TITLE PAGE

THE EFFECTS OF RAINSTORM ON BUILDINGS IN CHANGHAGA AREA OF NIGER STATE

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DECLARATION

I hereby declare that this work was done solely by myself and no other son's work has been copied except for materials used which have been duly renced. This project has not been presented somewhere else for award of any e.

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CERTIFICATION

I hereby certify that this work has been supervised, read and approved, eeting part of the requirements for the award of Post graduate Diploma [PGD] ederal University of Technology Minna, Niger State.

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DEDICATION

This thesis is dedicated to the Paul Gimba Yisa's Family for their love and rayer throughout this programme May their expectation over my life be fulfilled y God's Grace, Amen.

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ABSTRACT.

Man as a result of his activities, has affected the environment. these effects felt through environmental hazards like rainstorm. Alteration of natural heat nce due to Man's activities has resulted in changes in weather condition, lly and globally. Rainstorm is one result of such changes in weather condition.

Rainy Season in Nigeria is ushered in by the inter-play of tropical maritime tropical continental air masses resulting into rainstorm. Rainfall with strong d has adverse effects on the external building component. This effect of storm leads to deterioration of building materials. These effects are severe n the buildings are exposed without trees, to direct effects of the prevailing d.

This research study is aimed at highlighting some deterioration on buildings are as a result of rainstorm (Rain and Wind). The Researcher uses stionnaires and Reconnaissance survey method to collect data for analysing dings within Chanchaga. The data is used to analyse the effects of rainstorm on buildings. The study shows that some buildings externally have defects with e roofing sheets, painted surface, fascia board, ceiling board, rendering, dow, doors and frames.

Also, the study shows that buildings within Chanchaga have trees around n, but the trees are not planted at the direction of the winds to break wind flow n rain is falling. Lack of maintenance culture has also increased the rioration of buildings.

Since rainstorm can't be controlled, Man's activities can be controlled. It is essary then that Man should avoid activities that are not environmentally ndly. Trees should be planted around buildings in the direction of wind to serve vind-breakers and protect buildings from wind-driven rains.

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CHAPTER ONE

INTRODUCTION

Man's drive for rapid growth has not spared the government in any way. The Environmental degradation experiences all over the place are the gains of our desire for growth and development.

As population increases, the desire for growth (development) increases. These increases exert pressure on the environment and the environment in turn exerts pressure on the structures (buildings). The general rapid rate of population growth and the increasing process of urbanisation in Nigeria have brought pressure to bear on structures such as Buildings, Transport, Communications, and Health Education. Unfortunately, because of the rapid rate of these developments, unplanned infrastructural development often take place which further compounds the liveability of the environment (Jimoh and Ifabiyi, 2000)

Deforestation or removal of vegetation covers to meet up with urban growth, expansion and development, are ways that Man has interacted with the environment. These interactions of Man with the environment have led to the abnormal cases often experienced.

Climatic modification is one of such abnormal cases that result from Man's activities which have in turn generated Micro climate variation. Specifically, urbanisation has been found to modify the city's climate in a number of ways. These include the effects of changes in physical surface of the land and buildings, which increase the roughness and consequence wind speed. (Bryson and Rose 1972). Increasing Earth temperature leads to a fast cycling of water leading to severe storms and flooding in some area and

drought in some other. Extremes of wind are also expected (Jimoh and Ifabiyi 2000)

Next to food in priority ranking for Man's basic need for survival is Shelter. It is an important part of Man's environment. It's where Man lives and performs his daily activities. for Man to continually live and perform his daily activities comfortably and effectively, the building must be structurally sound in terms of performance or utilization. Griffith (1990) described how in recent years increasing concern has been expressed at the frequent low standard of performance and quality achieved in the United Kingdom [UK] building work. Apart from the performance, workmanship and quality problem, the environment within which the building are constructed are having negative impact on the building materials.

Removal of vegetation cover especially trees have had negative impact on buildings and their materials. These impacts include direct solar radiation on the building, rainfall, wind, temperature and atmospheric humidity. These environmental factors have profound effect upon the durability of materials and their behaviours. Since buildings have become part of Man's environment. Apart from performing major functions as shelter for Man and his activities, it is now under the direct influence of environmental components namely; Physical, Biological and Social.

An Architect when designing building should not consider function and aesthetic values alone but also consider construction implication with respect to prevailing weather condition (climate) within the proposed building site. When prevailing weather condition are considered during design stage and properly implemented during the construction work, cost effectiveness in terms of durability of the building component and materials used will be achieved.

Rainstorm is one of the numerous environmental hazards that affect building components. Rainstorm is a violent weather condition of strong winds with heavy rainfall. Nigeria enjoys a tropical climate with distinct wet and dry seasons the air masses responsible for these seasons in Nigeria are the tropical maritime air mass which is the south West trade wind, tropical continental air mass i.e. North East trade wind (Harmattan wind) and the Equatorial Easterlies. The tropical maritime air mass is the main factors which brings rainfall. The Rainy Season in the Northern part of Nigeria where this study is carried out occur between April and October. The tropical continental air mass (harmattan wind) is the factor responsible for the dry season. It occurs during the Month of October to June.

Rainstorm effects are usually experienced at the beginning of the rainy season around March to June and towards the end of the rainy season around October. Rainstorm has adverse effects on most buildings in Nigeria climate element such as rain and wind or combination of rain and wind find a way through a roof covering can cause the final breakdown of the roof covering following a long period of slow deterioration.

Moisture is the principal agent of deterioration and probably also the agent with the greatest influence on the properties of materials (Howson and Yven 1992). Moisture, (rain) and wind coupled with other agents of deterioration have deteriorated our buildings leaving the whole urban area degraded.

It is in view of these prevailing effects of rainstorm on building component that this research study is carried out to look into the problem and come up with possible measures that will improve the durability of the building component and materials used.

1.1 STATEMENT OF THE PROBLEM

Physical decay of our buildings is a common sight all over our urban and rural areas. Buildings with discoloured paint surface, peeled off rendering, cracked or flaked rendered wall are seen all over the place. During the rainy season, block wall and mud block can be seen seriously dumped in very weak condition ready to collapse at any time.

Roofing sheets are partly or completely blown off by strong wind. The ones that are still fair, large stones or blocks are placed on them to protect them from any event of strong wind during the rainy season.

Timber parts of a building such as fascia board, wooden doors and windows and their frames, ceiling boards e.t.c. are seen seriously dump and some have completely decayed, ready to fall or already falling off.

Metal buildings are not left out in deterioration. Rusty metal doors, windows, gates, frames e.t.c deteriorate. Deterioration is common sight within Chanchaga area (Study Area). A critical survey carried out by the Researcher shows that one major cause of this deterioration within the Study Area is as a result of rainstorm.

Man in his drive to provide shelter have cut down trees to erect buildings. This indiscriminate cutting down of trees for the purpose of building construction degrade the environment. The degrading of the environment has generated into environmental hazards such as rainstorm that in turn affect Man and the buildings he constructed.

This environmental hazard, rainstorm is affecting buildings and other infrastructural facilities within the Study Area resulting to physical decay.

1.2 Aims and Objectives

Aims

This Research is aimed at studying the effect of rainstorm i.e. rain and storm (wind) on buildings within Chanchaga area.

Objectives

1. To understand the relationships that exists between Rainstorm (Rain and Wind) and their effects on buildings.
2. To identify various deteriorations on the existing buildings that is as a result of rainstorms.
3. To identify the natural features present within the Study Area.
4. To identify existing measures of combating the effects of rainstorm on buildings within the Study Area.
5. To make recommendations on possible ways of controlling the effects of rainstorm on buildings within the Study Area.

