


Chapter 3


Impacts of Climate Change on Coastal Communities

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ABSTRACT

Earth and coastal ecosystems are not static, and they usually respond to environmental changes, mostly anthropogenic and climatic. Here, the authors described natural values, coastal landforms, and types of infrastructure that are most likely to be affected by climate change (CC) and provide information for assessing inundation, erosion, and recession risks for a chosen location. In this chapter, the authors focused on the land uses, the vulnerability of coastal infrastructure, and argued for effective linkages between CC issues and development planning. They also recommended the incorporation of CC impact and risk assessment into long-term national development strategies. Policies will be presented to implement these recommendations for adaptation to climate variability and global CC. The authors

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provide general recommendations and identify challenges for the incorporation of climate change impacts and risk assessment into long-term land-use national development plans and strategies. Overall, this chapter provides an overview of the implications for CC to coastal management.

INTRODUCTION

Nearly 1.2 billion of people in the world (23% world's people) live with 100 km of the coastal areas and by 2030 (Small & Nicholls, 2003) it will be at 50%. These people are unprotected to definite hazard such as hurricanes, tsunamis, coastal flooding and transmission of marine related infection diseases (Adger et al., 2005). Currently, an estimated report says, about ten million of world people facing coastal flood every year because of storm landfall typhoons and surge and near future 50 million could be at risk by 2080 due to climate change and growing population masses (Nicholls, 2004). The climate change has occurred to changes in flooding, temperature and precipitation that make more vulnerable to the people of coastal areas. Additionally, the rise in sea level and wave heights will also affect the lives of coastal people. Both straight impact (frequent storm surges and faster coastal erosion) and secondary effects (loss of coastal resources such as aquaculture and loss of critical physical infrastructure, along with decays in associated ecological, economic, subsistence and cultural values) will have socio-economic and physical impacts on coastal societies. At present the coastal societies already face a numerous difficult problems that make challenging for the policy of climate change. In demographic viewpoint, the current people of coastal societies are becoming gradually elder that results of high numbers of internal migration of elderly people with youth out migration (Ali *et al.*, 2016). In financial standpoint, the coastal people is constantly considered by high average unemployment rates, vulnerable financial conditions, including low incomes and stress on services throughout the months of summer due to tourism. Many regions of the coastal zones like England, are facing severe level of multiple deprivation like high levels of deficit related to remunerations, education, employment, skills and training. This might be due to lot of issues, comprising the reliance of naturally poor-skilled, less wages in industrial sectors for example which are related to tourism, that often also need part time and seasonal employees. Seasonal of works also creates it challenging for personnel to development in terms of educations or profession development, as each term of employment may be with a dissimilar company (Hossain *et al.*, 2016). The physical segregation of numerous seaside peoples can also frequently act as a barrier to financial progress. High levels

of scarcity and the relative segregation of some coastal societies are the physical hazard of climate effects. The Impact of climate change on a particular agricultural crop, such as bananas, may lead to lost profits, unemployment of farm workers, foreclosures on mortgages, and loss of human, financial and social capital within communities. The disadvantages and hazardous of these regions in the coastal societies are the focus of this research. Here we also demonstrates how the impacts of climate change manifest across the triple-bottom line i.e. economic, environment and social. The principal objective of this chapter is to recognize current climate change vulnerabilities especially to backward coastal communities and make policy recommendations to mitigate these encounters. It also aims to make endorsements to enhance coastal people`s ability to adapt to the climate change and aimed to draw in a range of perceptions on the matter from societies and local and national stakeholders.

