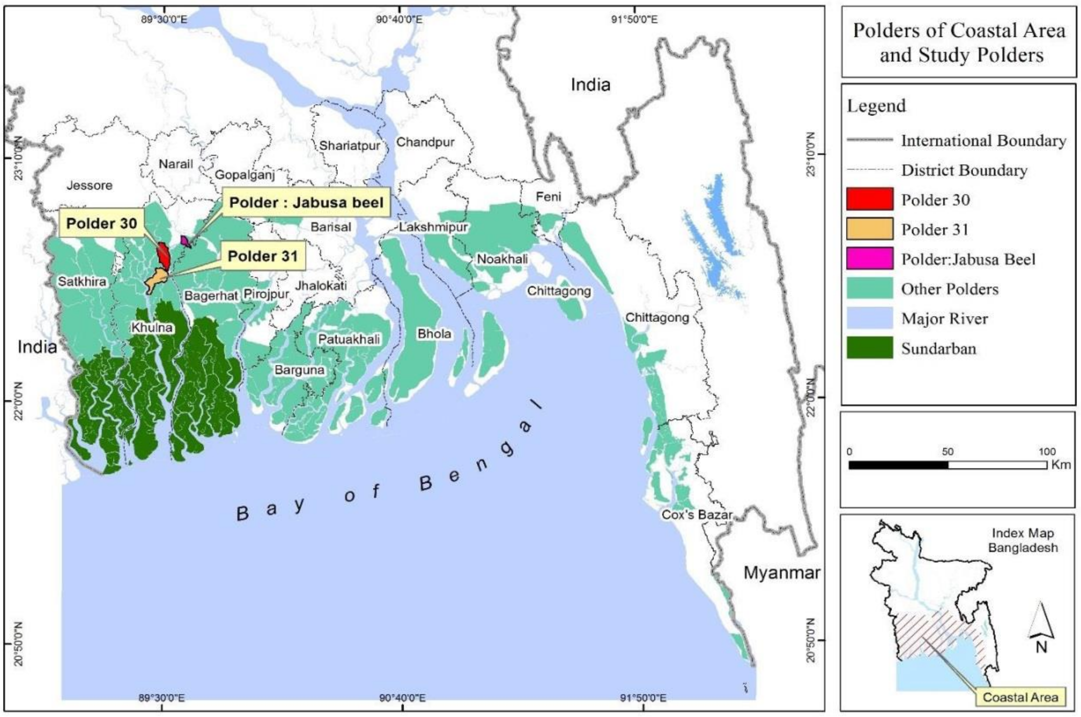

Figure 1: Location of study area

CAUSES AND IMPACTS OF WATERLOGGING

- **Causes and severity of waterlogging**

People from different locations show different perceptions on the causes of waterlogging in the study area. For instance, blockages in the canals create waterlogging in Rupsha substantially, while it has minimal effect in Dacope and Batiaghata. Encroachment of canals is a severe problem in Rupsha and Batiaghata upazilla. In contrast, accumulation of agricultural residues has been perceived to be the main problem causing waterlogging in Dacope. Figure 2 shows the summary of causes of waterlogging in Khulna.