1.3 JUSTIFICATION OF STUDY

In order to meet the functional requirement of the building to provide shelter for Man and an enabling environment to carry out his activities, climatic condition of the building site should be considered during the design stage. The utilization capacity of a building is greatly influenced by the climate condition of the site.

Most buildings within the urban settlement are faced with the menace of deteriorated buildings. Deteriorated buildings are on their own-environmental hazards that pose a serious threat to Man and also his environment. Chanchaga area (Study Area) is an example of such environment with deteriorated buildings.

Based on the deteriorated condition of Chanchaga environment, this Research is carried, to reconcile sustainable performance of a building and adequate physical planning with environmental management. It may be a very difficult task to control environmental hazard such as rainstorm directly when it occurs. But it is a much easier task to manage the environment. Management of the environment will on the other hand help to maintain buildings thereby reducing deterioration.

This Research will look into how adequate environmental management can be used to combat the effect of rainstorm hazard on buildings. Achieving this in our urban areas will go a long way to protect/guard against deteriorated buildings to meet up with the required performance throughout the life span of the buildings with limited defects.

1.4 SCOPE AND LIMITATION OF RESEARCH

i. The data collected and information are only for buildings within Chanchaga area in Niger State.
ii. The data/information collected are only for schools and residential buildings.
iii. The data/information collected are those related to the external part of the buildings component only.
iv. The data/information collected is on the effects of rain and wind on the buildings.
v. The data/information collected does not give full and elaborate schedules and specification of materials.

CHAPTER TWO

DESCRIPTION OF STUDY AREA

2.1 LOCATION

Chanchaga is located in Minna West Local Government Area of Niger State. Niger State lies within latitude 7^0 and 11^030 N of the equator and within longitude 3^030 and 7^030. Chanchaga is situated at the Western part of Niger State lies within the middle belt of Nigeria in the Guinea Savannah vegetation belt.

2.1.1 Administrative Area

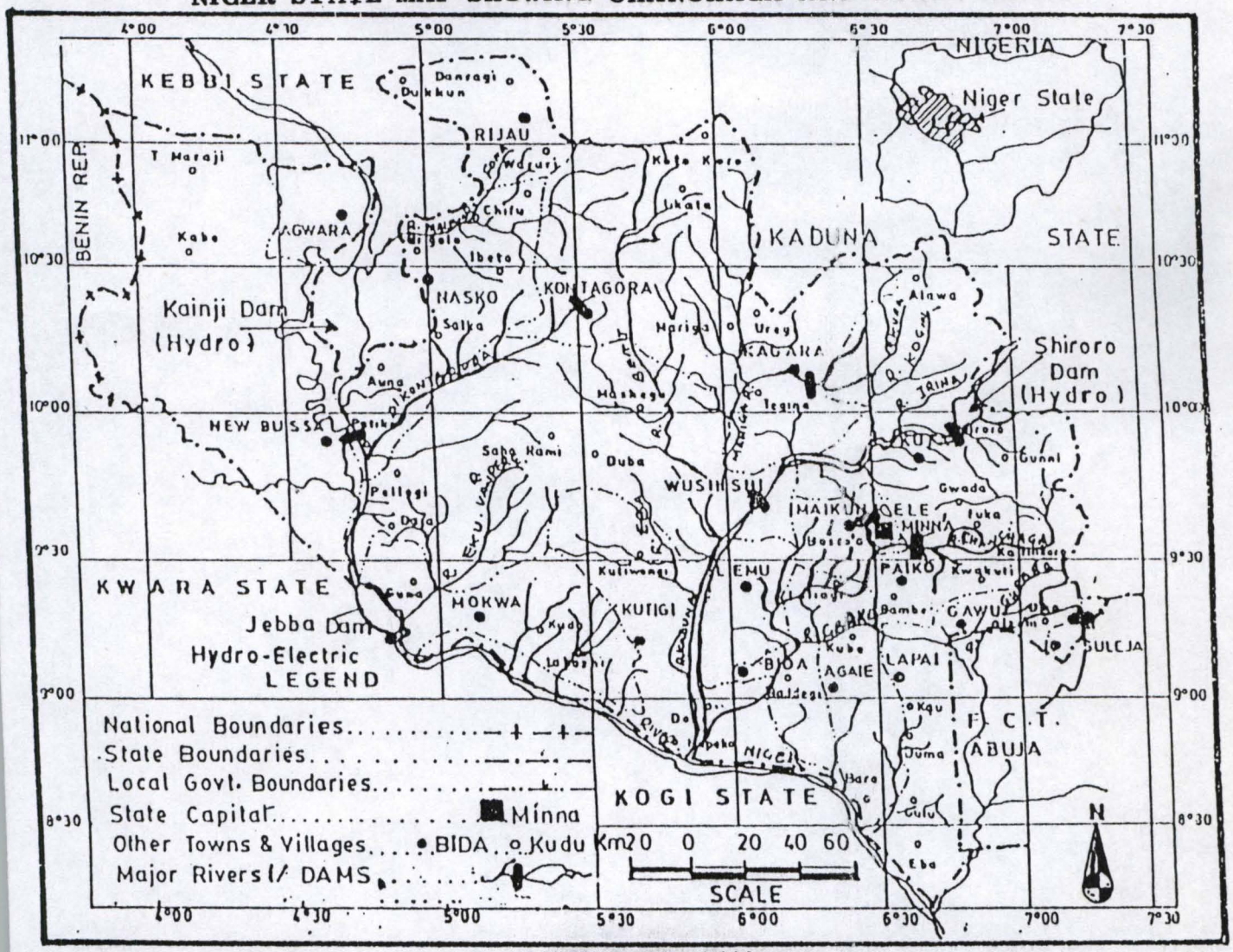
The Study Area, Chanchaga is the headquarter of Minna West Local Government council. It was carved of the old Chanchaga local government council in January 2002 as a result of the additional 17 Local government area in Niger State.

The Local Government has only one district namely Minna district. It has II wards namely; Limawa A, Limawa B, Dutsen Kura Gwari, Makera, Minna Central, Minna South,B (Kpakungu/Soje), Minna South A, tudun Wada South A, Tudun Wada South B, Chanchaga A and Chanchaga B. (Information Department, Minna West L.G.A.)