Climate Change Impact on Coast

The coastal communities are to be more at risk to climate change than inland areas due to changes in flooding, precipitation and temperature, rise in sea level, wave heights, and coastal erosion. The disadvantages communities identify, as those are vulnerable of the physical impacts of climate change and undergoes from severe level of deprivation of environmental isolation (Zsamboky *et al.*, 2011) and direct and indirect impacts are shown in **Table 1**. The coastal areas are highly vigorous

Table 1. The impacts of direct and indirect climate change on coastal communities

Direct Impact	Indirect Impact	Event
Inundation of low-lying residential areas	Economic- Loss of property assets Environmental- Salinity impacts on native vegetation and coastal water aquifers Social- Loss of social capital if communities are dispersed through relocation	Sea level
Damage to critical infrastructure such as a sewer pumping station	Economic- Repair costs Environmental- Increased nutrients entering waterways Social- Increased risk of disease and infection	Flooding
Extreme waves overtopping esplanades and reserves	Economic- Loss of tourism revenue Environmental: Foreshore vegetation damage Social- Loss of recreational amenity	Storm surge
Uprooting of trees	Economic- Damage to homes and cars Environmental- Loss of mature vegetation and habitat Social- Reduced shade protection in summer	Wind
Bushfire in a coastal national park	Economic- Reduced purchases by visitors for local businesses Environmental- Habitat fragmentation Social- Loss of amenity and recreational values	Fire

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and geo-morphologically multifaceted systems that respond in numerous behaviors to dangerous weather events. Among the most dangerous and harmful of natural disasters coastal floods one of them (Douben, 2006). Climate change is the reason of faster sea-level rise with accelerated erosion, rising water tables, increasing occurrence of cyclones, storm surges, increased frequency of flood and increased saltwater intrusion, salt-water intrusion into aquifers as the sea rises, flooding of coastal wetlands and marshes, changes to water availability and quality, ocean acidification (due to higher concentrations of carbon dioxide in the atmosphere), lower oxygen levels in wetlands, changes in habitat and species distributions, etc. (Prakasa & Murty, 2005).

Coastal Erosion

Coastal erosion has direct impact on regular income source and income generating activities and schooling for children, health facilities. In addition, coastal people suffered from the lack of drinking water, sanitation facilities and emergency health care services, and in addition to food crisis and lack of employment (Islam *et al.*, 2012). In recent years, one of the major contribution of the climate change is rapid siltation of the river, which is intensifying bank erosion during the monsoon. Due to the climate change, riverbank erosion occurs increasingly and has longstanding effects that are difficult to manage for the coastal people (Alam, 2016). Scholars established that riverbank erosion has severe effects on financial, physical, political and social circumstances, causing in terrible hazards in lives and livelihood in coastal regions (Ahmed 2015; Alam, 2016). The erosion of riverbank is the catastrophe accounting for the severe losses in the coastal communities (Penning-Rowse *et al.*, 2013). The coastal households are more unprotected to regular flooding and water logging due to nearness of the coastal with river bank erosion that create more vulnerable to them (Alam *et al.*, 2017). The coastal households are more vulnerable to riverbank erosion and other climate-induced hazards and forced into a low livelihood (Alam 2016; Ahmed 2015). Climate change is a key factor in coastal erosion and erosion is a complex procedure that has variety of impacts on coastal communities (Masselink & Russell, 2013). The 3,700 km coastline of England and Wales 28% is experiencing erosion greater than 10 cm per year and a large proportion of the coastline of the UK and Ireland is currently suffering from erosion (17% in the UK; 20% in Ireland) (Masselink & Russell, 2013). The riverbank erosion causes long-term slum dwellers in urban areas. The tremendous of them live in temporary housing systems that are in a very poor condition. Riverbank erosion generally creates much more suffering than floods.