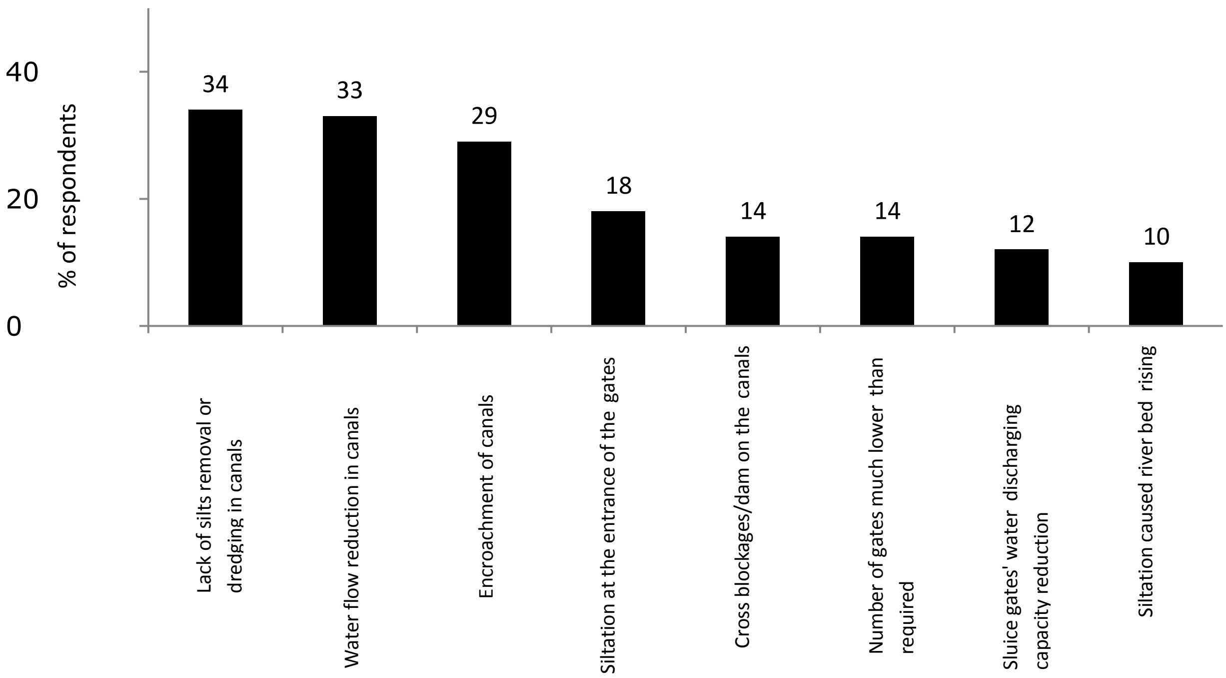

Figure 2: Causes of waterlogging and drainage congestion in Khulna

On a five-point scale of severity, the households' perception on the problem shows that 75% of the total respondent senses the problem as 'severe' not a 'very severe' problem. Ninety percent of the respondents from Rupsha upazilla categorize waterlogging as a severe problem.

- **Impacts of waterlogging**

For analyzing the impacts of waterlogging, two broad impacts related to agriculture and transportation were listed. Most of the respondents in Rupsha and Batiaghata think that delayed start for cultivating Rabi crop (winter season crop) is inevitable due to waterlogging. Due to geographic location, Dacope upazilla faces more problems with transportation and communication with waterlogging. Although information on the impact of waterlogging and climate change are disseminated quite considerably both by the government and the private sectors, substantial portion of the community households have yet to enhance understanding on the issue.

ADAPTATION MEASURES TO WATERLOGGING

- **Individual actions**

Survey shows that most of the residents in the region perceive that they do not take any initiative to adapt to the waterlogging problem. Very few have voluntarily involved themselves for adaptation while a minimal number of people have contributed money for hiring labor (Figure 3)

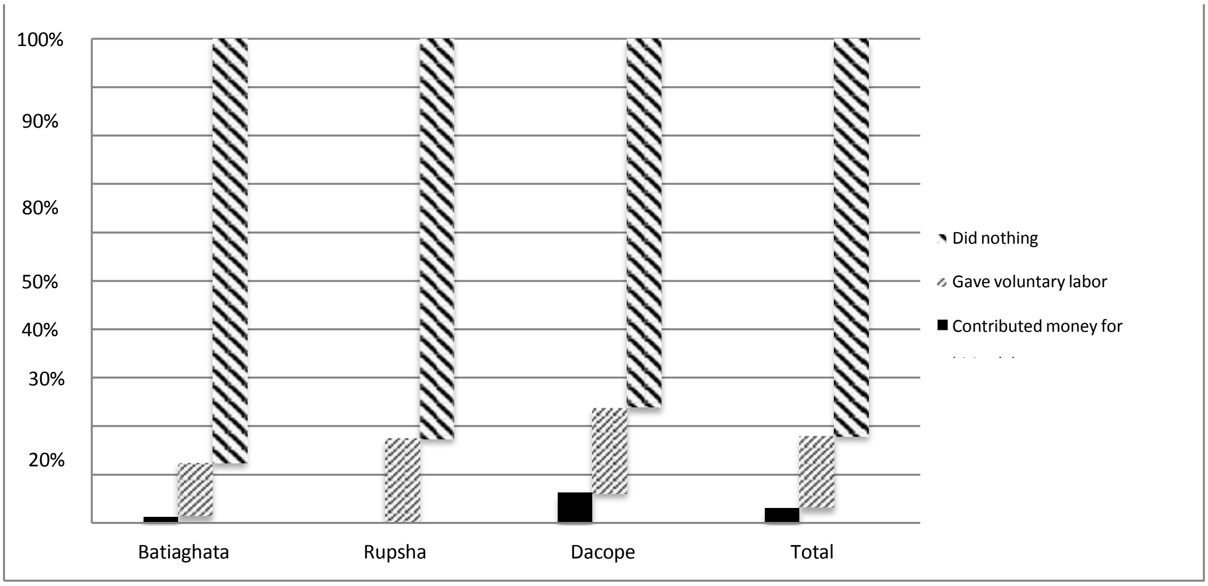

Figure 3: Individual actions to reduce waterlogging

- **Institutional actions**

The study shows that 65% of the respondents assume that institutional measures are in operation to tackle the problem of waterlogging. Nearly six percent of the population has no idea about what institutional measures are being carried out. There are different categories of institutions taking part for improving the waterlogging situation in the polder areas. They are mainly the government institutions – Bangladesh Water Development Board and Local Government Engineering Department, Local Government Bodies (Union Parishad and Upazilla Parishad), non-governmental organizational (NGOs), Water Management Groups (WMGs) and the local people. Residents have shared that the government and local government institutions mainly does dredging or removal of silt from canals, and the NGOs, WMGs and the local people take part in the removal of silt (Figure 4).