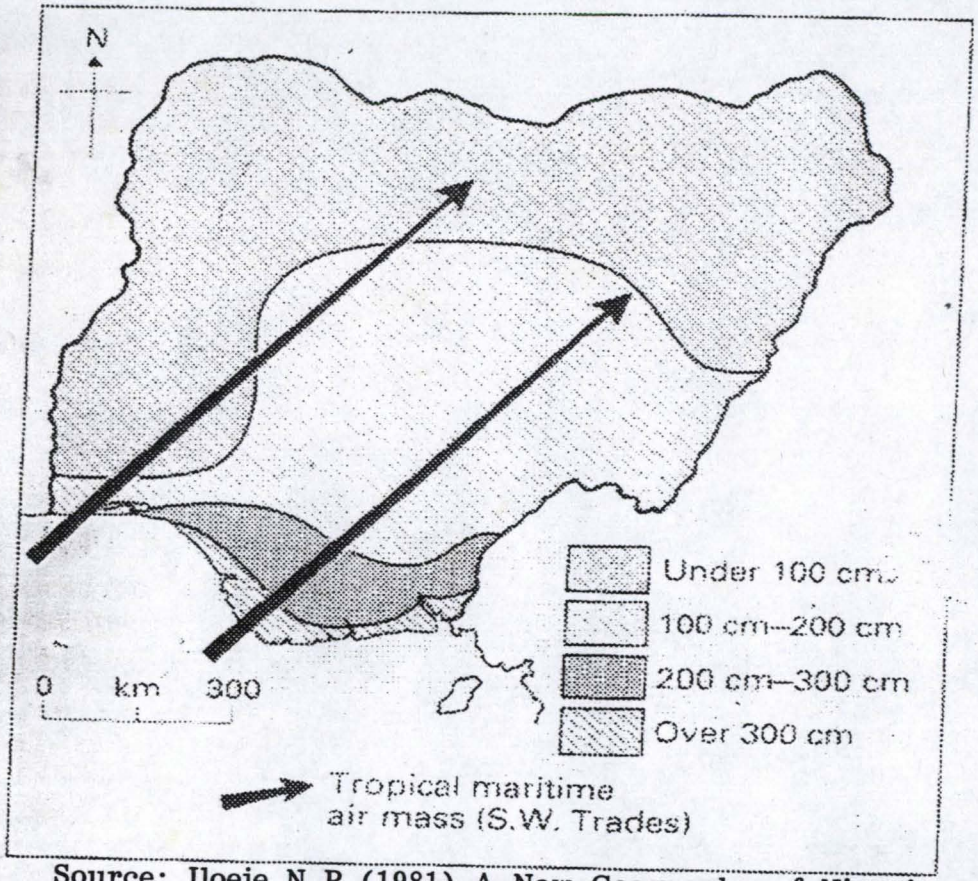
2.1.2 Population

Chanchaga has a projected population of 17, 056 people (Information Department, Minna West L.G.A) This implies that most houses are clustered together. Most of the buildings observed through ground studying are not planned.

FIG. 2.1 NIGER STATE MAP SHOWING CHANCHAGA AND OTHER AREAS



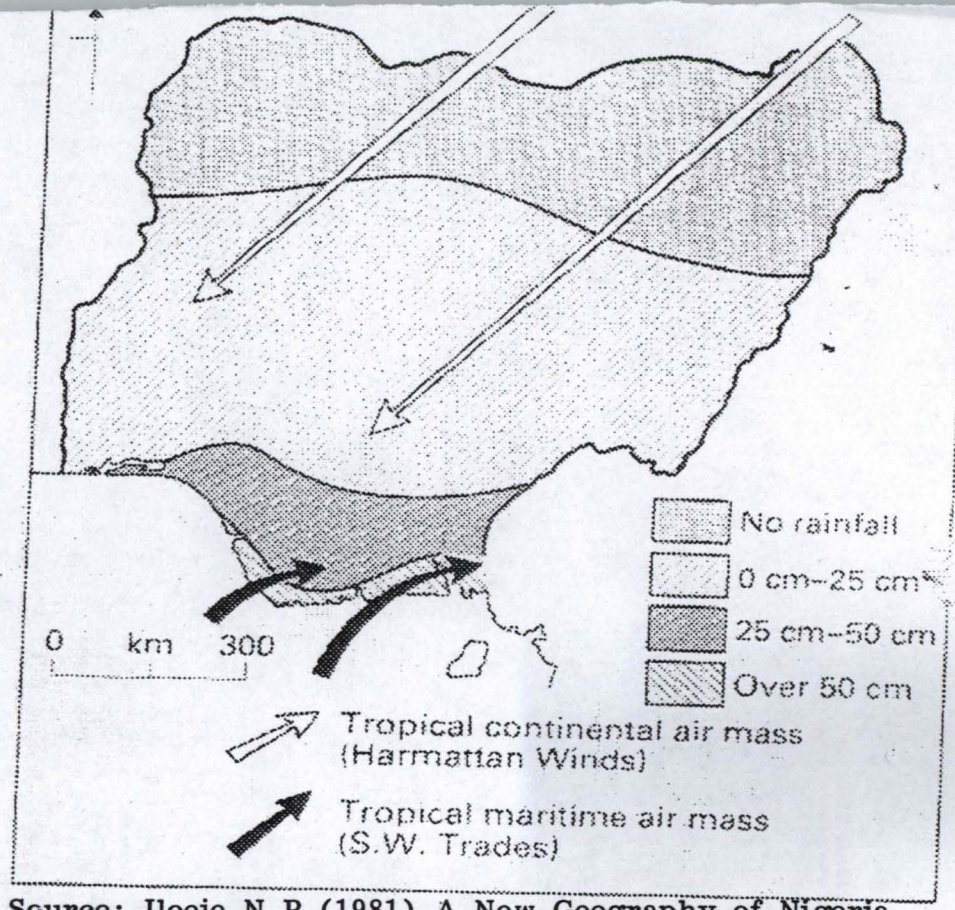
Source: Adefolalu D.O(1999) Ecological map of Niger State.



Source: Iloeje N.P (1981) A New Geography of Nigeria

Figure: 2.2

Wet season winds and rainfall (April-October).
The full effect of the tropical maritime air mass as the main factor which brings rainfall is felt in this season. Because it comes from the south and drops its moisture progressively northwards, rainfall diminishes from south to north.



Source: Iloeje N.P (1981) A New Geography of Nigeria

Figure: 2.3

Dry season winds and rainfall (November - March).
This is the dry season when rainfall is least. Notice that even during this season, the coastal trades still bring some rains to the southern coastal fringe of the country. The % for the wet season increases as one goes from south to north; while that for the dry season shows a corresponding decrease.

2.2 PHYSIOGRAPHY

2.2.1 Relief

Niger State lies within the low-land area of the guinea savannah region. Its surface generally lies below 300 meters. The under laying parent material is the crystalline basement complex rock. Other materials found within the area are cetacean sediments and alluvial deposits. Chanchaga is interspaced with a hilly land form. Most of the buildings were located on mostly plain terrain.

2.2.2 Drainage

The main river that passes through Chanchaga town is river Chanchaga which is a distributary that took its source from River Kaduna.

Surface water within the Study Area is drained off mostly on the ground surface directly with very few well constructed drainage systems. The water from the surface and drainage system are drained into streams and streams drained into River Chanchaga.

2.2.3 Soil and Vegetation

Soil types found in Niger state are sand-loamy soil which falls within the laterite and alluvia; soil zone of Nigeria. Niger state lies within guinea savannah belt because of its distinct dry and wet seasons of more or less duration, laterite soil are easily formed.

Laterite soil is deeply corroded and grey or reddish in colour. They are sticky, imperious to water and of mediocre fertility. When exposed to the surface, they become as hard as bricks. The soil is more useful in road – paving and wall construction.

Alluvial soil is seen along valleys of rivers. The soil is sandy, light and hued and often sterile. They are clayed or muddy, dark grey in colour usually water logged and good for rice cultivation. .

Niger State lies within Guinea Savannah vegetation belt of Nigeria. The vegetation of Chanchaga town is made up of ranges of tall grasses and trees. Main trees found within the area are locust beans, shear butter, mango, and cashew and raffi palm along riverbank. The trees have long tap roots ad thick barks which enable them to survive the long dry season. The grasses have durable roots which remain in the ground when the surface has been burnt. During the dry season the whole area looks bared and dry especially between the middle of November and the end of march, due to lack of moisture.

2.3 CLIMATE

2.3.1 Seasons.

Two seasons are experienced within the study area. These are wet and dry seasons. Hot and humid weather condition in the dry season and heavy rainfall of six or more months between April to October (Adefolalu 1989). The wet season is ushered in by the interplay of tropical maritime and tropical continental air masses. The long dry season,(harmattan season) lasts from November to March. The nights and mornings are cool and misty during harmattan. Afternoons are full of haze because of air particles brought down by winds.