Sea Level Rise

The worldwide percentage of sea level rise estimated information over than 15 (1993-2008) year is 3.5 mm per year (Nicholls & Cazenave, 2010) and few of the study suggest that the rate of sea level rise is rushing (Church & White, 2006; Rahmstorf, Perrette, & Vermeer, 2012). The rise in world sea level by 2100 will be in the range of 18–38 to 26–59 cm (Meehl, 2007) and other studies mentioned 0.75–1.90 m (Vermeer & Rahmstorf, 2009), 0.72–1.60 m (Grinsted Moore, & Jevrejeva, 2009), and 0.5 and 2 m (Nicholls et al., 2011). The latent impacts of sea-level rise are substantial for the broader coastal ecosystems (Kumar, 2006). The temperatures of sea water have changed at extraordinary rates in last 10-15 years (Philippart *et al.*, 2011) and it is expected to increase sea surface temperatures by 1° to 2 °C during the 21st century (Furevik *et al.*, 2002). Due to climate change, the temperature is raising that reasons sea level also rises and impact of coastal communities and deltas in around the world. Rising sea level will cause salinity intrusion, river bank erosion, land erosion, flood and crop failure, fisheries destruction, loss of diversity and damage of infrastructure in the coastal areas. Additionally, raising sea level it will destroy costal resources, water resources, agriculture and eco systems (Sarwar, 2005). Raising sea level will change the position of the river that affecting a change in fish environment and breeding ground. Moreover, the coastal fisheries also affecting by flooding, salinity and increasing cyclones due to climate change (Sarwar, 2005).

Storminess

The intra-annual precipitation regimes have been already become more extreme and thrilling at, local, regional and global scales (Easterling et al. 2000; Groisman et al. 2005; Knapp et al. 2008). Willmott and Legates (1991), reported that the uncertainty of climate information poses challenges for the analysis of observed rain data because the heaviest areas of precipitation may fall between recording stations. The extreme precipitation changes maybe more reliable for regions with dense networks because of the small radius of correlation for many intense rainfall events (Groisman et al. 2005). Very less literature sources are available worldwide concerning the extreme precipitation, especially about rainstorm effects on water resources and terrestrial ecosystems (Clarke and Rendell 2007; Curtis et al. 2007; Zolina et al. 2009). A large number of coastal communities are hazard from flooding- especially, when tides combine with storm surges of higher river flows (Mcgranahan, Balk, & Anderson,

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2007). Climate change will enhance the hazard of equally. Due to climate change rising sea level will escalation of floods, and stronger tropical storm and marginalized income group on flood plains will more vulnerable (Mcgranahan, Balk, & Anderson, 2007). The coastal areas are more affected by storm surges and that make them more vulnerable in the communities (Philippart et al., 2011).

Climate Change Impact on Coastal Communities

The impacts of climate change hazards are visible in many coastal areas around the world (Spalding *et al.*, 2014) and it is significant sea level rise, while its degree and frequency of change is likely vary over broad and to be hard to identify locally (Cazenave & L lovel, 2010; Han *et al.*, 2010). The populations are growing faster in the coastal areas and around 10% of world population living in the coastal areas (Mcgranahan, Balk & Anderson, 2007). In the period of 1994 and 2004, nearly one-third of the 1562 floods, half of the 120,000 lives killed and 98% of the 2 million people affected by flood in Asia due to climate change (Mcgranahan, Balk, & Anderson, 2007). The experience from tsunami of Indian Ocean of 2004, lost of live s of 200,000 and millions more houses destroyed (Mcgranahan, Balk, & Anderson, 2007).

Health and Well Being

Climate change will hazards and challenges for the coastal population, with their psychological and physical health, and for coastal financial and native industry like agriculture, fisheries and tourism. Additionally, it will also affects people to entrance and quality of basic daily goods and services like food, water, health and emergency care, for them. The budgets of emergency action, prevention and recovery might be a severe burden to coastal communities and local authorities in regions with already inadequate resources (Zsamboky *et al.*, 2011). Rising sea levels enhance the risk of health vulnerability like cholera and diarrhea and it is infectious diseases of human beings and very communal in coastal area around the world (Sarwar, 2005). The growing density of population and spreading salinity, diarrhea and cholera microbes are spreading in the coastal communities (Sarwar, 2005). The coastal areas are always densely populated (Ericson et al. 2006). Increase movement of coastal people has extended infection diseases such as Acquired Immune Deficiency Virus (AIDS) and Human Immunodeficiency Virus (HIV) high in some coastal fishing

communities and climate change is certain to worsen vulnerability to vector borne disease (cholera and malaria)(Allison & Seeley, 2004). On the other hand, increased in the saline water in the coastal areas will decrease fresh water and scarcity of fresh water will force to drink polluted water leading diarrhea, cholera and other vector borne diseases (Sarwar, 2005).