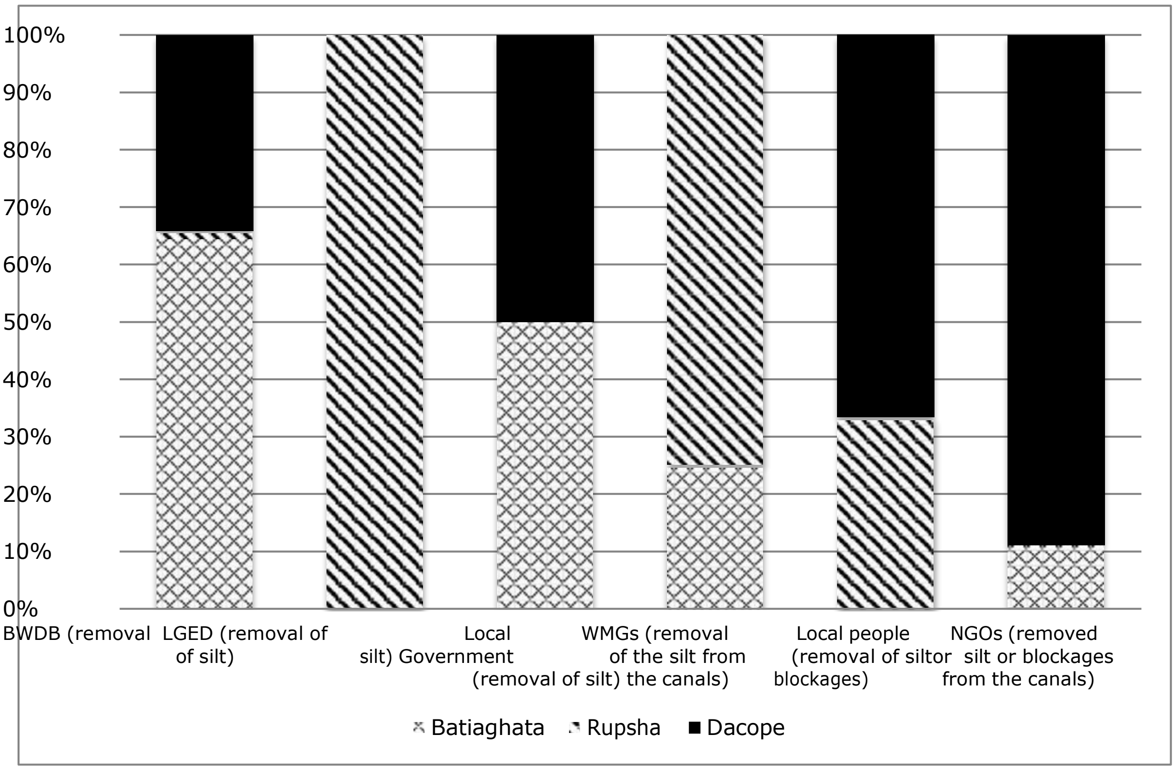

Figure 4: Institutional adaptation interventions

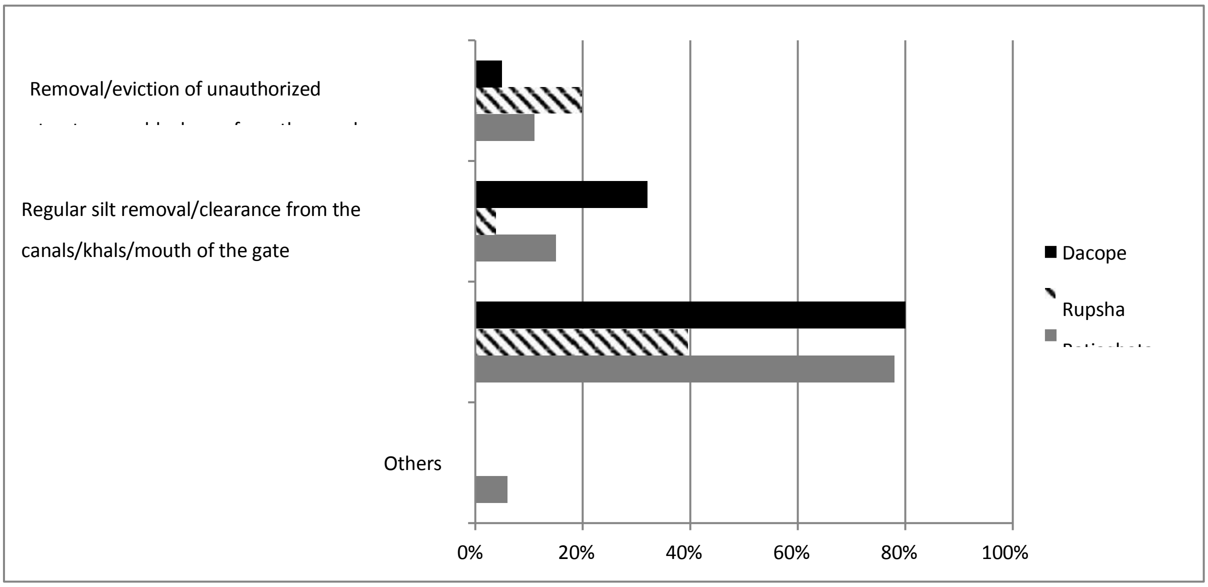

Figure 5: Community suggestions on adaptation interventions

DISCUSSION

Waterlogging as a whole is an acute problem in the southwestern Bangladesh causing severe damages to livelihood and also often creates social unrest. Due to the construction of the polders in 60s and 70s, the water flow has been restricted to enter into the settlement areas and consequently hinders the sedimentation process inside the polders. Special nature of the soil in the coastal areas is causing the subsidence annually at the rate of six mm per year (Brammer, 2013). Beside, the level of sedimentation in the riverbeds outside the polders is increasing the gap between the level of ground surfaces in and outside the polders. Difference in the elevation of land surfaces is the main reason for differential water level, which is ultimately causing waterlogging.