2.3.2 Rainfall

Chanchaga is characterised with relatively high annual rainfall of about 1,200 to 1,400 mm. the rainfall is concentrated in the month of July, August and September. Adefolalu (1999) Ecological map shows the onset of the rains in the Study Area to be from April 10th to April 30th and cessation date of rain to be October 7th to October 27th.

2.3.3 Temperature

Mean temperature varies throughout the year. The hottest months in the year are March and April, in Chanchaga-Niger State. The mean daily maximum temperature is 32^0C for most of the year. There is a fall in temperature in the months of July to September (Adefolalu 1999). Maximum temperature of about 24^0C-27^0C is experienced during the hot and humid dry season in the Study Area. (Adefolalu 1999)

2.3.4 Relative Humidity

The Relative Humidity of Niger State where Chanchaga is located is between 30% and 75 % throughout the year. In the months of July, August, September and the early part of October, Relative Humidity is relatively high (about 70%) while the dry months have relatively low Relative Humidity (less than 30%) Adefolalu. (1999)

2.3.5 Wind

Niger State is under the influence of two winds namely; the North-East trade wind and the South-west trade wind. The North-East trade wind is characterised by high velocity, dryness and it carries dust particles. It is very severe during the dry season (harmattan season). The South-west trade wind-

on the other hand is characterised by low velocity, moisture and dust free. The South-west trade wind originated from the coast hence contains water droplets. Its presence is felt during the rainy season.

2.4 LAND USE

2.4.1 Agriculture

The soil of Chanchaga is sandy-loamy soil which provides room for good agricultural activities. Large areas of Chanchaga land are wetland (fadama) which is good for rice cultivation, sugar-cane plantation, banana plantation e.t.c. The dry land (Upland area) is also used to cultivate maize, ground-nut, guinea-corn e.t.c. Vegetable gardens are cultivated along the River-bank.

Other agricultural activities within the Area include fishing, rearing of domestic animals and birds. The presence of River Chanchaga enables the people to practice irrigation method of farming.

2.4.2 Settlement

Chanchaga town is situated along the road; this has led to the growth of the Area. The road links the settlement to Paiko-Abuja. The settlement is situated at an advantageous position with respect to natural features such as water supply, food, drainage, access to transport, communication, electricity supply schools-both private and public, hospital, clinics and bore-holes.

The settlement is sparsely populated with unplanned buildings that have no definite patterns. The settlement comprises both traditional and conventional buildings constructed with mud blocks, bricks and Sand Crete

blocks. The buildings are covered with corrugated zinc and aluminium roofing sheets, some with grasses; i.e. barns used for storing grains.

The housing units within the Area comprises of single or double bedroom apartments either owned by private individual, government or rented, others are self-contained bungalows. The settlers mostly depend on farming and trading, which traversed in the local production for livelihood. Few of the inhabitants of the Area are civil servants working with the local or state government.

CHAPTER THREE

LITERATURE REVIEW

3.1 RAINSTORM

Collins Concise Dictionary defines rainstorm as "Storm with heavy rain". Rainstorm is a violent weather condition of strong wind with heavy rainfall.

Three factors are responsible for rainfall-excessive heat which generates vertical current, relief which present barrier to wind and thus forces them to rise, and a cold air which under-cuts a warm wet air and therefore lighter air may cause rain (Iloeje, 1981)

Wet season within the Study Area is usually ushered in by the interplay of the tropical maritime and tropical continental air mass. The end of the season is also characterised with rainfall and strong winds. The buildings within the Area are exposed to the effects of rainstorms (rain and wind).

3.1.1 Air Masses (Wind)

Three main air masses responsible for rainfall in Nigeria are the tropical maritime air mass (South-west trade), tropical continental air mass (harmattan winds) and the equatorial Easterlies (Iloeje, (1981)

Tropical Maritime air mass originates from the southern high-pressure belt. It crosses the equator picking up moisture from over the Atlantic and entering Nigeria from the south. The air mass moves up towards the hinterland dropping its moisture progressively northward. It is the main factor that brings rainfall (Abegunde et al 1997)

Rainfall diminishes from the south towards the northern part of the country. Its effects are felt between April and October. The rainfall within the Study Area is influenced by the tropical maritime air mass.

Tropical continental air mass on the other hand originates from the Sahara high-pressure belt. It picks up little or no moisture en route and is therefore dry. It enters Nigeria from the North in the month of October, grains ground bit by bit on the tropical maritime air mass. By January, it pushes the maritime air mass to the south coast extending its influence to over 90% of the country. (Abegunde et al 1997). It starts to retreat in March and by July, it is completely out of the country. The Study Area is under the influence of tropical continental air mass at the beginning of the rainy season and towards the end of the season.

Equatorial Easterlies is a cool erratic wind which comes from the East and blows in the upper atmosphere along the inter-tropical zone of convergence. This is the front area where tropical maritime air mass and tropical continental air mass to some extent mixed as a result of the rubbing.

3.2 RAINFALL IN NIGERIA

Three types of rainfall experienced in Nigeria are; conventional, relief and frontal rainfall (Ajayi 1998). The Conventional rain follows the overhead sun and shifts North and South across the country. It is experienced nearly all the year round along the coast which is near the equator. Relief rainfall is found on the wind-ward side of Jos, Obudu and Adamawa plateaux. Frontal rainfall is associated with the inter-tropical front line squalls (Ajayi 1998). The air mass of Nigeria is in conflict over the inter-tropical zone of convergence in frontal rainfall. They are characterised

with strong winds and heavy rainfall, (Iloeje 1981). This type of rainfall causes damage to buildings, blowing off roof tops, dump wall surface, e.t.c.

Buildings within the Study Area are seen with partly or completely blown off roofs, some; large stones or blocks are placed on them to prevent it from being blown off in the event of rainstorm.

3.3 CLIMATE CHANGE

Change in climate can be associated with Man's day to day activities within the environment. These activities have generated macro climate variations. Fuel burnt daily from households, automobiles, industries, emission from decayed timber generate heat alter the natural heat balance (Ifabiyi and Jimoh 2000). Clearing of trees indiscriminately, that will have used up CO_2 released into the atmosphere compounds the issue of micro climate variation. Micro climate variation is also peculiar to Chanchaga town due to Man's activities within the Area. Local industries like black-smith , welding industries within the Study Area generate heat that alter the heat balance and pollute the air. Emission from vehicles that move along the Minna-Abuja road that pass within Chanchaga town affects the micro climate.

Changes in micro climate affect the element of weather, such elements include; temperature, .pressure, air masses, wind atmospheric humidity, and precipitation. They are in turn affected by major factors like latitude, altitude, relief, proximity to the sea, ocean current and winds. Minor factors include vegetation, the nature of soil, and the position of a place in relation to direction of sun's rays (Iloeje 1981).

A relatively large spatial and temporal variation in condition takes place in and around the building surface and ground. These effects can

significantly alter the thermal response pattern of a building. When multiplied by the presence of several hundred thousand buildings. In urban chipsets-the effects are more marked and gives recognizable different climate to the urban region from that of its rural hinterland (Kelechi 2000).

Bryson and Ross (1972) observed specifically that urbanisation have been found to modify the city's climate in ,a number of ways. These include; the effects of change in the physical surface of the land, removal of vegetation for purpose of development. These increase the roughness and in consequence, wind speed. Some area of Chanchaga are devoid of vegetation. This increases wind speed which results in blown off roof during rainstorm. Also, when the foundation of the building is wet due to underground conditions, increase in speed of wind during rainfall can cause collapse of buildings.

Hupter et al (2000) stated that if the rhythm of oscillation is disturbed however, the zones shifts within large-scale air flow changes. If this occurs, areas with tropical rain climate become dry for relatively long period of time, while other areas can receive considerable damages from surplus rain.