Livelihood and Economic Costs

The increasing salinity in the coastal communities will decline agriculture and food production that causing severe malnutrition for the coastal people (Sarwar, 2005). The higher tropical levels in worldwide have reduced big fish (Myers & Worm, 2003). A numbers of people has been displaced from their houses becoming environmental refugees due to climate change (Sarwar, 2005). The coastal states in the United States of America (USA) contributed more than \$6.6 trillion of Gross Domestic Products (GDP) has of the nation`s total GDP, from less than 10% of the land area (NOAA, 2013). Due to climate change, this achievement soon will be translated heavy financial and social vulnerability and make unsustainable coastal development (Spalding *et al.*, 2014). The concern is high in the poor communities, who are direct depended on coastal ecosystems for basic needs such as livelihoods, where capacity to cope with climate change is far less than developed country (ISDR, 2009). The attention of the populations and financial matters on and near coast has severe environmental influences. It is projected that nearly one-third of coastal mangrove forest and one fifth of coral reefs have already lost. Additionally, many areas of the world wide fish has reduced significantly (Mcgranahan Balk & Anderson, 2007). The study also suggests that climate change will also effect of coastal communities livelihood those are dependent of fishing and tourism. Additionally, lower income people or unemployment were seen greater of risk to their lives and well-being of climate change (Zsamboky *et al.*, 2011).

Access, Quality and Choice of Goods and Services

Large number of coastal populations facing of important financial challenges such as older people, youth out migration and inward migration of elderly, low quality housing, transitory populations, seasonal employment and poor income (CCA, 2010). The social impacts of climate change on the coastal people will effects health due to increase in severe event such as flooding and heatwave and specially, very older to be worst affected and those who have existing health hazards. Among flood victims,

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mental health impacts are particular prevalence and severe events with climate change (flooding and storm) are likely to effects on public infrastructure such as health and emergency basic needs and communication systems of coastal people (Zsamboky *et al.*, 2011). Due to the climate change of coastal people, their agriculture production is less and low earning decrease their buying capacity to obtain basic needs and services. Consequently, lack of food forced them into becoming food insecurity with limited health care services that lead to them numerous diseases and poor health. This vulnerability pushes them into vicious circle of poverty. Majority of the people in coastal Bangladesh do not have access to proper nutrition, housing settlement and healthcare facilities. Poverty situation is further deteriorated because of natural hazards and calamities every year. Nearly twelve million people live in poverty in the coastal regions of Bangladesh (Dasgupta, 2016).

IMPLICATIONS FOR THE ADAPTATION OF COASTAL COMMUNITIES

Ability to Adapt

Adaptations pursues to decline the severe impact of climate change on living organisms, socio-economic including human and environment. The capacity to adjust and cope is a purpose of income/wealth, scientific and technological knowledge, skills, infrastructure, information, policy and management (Chatterjee & Huq, 2002). To mitigate to the potential disaster during the Asian tsunami 2004, individuals and communities take adaptive policies that include the mobilizations of assets, social capital and social networks (Adger *et al.*, 2005). Social resilience, robust governance systems including institutional for mutual actions are essential wealth for buffering the effects of dangerous natural hazards and promoting social reformation such as those associate with climate change (Adger *et al.*, 2005). The main aim of the adaptation is that to reduce vulnerability and form resilience among the coastal communities (UNFCCC, 2011) and this has led to increasing calls of cooperation into coastal adaptation policy (World Bank, 2009). There is emergency need for action of adaptation at local, national and international arena, particularly noted that sea level rise and coastal erosion are serious threats for many coastal regions and islands (Spalding *et al.*, 2014).