Asset value in Rupsha upazilla is higher than many other places in Khulna due to its proximity to the main city. Hence, the dominant community people including businesses try to keep a control over the assets, involving the control over rivers and canals. Local administration seems to be less effective in enforcing the national regulatory guidelines and instructions for proper management of water resources. The local people perceive that the standard of technology and infrastructure available is not posing any serious threat to waterlogging, which also implies that the less effective institution and weak management of water resources are critical. In terms of the level of severity, the community people rank waterlogging a second-tier problem on a five-point scale, which is unrealistic. The reason may be the long-standing of the community in surviving with the existing system. Enhanced coping capacity along with the varied features of the terrain may have influenced the perception of the community people on ranking the severity of the problem.

Three broad consequences of waterlogging as faced by the community are not unique in the study areas. In Batiaghata and Rupsha, although not prime but substantial quantity of Robi crops are cultivated due to favorable soil condition and topography. Since the cultivation of Robi corps depends on the receding of monsoon water, delay in which further contributes to waterlogging, the cycle of agricultural production gets affected. However, in Dacope, due to the level of high salinity, dry-season crops, like Robi, are hardly grown; hence, the delayed start has not been considered as an important factor to the community. Dacope upazilla suffers more crop damages due to excessive tides. Transportation is a common problem caused by unusually stagnant water level around one third of the year.

With respect to individual action, the community people acknowledge that they are not involved in any type of adaptation practices. However, physical observation in the study area for several months revealed that a set of indigenous adaptation interventions is widely practiced. For instance, people inside the polder use locally made boat and raft from banana tree trunks for transportation; change in livelihood from agriculture to fisheries; shift from Robi crop to alternative crops, for instance, sesame; create of sub-polders inside the polders based on the terrain condition to overcome the barriers. In some cases, a small of group of community people has started adopting the short maturing variety as supported by the Agricultural Extension Department of the government of Bangladesh. All of these activities are adaptation interventions in deed; however, the people perceive they are not doing anything. The reason may include low level of education and lack of knowledge to identify adaptation strategy.

Institutional actors addressing waterlogging include – government agencies, NGOs and water management groups (WMGs). Government agencies operate through two wings – central government agencies located at the local level and the elected local government bodies. Major part of the government activities are confined to hardware part of adaptation measures while the WMGs interventions focuses both on mobilization of the community resources and technologies for managing the embankments, sluicegates and canals. Although the suggested measures by the community apparently relate to technological and structural solutions, in reality these measures are associated more with taking up adequate, timely and efficient use of resources by the policy and decision makers. Community people suggest re-excavation of canals and internal khals and regular silt removal from the mouth of the gate. However, the community people underrate removal of unauthorized structures in the water streams, while it is a serious issue. One reason may be the unauthorized ownership of such infrastructure that belongs to the influential groups of the society and the ordinary people are reluctant to raise the issue in anticipation of unforeseen problems.

Only in few nearby areas, for instance, Polder No. 25, Tidal River Management (TRM) approach has been practiced. As a result, the community people are less aware about the technology and the government and non-government organizations are not sufficiently able to disseminate the information to the community on suitability of the approach. The World Bank (2005) has also identified technology, i.e. infrastructure, to be taken care to ensure effective operation.

The adaptation interventions currently practiced and the intervention suggested by the community people fall mostly under the private adaptation category while few in the public category. Community people are keen towards ex-post adaptation, i.e. after the problem surfaced, they take actions to cope up with. However, for efficient adaptation, pre-facto initiatives are required to reduce the volume of losses and damages.

CONCLUSION

With a view to exploring the causes and impacts of waterlogging and the required adaptation strategies, this study investigated the practices and perceptions of the local residents on various adaptation measures. Although this research is not a comprehensive representation of the whole country, it provides a snapshot from one of the highly vulnerable regions of the country. The study has found that the severity of the waterlogging varies depending on the location, topography, proximity to the sea. Adaptive approaches, including monetary contribution and voluntary labor, are impressive, but the community does not value it as special. Although some interventions do exist, community people identified re-excavation of khals as the major strategy to be taken to adapt with waterlogging problem. However, TRM as an approach for integrated adaptation measures has not been tested in the study locations. Feasibility of TRM in the said location to minimize the impact of waterlogging problem needs further investigation