Buildings within the Study Area are affected as a result of climate change. The rains are characterised with strong winds that cause damages of buildings.

3.4 STRUCTURAL CONDITION OF BUILDINGS

The performance of a building depends greatly on structural condition. When Man decides to erect a building, which will meet his need for shelter and other activities, his desire is that the structures perform its function.

Griffith (1990) described how increasing concern has been expressed at the frequent low standards of performance and quality achieved in the United Kingdom [UK] buildings work. It highlighted the need for structural and formal system of construction management to improve performance, workmanship and quality.

Some Buildings within the Study Area do not meeting up with building standard when considered in terms of performance, workmanship and quality. This is revealed by the level of deterioration that set in even to newly constructed buildings. The level of workmanship and quality of materials used goes a long way in determining the durability of the building. Most new buildings are not meeting up with performance standard prescribed by the building regulation of 1991. For instance, part A of the regulation covers the strength and stability of the building. Part C covers the site penetration and resistance to moisture as it is vital that all buildings shall be wind and weather-tight (Seeley 1995).When this regulation are not followed and couple with the effect of rainstorm on the building the rate of deterioration is also increased.

3.5 BUILDING DESIGN

Housing provisions in Nigeria varies from one place to another. This is due to difference in culture, climate and socio-economic characteristic of the people. Some of the houses within most of the Northern metropolitan towns and local government headquarters have no definite building design (Zakari 2000). Such is the case of Chanchaga town. Most of the buildings are constructed with out design plan. To ensure predictable performance, the designer must possess a good knowledge and understanding of materials will have their environment in service (Howson and Yven 1992). This is not a

usual practice in the Nigerian context especially in settlement such as the Study Area.

The influence of physical component of our environment on buildings cannot be over emphasized. Climatic factors have both active and direct influence on our buildings. Most of building components or elements deteriorates on reacting with weather. BRE (1964) has instanced case where accelerated deterioration and/or unsightly appearance has resulted from unsuitable placing of incompatible materials or inadequate attention to design details. Streaking by rainwater washing over walling results from lack of suitable projecting features with flat roofs is a typical example. Changes in appearance of materials used externally in buildings may result in the process of natural micro climate influence frequently unpredictable in design details.

Changes are noticed in the external parts of the buildings within the Study Area. For example, discoloured paint surface, peeling or flaking of rendered walls, rusting of metal surface, e.t.c. These changes can be linked to lack of adequate knowledge on how environment can influences building materials during the design stage.

3.6 BUILDING MATERIALS

The choice of design in relation to the materials to be used, and in relation to the proposed used of building, its environment is probably the factor most affecting the risk of defects and failure (Howson and Yven 1992). Howson and Yven stated that choice of materials should be governed mainly by the following factors;

- Their ability to withstand the effects of the climate
- Their ability to fulfil their design function.

- Their ease of maintenance and/or replacement
- Overall economic acceptability

Knowledge of how various materials react with the environment is one problem being observed within the Study Area. This has increased the rate of deterioration of external building materials within the area. For example, emulsion paints are commonly used for painting wall surfaces. Seeley (1995) states that "Severe climatic condition can have adverse effects on many building materials. In particular, organic materials such as Paints and Plastics perform satisfactorily in temperate climates but are much less durable in the tropic. This is because of the combination of high temperature, ultra-violent light, level and possibly high ambient humidity.

Environmental factors have an important influence on the durability of materials. The factors affecting climate that cause deterioration to building materials arise due to the following conditions. Moisture, condensation, dampness, mould growth, water penetration, frost, thermal moisture, structural collapse, wind (Zakari 2000). These conditions affects building materials such as bricks, Sand Crete and mud blocks; rendering materials like ordinary Portland Cement, paints, timber, metal ceiling board and roofing sheets within the Study Area

3.7 EFFECTS OF RAINSTORM ON BUILDING FINISHES.

3.7.1 Moisture Penetration.

Moisture is the principal agent of deterioration and is probably also the agent with the greatest influence on the properties of materials (Howson and Yven 1992). Moisture exists in form of solid (Snow and Hail stones), liquid (rain) or vapour. Hawson et al mentioned that moisture is usually a

prior condition for physical, chemical, or biological reaction to take place. Examples include;

- Change in humidity can lead to dimensional change in material, with deformation, crazing or cracking.
- Rain, especially when driven by strong winds can erode and dissolve certain soft materials.
- When water freezes in the pores of materials such as bricks, stones and concrete, stresses are produced. This may cause spilling of the surface.
- Presence of moisture can promote corrosion of metals, efflorescence and other chemical reactions.
- Moisture also creates an environment For fungal growth as well as attack by insects in organic materials.
- Giant hailstones can cause damages of glass surface and roofing tiles.

Seeley (1995) identified the effects of moisture on the following materials:-

Metals; high humidity encourages corrosion and slows evaporation from wet surfaces.

Paints; movement leads to loss of adhesion, crazing and cracking. Condensation on a drying film causes loss of gloss, pitting, slow drying and general weakening of film also occur as a result of moisture.

Sealants; moisture may affect adhesion of sealants used for joining sealants to frames of windows and doors. Also, it affects sealants used in the treatment of wood rot in timber members.

Timber and wood products; large moisture movement can cause checking, splitting, warping and raising grain. Swelling and delamination of wood based boards. Rain-washing may leach out poor preservatives.

Bitumen felt; felts may blister. Rain removes water-soluble materials and washes off surface protective granules in time.

Roof; rain and snow may penetrate a pitched roof because the slates or tiles are laid at too flat a pitch. The problem is aggravated on exposed sites. Moisture penetration may also occur with sacking felt which sags excessively between the rafters or does not extend into the eaves gutter or over a large board. (Seeley 1985)

Rendering materials; external rendering can fail through cracking or detachment and allow rain penetration into the structure. The main causes are inadequate bend or key to wall, continuous rendering over zones where relative movement occurs in the background. Also when the rendering is stronger than the background or preceding coats, is too weak to exclude rain water adequately or too rich or too wet to avoid cracking.

Buildings within the Study Area are characterised with corroded metals, decayed timber products, discoloured paint surfaces. Other defects within the Study Area include; flaked and peeled renderings and damped wall surfaces.

3.7.1 Wind

Wind can cause direct physical damage by the removal of parts of a building. It can cause dampness by driving moisture into or through a building fabric. (Howson and Yven 1992)

BRE Overseas Buildings (1982) CATEGORICALLY DEFINED Tropical Storm as a large and more intense tropical depression with mean wind speed greater than 17 m/s but not exceeding 33m/s. wind pressure differs according to the direction and intensity of the wind. It affects the vertical, inclined and horizontal surface according to their location Howson

and Yven said that "Compression and suction forced from the wind may cause the loading or lifting of the building. Buildings that are severely affect through dampness can easily collapse in the event of a strong wind-driven rain, on the other hand, roofing with vulnerability edges can be easily lifted and blown off in the event of rainstorm. For these reasons, Hawson et al suggest that careful study of the effects of wind on a building and adjacent buildings which can cause deviation of air current become necessary during the design stage. The effects are more significant with increasing height and exposure of the building.

Some buildings are damaged because of their sitting and position. For example, wind speed is greater near the top of a hill (Seeley 1995). Many buildings resist rainstorm when they are sheltered by trees or other surrounding buildings. An important factor in designing buildings to prevent wind damage is knowledge of the likely exposure of storm. Two components to this assessment are namely; the metrological data and probabilities of a given wind speed, and nature of the local terrain and surroundings which will affect factors such as the likelihood of storm surge.

Buildings that are exposed without trees around and those sparsely located within the Study Area are the ones mostly affected by strong wind.