Understanding of Climate Change Risks and Its Awareness

To understand the climate change process, driving forces and meaningful managing and adaptive policies remained inadequate. Community practitioners and communities face main difficulties to create planning due to lack of awareness, knowledge and access to forecasts during climate jargon (Leary *et al.*, 2008). In some coastal communities, people have low levels of knowledge on climate change and capacity to empower them to survive. Assimilating climate change information into action learning process calls for a skillful balance of a possibly top-down agenda with community awareness and agency building (Tschakert, & Dietrich, 2010).

The measurement and nature of the hazard to be identified in order to motivate the coastal communities and timely actions (McGranahan, Balk, & Anderson, 2007). A significant additional further aspect of adaptation is to improve thought and consciousness of coastal erosion hazard through education, training, monitoring, policy and planned initiatives (Masselink, & Russell, 2013). The absence of active communication of climate change results to poor level of public awareness and understanding of the hazards of coastal communities and also low level preparation for the effects (Zsomboky *et al.*, 2011). In addition to climate change impacts, an increasing trend in demand for both agricultural and domestic usages will be expected with regard to population growth (Okkan and Kirdemir, (2018).

Recommendations for Adaptation to Climate Change

Adaptation of coastal societies should be a prime policy priority and it is likely to be integrated into national and international policy including coastal erosion and flood management and disaster planning (Zsomboky *et al.*, 2011). In the aspect of climate change, adaptation is usually to adapt in natural or human systems in response to real or predictable climate stimuli or their impacts that are harmful or exploits the beneficial opportunities (McCarthy *et al.* 2001). One of the significant ideas that have developed from few decades for sustainable coastal management is that adaptation to reduce the vulnerability of coastal erosion. It is of particular importance to formulate enduring adaptation policy for the full range of future climate change outcomes (Nicholls *et al.* (2011). A concrete and holistic framework of climate adaptation is very urgent to protect the nature of coastal communities (Spalding *et al.*, 2014). To minimize the impact of climate change it requires multiple governance systems that can enrich the capacity to handle with insecurity and surprise by organizing different sources of resilience (Adger *et al.*, 2005). Support should be provided to the coastal people long-term employment to reduce poverty and to enhance local and regional governance to manage the risk and continue to guide policy for future climate change (Tompkins, 2005). In some cases, enhance strong leadership and

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changes of social customs within administrations are obligatory to implement adaptive good governance of coastal social-ecological systems (Adger et al., 2005). Additionally, opportunity should be provided to vulnerable coastal communities to engage to apply indigenous knowledge and contribute directly in developing and applying adaptive policy to cope climate change (Spalding *et al.*, 2014). Further, salinity accepting production should be introduced like agriculture, fisheries and coastal forestry (Sarwar, 2005). Here we presented in details on Climate change vulnerability and for adaptation to improve costal environment in Table 2.

CONCLUSION

The coastal communities already face severe deprivation and connected with socio-economic challenges that make them more helpless to the impacts of climate change. The measurement and nature of the hazard has been identified in order to motivate the coastal communities and timely actions. Coastal erosion, sea level rise and extreme weather will gradually effects transport, housing, financial sectors including fisheries, agricultural farm, tourism potentially worsening deprivation in severe disadvantages coastal areas and future limiting coastal people`s capacity to adapt climate change. We recommended an array of short- and long-term measures, numbers of which can be used in individual to reverse the human impact of projected trends towards planning and implementing. And alos recognized current climate change vulnerabilities especially to backward coastal communities and make policy recommendations to mitigate these encounters. This will enhance the coastal people`s ability to adapt to the climate change and aimed to draw in a range of perceptions on the matter from societies and local and national stakeholders.