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REVERSE LOGISTIC IN SUPPLY CHAIN MANAGEMENT

Yashar Asari, Italy

With the onset of the Economic Crisis, most companies and organizations were losers and stopped earning profits. Under these conditions, the companies and organizations who are present in the successful Supply Chain encounter their customers' satisfaction with their high performance and by achieving remarkable long-term advantages in the competitive arena. Due to some unfriendly relations between the partners of the Supply Chain as well as the inappropriate, unprofessional conducts such as too much reliance on the increase in price, the costs exceed to unprecedented levels which, in case the Supply Chain is not designed according to the required conditions or is not noticed and revised and controlled after it is designed, the Supply Chain might be destroyed. In recent years, Supply Chain Management (SCM) is one of the focus areas for modern enterprises and researchers. On the other hand, for an innovative product characterized by short product lifecycle and high demand uncertainty, investment in capacity build-up has to be done cautiously. In this paper, we propose a method of capacity utilization in DEA from economic perspectives the system dynamics model of a supply chain by two methods, radial and non-radial. The proposed model also performance evaluation of supply chain with capacity utilization in the areas high and short-run strategies, by opinion or without opinion the manager.

KEYWORDS: supply chain, Data envelopment analysis, reverse logistic

Lifelong Learning Programme

cadre

CADRE WORKSHOP:
Mainstreaming Disaster Resilience within the Construction Process

Date: Thursday 8th September 2016
Time: 3.30 to 5.00pm
Venue: Case Room 2, Owen G Glenn Building, University of Auckland,New Zealand

Background to the workshop:

Disasters continue to exact a heavy toll on many communities around the world, including those in Sri Lanka. Globally during the last 10 years, over 700 thousand people have lost their lives, over 1.4 million have been injured and approximately 23 million have been made homeless as a result of disasters. More than 1.5 billion people have been affected by disasters in various ways, with women, children and people in vulnerable situations disproportionately affected. The total economic loss was more than
$1.3trillion.

It is critical to anticipate, plan for and reduce disaster risk in order to more effectively protect people, communities, their livelihoods, health, cultural heritage, socioeconomic assets and ecosystems, and thus strengthen their resilience. The Sendai Framework for Disaster Risk Reduction, endorsed by 187 UN states in 2015, recognises that disaster risk reduction practices need to be multi- hazard and multisectoral, inclusive and accessible in order to be efficient and effective. The Framework also identifies:

E. A need for the private sector, including the construction industry, to work more closely with other stakeholders and to create opportunities for collaboration, and for businesses to integrate disaster risk into their management practices

F. A need to promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, in formal and professional education and training

The vital role of the built environment in serving human endeavours means that when elements of it are damaged or destroyed, the ability of society to function – economically and socially – is severely disrupted. The protective characteristics of the built environment offer an important means by which humanity can reduce the risk posed by hazards, thereby preventing a disaster. Conversely, post-disaster, the loss of critical buildings and infrastructure can greatly increase a community's vulnerability to hazards in the future. Finally, the individual and local nature of the built environment, shaped by context, restricts our ability to apply generic solutions. The consequences outlined above serve to underline and support the growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters.

CADRE project

In recognition of these challenges, CADRE (Collaborative Action towards Disaster Resilience Education) is an EU funded project that aims to identify current and emerging labour market demands in the construction industry with a view to mainstreaming disaster resilience within the construction process. The project will a l s o improve the quality and relevance of higher education through active cooperation between Higher Education Institutes and partners from outside academia, including construction professional bodies, local/national/ international bodies and social partners. The project will also develop an innovative professional doctoral programme (DProf) that integrates professional and academic knowledge in the construction industry to develop societal resilience to disasters. Through the development of an innovative and timely curricular and learning materials, the project seeks to update the knowledge and skills of construction professionals.

The research team have already conducted a detailed study to capture labour market requirements for disaster resilience and its interface with the construction industry and its professionals. The investigation aimed at capturing:

G. the needs of 5 stakeholder groups (local and national government, the community, NGOs, INGOs and other international agencies, academia and research organisations, and the private sector) involved in disaster resilience and management

H. current and emerging skills for built environment professionals that could contribute to enhancing societal resilience to disasters across the property cycle (Preparation, Design, Pre-construct, Construct and Use)

I. emerging policy needs in the disaster resilience in the built environment

All needs and skills were categorised into five dimensions of resilience (Social, Economic, Institutional, Environmental, Technological). Finally, the identified needs and skills were combined 'like-for-like' to produce broader level of knowledge gaps.

w: www.disaster-resilience.net/cadre

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

Aim of the workshop:

The aim of the workshop is twofold:

- To disseminate the knowledge gaps that have emerged from the study, to mainstream disaster resilience within the construction process
- To refine and validate the DProf framework that has developed to address the knowledge gaps, and identify key themes that need further investigation

Tentative agenda for the workshop:

- Introduction to the workshop
- CADRE background, aim, objectives and methodology
- Initiative on market demands and skills needs in the construction industry to increase societal resilience to disasters
- Presentation of key findings including mainstreaming mechanisms
- Discussion on DProf framework in disaster resilience in the built environment
- Summary and future actions

Target audience:

- Disaster resilience and management experts
- Research and innovation community (universities, industry, government, private sector, SMEs etc.)
- Construction industry community

For further information:

Professor Dilanthi Amaratunga & Professor Richard Haigh Global Disaster Resilience Centre