3.7.2 Driven Rain

Driven rain is rain carried along at an angle to the vertical by wind so that it intrigues on the vertical surface of a building (Howson and Yven 1992). They mentioned that raindrops tend to fall vertically but when there is a steady wind, it will carry the drops along with it at the same speed, provided that the raindrops are of the same size. This seldom happens in practice.

When a droplet of wind-driven rain strikes building surface, it disintegrates. Its kinetic energy may force part of the droplet into the pores of the material used in the construction. The remaining parts either bounce off into the surrounding air, adhere to the surface, or be absorbed into the material by capillary action. The accumulation of moisture within the material may cause expansion of the material, which slower surface drying causes contraction at the surfaces, (Howson and Yven 1992). This is the relationship that exists between the building materials and rainstorm within the Study Area that result in most materials deteriorating.

Tall buildings can receive more rainwater on their walls than on their roofs, particularly where the building is facing the prevailing wind. Because of this, rain is often driven vertically up the face of the building.

3.7.3 Underground Conditions

Richardson (1991) emphasised that building designs should take account of normal sources of moisture as penetrating, rising and condensing dampness. Below ground factors that affect the performance of a building include the nature of subsoil, drainage and site stability.

In older buildings, damps may rise up walls to heights in excess of 1m because of the lack of damp-proof courses. The height of damp penetration depends on several factors such as; the pore structure of wall, degree of saturation of the soil, rate of evaporation from wall surfaces and presence of salts in the wall. Damp may also penetrate a solid floor in the absence of a damp-proof membrane (Seeley 1987)

Prevailing raising damp condition coupled with damp wall as a result of rainstorm can lead to the collapse of buildings.

3.8 LANDSCAPING AND ORIENTATION OF BUILDING

Landscaping, apart from increasing the aesthetic value of buildings, it also acts as a natural coolant to buildings. It also helps to filter air and many times used as wind breaker. (Kelechi 2000). Most buildings within the Study Area are extensively paved with concrete. Others are naturally paved due to the nature of soil (laterite) which becomes as hard as bricks when exposed to the surface.

The orientation or arrangement of the axis of a building is a way of controlling the effects of the sun, wind and rain. This is because the sun is regular in its path and favours the southern aspects of buildings in the northern hemisphere. (H0wson and Yven 1992). Orientation of a building can be maximised to control the local climate, when considered alone, other factors for example, the character of the local terrain may have some influence on the final orientation of buildings by the way in which undulating ground, trees and adjacent buildings create shade and reduce or intensify the effects of wind.

3.9 URBAN PLANNING

Many towns in Nigeria can be classified as orthogenic cities. The nature of their development has been sporadic and unplanned, especially in the core area. Thus, most of the Central Business district (CBD) of Nigerian cities lack planning. The mixture of land use without any recourse to modern planning and management are also common. The fact that rapid urbanisation

has taken over such settlements makes such central foci of urban problem. (Ifabiyi and Jimoh 2000). Similarly, housing quality is regarded as being worse in the CBD because of lack of plans. Most houses within the Study Area have no building plan. This is the reason for sub-standard buildings seen around the Area.

Majority of buildings in the World are low-rise houses and most of them are not designed at all. They are often built by house owners or small contractors, using traditional method and without specialist construction knowledge. This often results in vital connections such as those required between walls and roofs. When they are inadequate or omitted altogether result in disastrous consequence in a rainstorm (Seeley 1995)

Aderamo, in his paper titled City planning and Management Techniques stated that Physical planning is concerned with the changes that occur and the general regulation of these changes in the physical environment. Usually, these take the form of design and management of the environment in accordance with predetermined and agreed policies. Urban management has come to be accepted as an important component of urban planning.

The planning is expected to secure the maximum practicable degree of economy, convenience, health and beauty. But many problems are associated with urban development. Urban cities in both the developed and the developing world now face environmental problems which vary to the stage of the country's development (Haughton and Hunter 1994). These environmental problems such as deforestation, rainstorm, soil erosion, pollution, are identified as partly the product of modern industrial development and due to the rapid urbanisation.

As a result of urbanisation, there is now a tremendous pressure on housing so much so that the gap between housing supply and demand in our urban centres continues to widen.

Odongo, 1978 revealed that two conventional indicators of housing shortage are overcrowding and slum condition. Slum settlement is used to describe sub-standard housing. Though Chanchaga is not a slum settlement, some of the housings and buildings in general are sub-standard. Finding solution to urban environmental problems is very important to ensure liveable environment for the inhabitants of the Study Area.

3.10 MAINTENANCE OF BUILDINGS

As a country becomes developed, new constructions will slow down and the up-keep of existing buildings and other facilities becomes increasingly more important. (Hawson and Yven 1992). The major problems of maintenance of buildings in Nigeria are; who is responsible for the maintenance of the buildings? Is the person responsible ready to take up responsibility? Are there available funds to execute maintenance work?

The major group responsible for maintenance are the buildings' owners and the government. The responsibility of the tenants depends on the agreement reached between the tenants and the landlord. Some tenants, who consider their comfort, safety, and health very important, take up the responsibility of maintaining the building when the landlords are not responding. Government on the other hand, does little or nothing after she has provided the buildings for her citizens. This is evident in the level of government building properties that are deteriorated all over the Nation.

Gallion, 1986 says "the Government of every Nation is in partnership with the process of rebuilding or renovation of the buildings in the Nation

especially those in the cities. Lip service is given to local responsibility, but it has been customary for City and State Governments to avoid the issue of subsidy by transferring their responsibility to the Federal Government. Physical decay has eaten deeply into urban community unchecked, binging deterioration to urban area. This is as a result of irresponsible civil management and negligence of urban house keeping permitting the spread of deterioration.

Lack of funds has hindered building maintenance both to government and private owners of buildings. Stone indicates that running costs of building can amount to two-thirds of the annual equivalent of first cost. Inhabitants of the Study Area are mostly farmers and traders and the income they make are spent mostly to sustain their livelihood.

CHAPTER FOUR

METHODOLOGY

4.1 DESIGN OF THE STUDY

This research study is designed to assess the effects of rainstorm on buildings using Chanchaga town in Niger state as the Study Area. To analyse the various ways by which these effects of rainstorm on buildings can be controlled.

In this project, the survey research method was employed. This method was considered appropriate because it is a fact finding technique and facilitate the generation of information about current situation within the Study Area. The method adopted in the study is also reliable.

4.2 SOURCES OF DATA

To collect data for this research, the Researcher used two main sources of data namely; the Primary and the Secondary source of data.

4.2.1 Primary Sources

1. Questionnaire

A Structured questionnaire was designed by the Researcher and used as one of her primary source of data. The questionnaire has three sections. Section A contains questions with sets of answers to be ticked from describing the buildings. Section B describes the structural condition of the buildings while Section c contains other relevant questions that may be

useful during the project analysis. A sample of the questionnaire can be seen in Appendix 1.

A total of 70 questionnaires were used to collect data for the project. The questionnaires were administered personally by the Researcher herself to the occupants of the buildings within the Study Area for a period of some days.

2. Reconnaissance Survey Method

The Researcher personally carried out a reconnaissance survey of Chanchaga town which involves direct assessment of the buildings randomly, and gathering of data on the physical environment. Data/information collected include; photographs of buildings, environmental features like trees-observing their positions around the buildings. Other observations made include; spacing between buildings, arrangement of the buildings and the direction of wind in relationship to the affected surface of the buildings externally as a result of rainstorm.

4.2.2 Secondary Sources

Data were also extracted from various sources and climate change centre e.t.c. an in-depth study of works done by some Academicians, Theorist Professionals and Authors alike. It entails collection of information from text books, past project works, magazines, and formal and other publication materials.