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Table 2. Climate change vulnerability and for adaptation to improve costal environment

Vulnerability	Affect / Risk	Impact Detail	Possible Adaptation Measure
Beaches and sea-level rise	Loss of sand and vegetation; beach erosion	While beach morphology is complex and erosion is not only a result of sea-level rise, rising seas are likely to exacerbate erosion and also reduce the size of the beach.	Encourage businesses/ developers to minimise built structures close to the beach and plan for some form of managed retreat and adaptive access points to beaches.
Beaches and extreme events.	Loss of sand; beach erosion	The loss of sand is a major problem for the tourism industry (e.g. on the Gold Coast) and extreme weather events (e.g. tropical cyclones and their wider effects) exacerbate natural erosion rates, leading to amenity value decline and – in the worst case – loss of access to beach or dangerous beach profiles. Sea level rise and extreme weather events combine to increase erosion risk.	Soft (e.g. sand bags) and hard (sea wall, groynes etc.) structures for beach protection. Ecosystem-based protection of coastline. Sand pumping to replenish eroded sand. Avoid structures on the beach that exacerbate erosion.
	Debris on beaches	Debris on the beach affects aesthetic values and can be a hazard.	Clearing of beach.
Beaches and higher temperatures.	Tourist comfort Decreased and heat hazard	Increasing temperatures pose a challenge for tourism in destinations that are already classified as hot or potentially 'uncomfortable'.	Provide more shaded areas; social marketing on health risks of heat exposure. Consider planned changes in seasonality (i.e. shift away from current peak seasons to shoulder seasons) – local government to work with regional and state tourism organisations.
Adaptation of wetlands.	Saltwater intrusion	Saltwater intrusion of Fresh water wetlands may lead to substantial ecosystem changes, but also impact on visitor expectations of the natural area.	Obtain expert engineering and environmental advice on measures needed to protect significant freshwater habitats from saltwater intrusion.
	Loss of habitat	Encroaching seas reduce the size of wetlands and other coastal ecosystems that are the basis of nature based tourism.	Increase size of habitats, for example through restoration of wetlands, system repair, land swaps, compensation projects, development moratorium, etc.
Nature-based tourism and ecosystem changes.	Change in species composition and Ecosystem resilience	Fast changes in multiple physical parameters (e.g. temperature, precipitation, ocean currents, wind, salinity) will affect some species that cannot cope with new conditions.	Identify baseline parameters to effectively monitor the environmental changes. Continue to improve data management and the technical capacity of park staff. Undertake economic impact assessment of climate change impacts on key nature-based tourism activities (e.g. Penguin colony in Phillip Island).
Coastline settlements and infrastructure	Loss of assets	As a result of several factors including sea level rise, higher storm surges and larger spring tides will result in increased risk of coastal erosion and flooding/ inundation.	Encourage developers to: <ul style="list-style-type: none"> • build critical infrastructure (e.g. power houses) further from the beach; • Keep distance of buildings from the beach; • Raise structures to a minimum height