School of Art, Design and Architecture University of Huddersfield, Queensgate, Huddersfield,

This event is organised by:

Global Disaster Resilience Centre, University of Huddersfield, UK Vilnius Gedminas Technical University, Lithuania

Tallinn University of Technology, Estonia Northumbria University, UK

United Nations International Strategy for Disaster Reduction

KNOWLEDGE GAPS IN THE CONSTRUCTION INDUSTRY TO INCREASE SOCIETAL RESILIENCE TO DISASTERS

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ABSTRACT

There is a growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. In order to address this challenge, an EU funded research project entitled CADRE (Collaborative Action towards Disaster Resilience Education) is identifying knowledge gaps and developing an innovative professional doctoral programme (DProf). The project seeks to integrate professional and academic knowledge in the construction industry to develop societal resilience to disasters. Through the development of an innovative and timely curricular and learning material, the project seeks to update the knowledge and skills of construction professionals in the industry.

Before developing the proposed DProf programme, it is important to identify the knowledge gaps in the construction industry. This paper is an account of a study to identify gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. Capturing knowledge gaps involved identifying the needs of various stakeholder groups associated with disaster resilience and management, as well as current and emerging skills that are applicable to construction professionals and would contribute to enhanced societal resilience to disasters. In parallel, an extensive policy analysis was conducted to capture the emerging policy level needs. The primary and secondary data generated a long list of needs and skills. Finally, the identified needs and skills were combined 'like-for-like' to produce thirteen broad knowledge gaps and associated sub-themes. The paper provides an extensive analysis of the knowledge gaps identified through this process.

Key words: Construction; disaster resilience; knowledge gaps; professional doctorates

BACKGROUND

The past decade has seen a concentration of disaster events causing major social, economic and financial impacts. Seven of the ten most costly disasters since 1980 have occurred in the last decade (Munich Re, 2015). This increasing trend of disaster losses is due in part to the unprecedented rate of urban growth, increasing dependence on complex infrastructure and changes in climate that are increasing exposure to anthropogenic and natural hazards (IPCC, 2014).

In order to tackle these increasing losses, the Sendai framework for disaster risk reduction 2015–2030 (UNISDR, 2015a), endorsed by 187 UN states in 2015, promotes disaster risk reduction practices that are multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective. The Framework also identifies: "a need for the private sector to work more closely with other stakeholders and to create opportunities for collaboration, and for businesses to integrate disaster risk into their management practices"; and, "a need to promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, in formal and professional education and training".

As a process, building disaster resilience involves supporting the capacity of individuals, communities and states to adapt through assets and resources relevant to their context (Manyena, 2006). There has been growing recognition that the construction industry and associated built environment professions are a vital component of this capacity, which needs to be deployed before and after a hazard visits a community. Effective mitigation and preparedness can greatly reduce the threat posed by hazards of all types. The post-disaster response can impact the loss of life, while timely reconstruction can minimise the broader economic and social damage that may otherwise result.

This paper is an account of a study to identify gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. This study is part of an EU funded research project, CADRE (Collaborative Action towards Disaster Resilience Education – www.disaster-resilience.net/cadre), that is seeking to develop innovative and timely professional education that will update the knowledge and skills of construction professionals in the industry, and enable them to contribute more effectively to disaster resilience building efforts.

ROLE OF THE CONSTRUCTION SECTOR

The environments with which people interact most directly are often products of human initiated processes. The importance of this built environment to the society it serves is best demonstrated by its characteristics, of which Bartuska (2007) identifies four that are inter-related. First, it is extensive and provides the context for all human endeavours. More specifically, it is everything humanly created, modified, or constructed, humanly made, arranged, or maintained. Second, it is the creation of human minds and the result of human purposes; it is intended to serve human needs, wants, and values. Third, much of it is created to help us deal with, and to protect us from, the overall environment, to mediate or change this environment for our comfort and well-being. Last, is that every component of the built environment is defined and shaped by context; each and all of the individual elements contribute either positively or negatively to the overall quality of environments.

The economic scale, size and impact of the built environment are significant. In the UK, construction is one of the largest sectors of the economy. It contributes almost £90 billion to the UK economy (or 6.7%) in value added, comprises over 280,000 businesses covering some 2.93 million jobs, which is equivalent to about 10% of total UK employment (Department for Business Innovation & Skills, 2013). It generates about 9% of gross domestic product (GDP) in the European Union and provides 18 million direct jobs. The European Union's internal market offers international partners access to more than 500 million people and approximately EUR 13 trillion in GDP (Internal Market, Industry, Entrepreneurship and SMEs Directorate, 2016). As a major consumer of services and intermediate products such as raw materials, chemicals or electrical equipment, construction impacts many other economic sectors.

From these characteristics, Haigh and Amaratunga (2010) identify several important consequences for the development of more disaster resilient societies. The vital role of the built environment in serving human endeavours means that when elements of it are damaged or destroyed, the ability of society to function – economically and socially – is severely disrupted. Disasters have the ability to severely interrupt economic growth and hinder a person's ability to emerge from poverty. The protective characteristics of the built environment offer an important means by which humanity can reduce the risk posed by hazards, thereby preventing a disaster. Conversely, post-disaster, the loss of critical buildings and infrastructure can greatly increase a community's vulnerability to hazards in the future. Finally, the individual and local nature of the built environment, shaped by context, restricts our ability to apply generic solutions.