4.3 METHODS OF DATA ANALYSIS

The Researcher used Mathematical and Statistical methods of data analysis, these include; tabulation, percentage and diagrammatic illustrations. The above methods have been chosen to ensure simplicity and easy understanding of the result of the analysis.

4.4 DATA PRESENTATION ANALYSIS

Data/information collected from the field survey within Chanchaga town at this stage is presented and analysed. The analysis will consist two parts; one part will consist of the analysis of data/information from the questionnaire while the other part will be used to analyse the various observations collected during the reconnaissance survey.

CHAPTER FIVE;

DATA PRESENTATION ANALYSIS AND DISCUSSION OF RESULT

5.1 THE QUESTIONNAIRE DATA ANALYSIS

From the whole buildings within the Study Area, 70 were chosen as sample by means of random sampling, out of which 46 were of conventional construction and 24 were of traditional construction. All the questionnaires administered were valid and used since it was administered personally by the Researcher to the occupants of the buildings.

TABLE 5.1

Type of Construction

Construction Type	No. of buildings	% of buildings
Conventional	46	65.7%
Traditional	24	34.3%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that 46 of the buildings representing 65.7% are of the conventional type of construction while 24 buildings, representing 34.3% are of the traditional type of construction.

This indicates that some of the buildings are either too old-and-weak or are no longer strong enough to withstand various types of climatic hazards.

TABLE 5.2

Type of Building

Building	Number	Percentage
School	6	10.3%
Residential	52	89.7%
TOTAL	54	100%

Source; Field Survey 2003

The Table above shows that 2 of the buildings representing 10.3% are School, while 52 of the buildings representing 89.7% are residential buildings. This means that the Study Area doesn't have enough schools to serve the Community.

TABLE 5.3

Type of material used for the wall construction

Type of material	Responses	% Response
Brick	10	14.3%
Sand-Crete block	36	51.4%
Mud block	24	34.3%
TOTAL	70	100%

Source; Field Survey 2003

From the Table above, 10 of the buildings representing 14.3% of the wall were constructed with Brick blocks. 36 of the buildings representing 51.4% are of the hollow Sand-Crete block wall while 24 of the buildings representing 34.3% were constructed with mud block walls.

The above data indicates that more of the buildings are constructed of hollow Sand-Crete blocks followed by mud blocks. Only few are constructed with bricks. Plate 4, 7 and 8 shows buildings constructed with mud blocks while plates 1-3, 5,6, and 9 to 12 are Sand-Crete blocks.

TABLE 5.4

Ownership of the buildings

Ownership of buildings	Responses	% Response
Personal	27	38.6%
Rent	19	27.1%
Government	24	34.3%
TOTAL	70	100%

Source; Field Survey 2003

From the Table above 27 buildings representing 38.6% are occupied personally by the owners of the buildings. 19 of the buildings, representing 27.1% are occupied by tenants (Rent) while 24 of the buildings representing 34.3% are Government buildings.

Data above means that more of the buildings within the area are personal properties occupied by the owners which is followed by Government owned buildings occupied by its workers. Few of the buildings are rented buildings occupied by tenants.

TABLE 5.5

When were the buildings constructed?

Option (Years)	Responses	% Response
Below 5	4	5.7%
5-10	37	52.9%
Above 10	29	41.4%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that 4 buildings representing 5.7% are below the age of 5. 37 buildings representing 52.9% are between the ages of 5 and 10 years while 29 buildings representing 41.4% are above 10 years. This indicates that most of the buildings within the Study Area are above 5 years old. This could mean prolonged effect of rain and wind on buildings with increasing the rate of deterioration on building structures.

TABLE 5.6

Is your building affected by rainstorm (rain and wind)?

Option	Responses	% Response
Yes	52	74.3%
No	18	25.7%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that 52 of the buildings representing 74.3% are affected by rainstorm, while only 18 of the buildings representing 25.7% is not affected by rainstorm. This means that more of the buildings within the Study Area are affected by rainstorm. This can be seen from plate 1 to

12, it also show the level of the exposure of the buildings within the Study Area.

LEVEL OF DAMAGES OF THE EXTERNAL SURFACES OF BUILDINGS

TABLE 5.7

What is the level of damages of the rendered surfaces?

Option	Responses	% Response
Quite fair	14	23.3%
Fair	24	40.0%
Not fair	19	31.7%
Deplorable condition	3	5%
TOTAL	60	100%

Source; Field Survey 2003

The Table above shows that 14 buildings representing 23.3% of the rendered surface are quite fair, 24 of the buildings representing 40% have fair rendered surface. Rendered surfaces of 19 buildings representing 31.7% are not fair. The remaining 3 buildings representing 5% are in a deplorable condition.

The above data shows that 22 buildings out of 60 buildings assessed within the Study Area with rendering are affected. This can be seen on plate 3,4, and 7 with peeled rendered wall exposing the block work.

TABLE 5.8

Level of damages of roofing sheets

Option	Responses	% Response
Quite fair	12	17.1%
Fair	21	30.0%
Not fair	29	41.4%
Deplorable condition	8	11.5%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that in terms of the structural condition of the roofing sheets, 12 buildings representing 17.1% are quite fair. 21 buildings representing 30% are fair. 29 buildings representing 41.4% are not fair, while 8 buildings representing11.5% are in a deplorable condition.

This indicates that though some of the roofing sheets are fair, they are vulnerable to the effects of wind. This we can see from plates 7 and 8 where large stones are placed on top of the roofing sheets and plates 1,5, and 6 shows blown off roofing sheets.

TABLE 5.9

Level of damages of roofing timber

Option	Responses	% Response
Quite fair	32	45.7%
Fair	30	42.9%
Not fair	6	8.6%
Deplorable condition	2	2.8
TOTAL	70	100%

Source; Field Survey 2003

From the Table above, the structural condition of roofing timber shows that 32 buildings representing 45.7% are quite fair. 30 buildings representing 42.9% are fair. 6 buildings representing 8.6% are not fair. While 2 of the buildings representing 2.8% are in deplorable condition. This means that only few buildings within the Study Area have defects with their roofing timber for now. If the effects of rain and wind are not controlled, even the fair ones will be affected. If the defects are not also repaired, it will increase the rate of deterioration of roofing timber members within the Study Area.

TABLE 5.10

Level of damages of Fascia Boards

Option	Responses	% Response
Quite fair	8	15.4%
Fair	12	23.1%
Not fair	14	26.9%
Deplorable condition	18	34.6%
TOTAL	52	100%

Source; Field Survey 2003

From the Table above, the level of damages of Fascia boards within the Study area shows that 8 buildings representing 23.1% are quite fair, while 18 buildings representing 26.9% are not fair, 18 buildings represent 36.6% are in deplorable conditions.

The data shows that out of 52 buildings assessed that have Fascia boards within the Study Area, 32 representing 61.5% are having problems with their Fascia boards. This can be applicable to the whole Study Area. Plates 5 and 6 show that parts of the Fascia boards are completely off, plates 1 and 2 show wet and decayed Fascia boards.

TABLE 5.11

Level of damages of ceiling boards

Option	Responses	% Response
Quite fair	20	38.5%
Fair	4	7.7%
Not fair	4	7.7%
Deplorable condition	24	46.1%
TOTAL	52	100%

Source; Field Survey 2003

From the above Table showing the level of damages of ceiling boards, 20 of the buildings representing 38.5% are quite fair, 4 buildings representing 7.7% are fair; also 4 buildings representing 7.7% are not fair, while 24 of the buildings representing 46.1% are in a deplorable condition. This indicates that most buildings within the Study Area have defects with their ceiling boards. Even the ones that are fair, are likely to deteriorate to a

deplorable condition, plates 1,2 and 3 show ceiling boards that are damp, decayed and some-completely removed.