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Table 2. Continued

Vulnerability	Affect / Risk	Impact Detail	Possible Adaptation Measure
Coastline settlements and infrastructure and extreme events	Lack of warning resulting in unnecessarily high impacts	Many tourism operators have a very good understanding of the local weather; however, research also shows that many are insufficiently aware of early warning systems and have no systems in place themselves to respond to warnings.	Connect tourism operators into an early warning system (e.g. contact tree, text message), and encourage them to establish weather information routines: <ul style="list-style-type: none"> • Check weather forecasts and warnings daily • Develop policies for dealing with warnings • Consider seasonal forecasts • Develop tourist-targeted warning systems (e.g. mobile app)
	Safety of visitors and staff	The health and safety of tourists and staff depend partly on the ability of destinations, and individual operators, to adapt planning and management practices to address the current and anticipated impacts of climate change, including the prevention of, and recovery from, weather- and climate related disasters.	Tourism operators need evacuation plans, including: <ul style="list-style-type: none"> • Clear plan and signage for guests • Staff training and regular drills • Multi-hazard planning (e.g. fire, cyclone, strong wind etc.) • First aid kits, medically trained staff at hand • Sufficient emergency water and food
	Damage to Assets	More severe storms will put waterfront and coastal infrastructure at risk, including marinas, jetties, boat ramps, roads, restaurants, accommodation, and other buildings.	Conduct an infrastructure risk assessment to identify assets at risk from both chronic stresses (e.g. saltwater intrusion) and additional climate change impacts and extreme weather events. Keep distance of buildings from the beach by implementing a minimum distance away from the high tide mark.
	Rising insurance costs	These increased risks to infrastructure will cause increases in the cost of insurances.	Encourage businesses to have sufficient insurance cover, including potential innovative forms of insurance such as index insurance. Businesses need a continuity plan and should invest into product diversification (e.g. non-coastal products in their portfolio). Public sector can offer emergency assistance packages if needed.
	Insufficient recognition of good practice	Many tourism businesses have some form of quality label/certification. These systems could also include a business 'resilience health check' to help a business make changes to become more resilient to climate and disaster risks.	Public-private sector partnerships to develop a risk- certification scheme (e.g. Ecotourism Australia, Earth Check).
	Reputational damage for businesses	Immediate and appropriate communication is essential and strategies (including templates) need to be prepared before the onset of a disaster	Disaster communication plan for before and after an event, tailored to different audiences, including overseas wholesalers, travel agents, airlines etc.
	Impact on destination image	Extreme events can affect a destination for a long time, especially when impacts are handled poorly. Concerted efforts for recovery are essential to 'be back in business' as soon as it is possible and appropriate.	Crisis management and communication plan (e.g. by the destination marketing organisation), media training for key staff. Development of an integrated (with other sectors) reconstruction and recovery plan

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Table 2. Continued

Vulnerability	Affect / Risk	Impact Detail	Possible Adaptation Measure
Coastline tourism infrastructure and higher temperatures.	Increased demand for air conditioning (costs and increased CO ₂ emissions)	Tourism and community Infrastructure will be affected by hotter temperatures and changes in demand for energy, especially during peak times.	Ensure that tourism operators offer cool Spaces/buildings: Designs for hotels and visitor centres that create shade and cool buildings will be increasingly important in the hotter times ahead (e.g. natural air flow). Energy efficient systems e.g. ocean thermal energy conversion. Thermal energy from air conditioning exhaust vents to be used in resorts for heating water systems. Use of solar energy to benefit from renewable energy source to run air conditioning at zero emissions.
	Reduced tourist comfort	Tourists may alter their destination choices to avoid uncomfortably hot climates.	Minimise use of air conditioning, but provide shaded areas with natural air flow. Offer activities during less hot times during the day, e.g. morning and late afternoon. Networking with other businesses offers advantages in reducing impact of adverse weather conditions (e.g. heatwave).
Coastline settlements and infrastructure and changes in rainfall.	River Flooding	Inundation of coastal tourism infrastructure and settlements, and more frequent or severe flooding. Impacts can be exacerbated by storm effects and storm surges (e.g. in port areas).	Increases in the standard for drainage capacity for new transportation infrastructure and major rehabilitation projects, improvements in monitoring of conditions.
	Water shortage (drought)	Tourist businesses are often high water consumers. There is increasing need to contribute to water savings initiatives, both to reduce operational costs and as part of broader destination stewardship.	Maximising use of water efficient equipment (e.g. low flow shower heads). Staff training (e.g. housekeeping) and guest education (e.g. towel programs). Minimising water losses (e.g. leakage, evaporation from pools etc.) Building rainwater capture and storage tanks. Recirculation of recycled water to irrigate garden areas.

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