In recognition of the built environment's importance to a society, there have been growing calls for greater engagement of the construction industry in disaster resilience building efforts. Hecker et al. (2000), Prieto (2002), Godschalk (2003), Liso et al. (2003), Lorch (2005), Aldunate et al. (2006), Haigh et al. (2006), Rees (2009), Haigh and Amaratunga (2010) and Bosher and Dainty (2011) have all indicated a need for greater integration of disaster resilience concepts into the education of construction professionals.

Supporting this view, one of the construction sector's key professional bodies, the Royal Institute of Chartered Surveyors (2015), called recently for, "a massive rethink around how we build up skills across our sector to meet the challenges we're facing and how we ensure economic viability for land and real estate firms while delivering on social needs and managing finite resources."

The scope of this contribution to resilience building efforts would appear to be considerable. Witt et al (2014) mapped, "the many and varied disaster resilience roles of construction professionals identified in the literature", to the disaster management cycle. They noted that each of the roles identified also reflected a corresponding need for construction education and research inputs.

CONTEXT OF THE STUDY

The consequences outlined above serve to underline and support the growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. It has also revealed the perceived challenges to deal with in developing a more resilient built environment. There is a dire need for construction industry and its professionals to adopt disaster resilience concepts and practices incorporating the multi-dimensional nature of the problem.

To this effect, the CADRE research team conducted a detailed study to capture labour market requirements for disaster resilience, and its interface with the construction industry and its professionals. The initial investigation aimed at capturing current and emerging skills for built environment professionals that could contribute to enhancing societal resilience to disasters across the property cycle (appraisal, brief, concept, development, design, tender, construct, operate and maintain), the needs of key stakeholders (local and national government, the community, NGOs, INGOs and other international agencies, academia and research organisations, and the private sector) involved in disaster resilience and management and across five dimensions of resilience (Social, Economic, Institutional, Environmental, Technological). This framework (Malalgoda et al, 2016) was developed through an extensive consultation process with project partners and was refined with the emerging literature findings and with the opinion of stakeholders who were interviewed to capture the labour market demands in construction industry to increase societal resilience to disasters.

There is growing recognition that those responsible for the built environment have a vital role to play in developing societal resilience to disasters. If construction researchers and practitioners are to be able to contribute to reduce risk through resilient buildings, spaces and places, it is important that capacity is developed for modern design, planning, construction and maintenance that are inclusive, inter-disciplinary, and integrative. This provided the basis for the identification of this multi dimensional framework combining construction life cycle, key stakeholders and the elements of resilience. This further supports the view that resilience need to be created and embedded through the products and processes of the built environment. In this context, the importance of a community's built environment – the processes and physical products of human creation that enable society to function economically and socially – was examined in the context of broader societal resilience. The study also considered the relative importance of the end product and the process used to create it. To what extent should those responsible for the planning, design and management of the built environment focus upon the elements of resilience? The starting point is that as society becomes more complex, resilient communities tend to be those which are well coordinated and share common values and beliefs and a sense of interconnectedness

METHODOLOGY

A broad range of practitioners from Europe and Asia involved with five stakeholder groups were interviewed: local and national government (20), academia (21), NGOs (12), community (15) and private sector (19). The aim was to understand gaps in the knowledgebase of construction professionals to contribute to the development of a more disaster resilient society. In total, 87 qualitative semi structured interviews were conducted with a view of better understanding the needs of the stakeholder groups, and the current and emerging skills, applicable to construction professionals. All interviews were voice recorded, transcribed and thematically coded using NVivo data analysis software. The interviews generated a long list of needs and skills with respect to the property lifecycle stages under the respective dimensions of resilience. Finally, the identified needs and skills were combined 'like-for-like' to produce a broader level of knowledge gaps.

In addition to semi-structured interviews, a desk review of key policies related to disaster resilience was carried out to reinforce the gaps yielded from the primary data: the Sustainable Development Goals (UN, 2015); the Sendai framework for Disaster Risk Reduction (2015-2030) (UNISDR, 2015a); the Paris 2015 climate change agreement (COP21, 2015); and UNISDR's 10 Essentials for making cities resilient (UNISDR, 2015b).

The findings were then validated using focus group discussions that were conducted as part of two organised stakeholder workshops.These involved a total of 25 respondents. The next section presents the knowledge gaps identified through this process.

KNOWLEDGE GAPS

Analysis of primary and secondary data revealed 13 knowledge gaps and a number of associated sub-themes, as shown in Table 1. Almost all of the stakeholders were in agreement about the key knowledge gaps, with the exception of 'ethics and human rights', which was only identified by private sector stakeholders. However, due to the importance placed on human rights in the Sendai Framework, it was considered as one of the key areas.

Among others, the imporatnce of governance, legal frameworks and compliance were strongly highlighted by many interviewees. Interviewees also highlighted the importance of greater engagement of the construction industry in developing and implementing building codes and land-use regulations in disaster resilience building efforts. Both primary and secondary data revealed a gap in the knowledgebase of the construction professionals in this context, especially at the planning, design and construction phases of the property cycle. Similarly, many interviewees highlighted the role construction professionals can play in developing resilient technologies, engineering and infrastructure, and highlighted a gap in this area. This is applicable for all phases of the property cycle, however interviewees extended particular emphasis to the 'use stage', and outlined the importance of strengthening and retrofitting vulnerable infrastructure.

While recognising the importance of a multi-stakeholder approach in disaster resilience and management, interviewees emphasised the importance of soft skills such as team working, communication and leadership while highlighting the need for alliances, partnerships and interdisciplinary working. All stakeholders equally acknowledged the gap in this area and highlighted the importance of promoting a multi-stakeholder approach and interdisciplinary working. Another key gap identified in the study was about the business continuity management (BCM). Although all stakeholders emphasised the importance of BCM, community and private sector stakeholders were more concerned about it. In terms of the construction industry's role, interviewees outlined the importance of effective supply chain management in order to ensure uninterrupted services during disaster times.

The construction industry's role in multi-hazard risk assessment, disaster response, contracts and procurement, and, post disaster management were equally highlighted by all stakeholder groups. Another key area was knowledge management. Within knowledge management, data and information management were particularly highlighted by the interviewees, along with related areas such as big data, analytical skills, standardisation and integration of data, and performance metrics, which emerged from the secondary data. Furthermore, all stakeholders agreed on the importance of indigenous knowledge and cultural intelligence in planning, designing and constructing houses for disaster affected people. Interviewees from Asia in particular highlighted about the abandoned post-tsunami housing in Sri Lanka due to a lack of social and cultural awareness at the planning and designing stage.

In terms of innovative financial mechanisms, all stakeholders emphasised the importance of risk transfer mechanisms such as insurance. Stakeholders attached to academia particularly highlighted the gaps related to affordable and cost effective designs, and cost benefit analysis, while private sector stakeholders highlighted the importance of investment appraisals at the planning stage. However, areas such as public-private partnerships and economic loss of disasters did not emerge from the interviews. These areas were cross cutting areas of the Sendai Framework and as a result, they were included under innovative financing mechanisms. Only the government stakeholders highlighted the importance of sustainability and resilience. However all stakeholders emphasised the importance of environmental impact assessment and management.

Table 1: Knowledge gaps

No	**Key knowledge gaps**	**Sub themes**
1	Governance, legal frameworks and compliance	8. Building codes, regulations and planning 9. Urban planning and land-use 10. Health & safety 11. Principles of accountability and transparency 12. Inclusive economic planning 13. Changing practice and policies
2	Business continuity management	J. Supply chain management
3	Disaster response	- Emergency and temporary shelters - Evacuation - Damage assessment - Temporary services
4	Contracts and procurement	• Supply chain management • Dispute resolution • Community wide engagement
5	Resilience technologies, engineering and infrastructure	q. Capacity and adequacy of critical infrastructure r. Strengthen / retrofit the vulnerable infrastructure s. Infrastructure interdependencies t. Clean and environmentally sound

		technologies and processes • Automation & standardisation • Project complexity • Climate change adaptation technologies
6	Knowledge management	• Data and information management • Communication • Big data analytical skills • Standardisation and integration of data • Performance metrics
7	Social and cultural awareness	• Cultural intelligence • Indigenous knowledge
8	Sustainability and resilience	• Environmental impact assessment and management • Sustainable design principles • Waste production and pollution of land water and air • Sustainable retrofitting • Debris management
9	Ethics and human rights	• Reflecting social demographics • Social responsibility
10	Innovative financing mechanisms	• Budgeting and estimating • Investment appraisals and cost benefit analysis • Economic loss of disasters • Affordable and cost effective design and usage • Claims and insurance • Public-private partnership (PPP)
11	Multi stakeholder approach, inclusion and empowerment	• Team working – collaboration and cross professional working • Soft skills of communication • Community empowerment • Leadership and people management • Disaster awareness • Alliances and partnerships • Interdisciplinary working • Change management
12	Post disaster project management	• Time management • Human resource management • Leadership and people management • Process and quality management • Materials and resource management

13	Understanding disaster risks	• Vulnerability, risk and exposure mapping • Multi hazard risk assessment

CONCLUSIONS AND WAY FORWARD

There have been growing calls for greater engagement of the construction industry in disaster resilience building efforts. This paper investigates the gaps in the knowledgebase of construction professionals that are undermining their ability to contribute to the development of a more disaster resilient society. This paper reports the findings of 87 stakeholder interviews which were supplemented by a comprehensive analysis of key policies related to disaster resilience and management. The primary and secondary data revealed thirteen key knowledge gaps and a number of associated sub-themes. This study is part of an EU funded research project, CADRE (Collaborative Action towards Disaster Resilience Education), that is seeking to develop an innovative professional doctorate for disaster resilience in the built environment. The knowledge gaps identified in this phase of the study will inform the next phase of the research, to develop a professional doctorate programme that can update the knowledge and skills of construction professionals in the industry.

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Notes