TABLE 5.12

Level of damages of windows

Option	Responses	% Response
Quite fair	27	38.6%
Fair	21	30.0%
Not fair	11	15.7%
Deplorable condition	11	15.7%
TOTAL	70	100%

Source; Field Survey 2003

From the above Table showing the level of damages of windows, 27 of the buildings representing 38.6% are quite fair, 21 representing 30% are fair, 11 representing 15.7% are not fair while 11 buildings representing 15.7% are in a deplorable condition. This indicates that only 22 buildings representing 31.4% have serious defects with their windows. The windows that are fair are also liable to a deplorable condition in the near future if the effects of rainstorm continue on them.

TABLE 5.13

Level of damages of doors

Option	Responses	% Response
Quite fair	19	27.2%
Fair	25	35.7%
Not fair	15	21.4%
Deplorable condition	11	15.7%
TOTAL	70	100%

Source; Field Survey 2003

From the above Table showing the level of damages to doors shows that 19 buildings representing 27.1% are quite fair, 25 representing 35.7% are fair, 15 representing 21.4% are not fair, while 11 buildings representing 15.7% are in a deplorable condition.

The data above shows that only 26 of the buildings representing 37.1% have serious defects with their doors which could also mean that the other buildings with quite fair or fair doors could deteriorate themselves if the effects of rainstorm persist within the Study Area.

TABLE 5.14

Level of damages of walls

Option	Responses	% Response
Quite fair	25	35.7%
Fair	26	37.1%
Not fair	17	24.3%
Deplorable condition	2	29%
TOTAL	70	100%

Source; Field Survey 2003

The Table above showing the level of damages to walls shows that 25 buildings representing 35.7% are quite fair. 26 of the buildings representing 37.1% are fair. 17 buildings representing 24.3 are not fair, while 2 buildings are in a deplorable condition. This indicates that, 19 of the buildings representing 27.1% have walls that are affected as a result of rainstorm on walls. As other defects such as peeling of renderings or wetness of walls persist coupled with other agents of deterioration, the wall may collapse.

TABLE 5.15

Level of damages to gates

Option	Responses	% Response
Quite fair	12	54.6%
Fair	4	18.2%
Not fair	4	18.2%
Deplorable condition	2	9.0%
TOTAL	22	100%

Source; Field Survey 2003

The Table above shows the level of damages to gates, 12 of the buildings representing 54.6% are quite fair. 4 buildings representing 18.2% are fair, also 4 buildings representing 18.2% are not fair, while 2 of the buildings representing 9% are in a deplorable condition. This could mean that for now, only few of the building within the area are not in good condition, but the others that are fair may also deteriorate. Plate 1 shows a gate that rain has washed off the paint and is rusty.

TABLE 5.16

Level of damages to floors

Option	Responses	% Response
Quite fair	18	25.7%
Fair	22	31.4%
Not fair	28	40.0%
Deplorable condition	2	2.9%
TOTAL	70	100%

Source; Field Survey 2003

The Table above showing the level of damages to floors shows that 18 of the buildings representing 25.7% are quite fair. 22 buildings representing 31.45 are fair, 28 representing 40% are not fair and 2 of the buildings representing 2.9% are in a deplorable condition.

TABLE 5.17

Level of damages to paints

Option	Responses	% Response
Quite fair	4	7.1%
Fair	8	14.3%
Not fair	4	7.1%
Deplorable condition	40	71.5%
TOTAL	56	100%

Source; Field Survey 2003

The Table above shows the level of damages to paint surfaces, 4 of the buildings representing 7.1% are quite fair, 8 representing 14.3% are fair. 4 buildings representing 7.1% are not fair while 40 buildings representing 71.5% are in deplorable conditions. This indicates that 44 buildings representing 78.6% have paint surfaces affected by rainstorm. Most of the buildings within the Study Area have most of their paint surfaces deteriorated as a result of the effects of rainstorm. Plates 7,9,10 and 12 show the paint on the walls almost washed off as a result of rainstorm.

TABLE 5.18

Do you have trees planted around your buildings?

Option	Responses	% Response
Yes	45	63.3%
No	25	35.7%
TOTAL	70	100%

Source; Field Survey 2003

From the above Table, 45 buildings, representing 643% have trees planted around them, while 25 buildings representing 35.7% have no trees planted around them. This means that more buildings have trees planted around them, the trees might not be planted in the direction of the wind when rain is falling, compared to the orientation of the buildings. Plates 5 and 6 show the position of trees around the buildings but the effects of rain and wind is more on the exposed side without trees.

TABLE 5.19

How many trees do you have around your building?

Option (No.)	Responses	% Response
1-3	29	41.4%
3-6	2	2.9%
More than 6	14	20%
Without trees	25	35.7%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that29 buildings representing 41.4% have about 1 to 3 trees planted around them, 2 buildings representing 2,.9% have about 3-6 trees planted around them while 14 buildings representing 205 have more than 6 trees planted around them. The remaining 25 buildings have no trees planted around them. This explains why some of the buildings as a whole or partly are exposed to the direct effects of rain and wind.

TABLE 5.20

Who is responsible for repairing buildings within the Area?

Option	Responses	% Response
Personal	27	38.6%
Landlord	19	27.1%
Government	24	34.3%
TOTAL	70	100%

Source; Field Survey 2003

From the Table above, 27 of the buildings representing 38.6% are repaired personally by the occupants. 19 of the buildings representing 27.1% are repaired by the Landlord, while 24 representing 34.3% repairs is the responsibility of the Government.

Relating Table 5.7 to 5.17 with the above data indicates that the occupants of the buildings may not pay much attention to repair works on their buildings.

TABLE 5.21

How regular are repair works carried out on the buildings?

Option	Responses	% Response
When there is any problem	29	41.4%
Every 2 years	4	5.7%
Every 4 years	3	4.3%
Above 6 years	2	2.9%
Never since construction	32	45.7%
TOTAL	70	100%

Source; Field Survey 2003

The Table above shows that 29 out of respondents representing 41.4% said repair works are carried out when there is any problem. 4 respondents representing 5.75% said repair works are carried out every two years, 3 respondents representing 4.3% be execute repair work every 4 years, 2 respondents representing 2.95 carry out repair work every 6 years and above, while 32 respondents, representing 45.7% have never carried out any since construction.

Most of the buildings (32 in number) representing 457% have never received any repairs. This means that most of the buildings within the study area are left to deteriorate to a critical state before repair work is carried out on them. For example, plates 1,2,4 and 5 show serious deterioration of the buildings.

5.2 ANALYSIS OF RECONNAISANCE SURVEY DATA

1. Photographs

The pictures taken on the structural condition of buildings within Chanchaga reveals the effects of rainstorm (rain and wind) on buildings. The picture shows that wind-drive rain has caused wall surfaces to be damp, most especially during the rainy season. Also, rainstorms have washed off paint on walls, doors, windows and other painted surfaces as show on plate 1 to 12. The Survey also reveals that Fascia boards, ceiling boards and other timber materials are damped, resulting to the decay of some while others have completely decayed and fallen off as on plate 1and 2. The first floor of the storey building on plate 9 and 10 shows the effects of moisture penetration leading to paint surfaces being washed off.

The pictures on plate 1,2,5 and 6 show how wind has affected buildings by blowing off complete or part of the roofing sheets. The survey also shows that large stones, metals and Sand-Crete blocks are placed on roof tops most especially the fragile ones to prevent them from being blown off in the event of any rainstorms that may occur as show on plate7 and 8.

2. Site Observation Of Natural Features

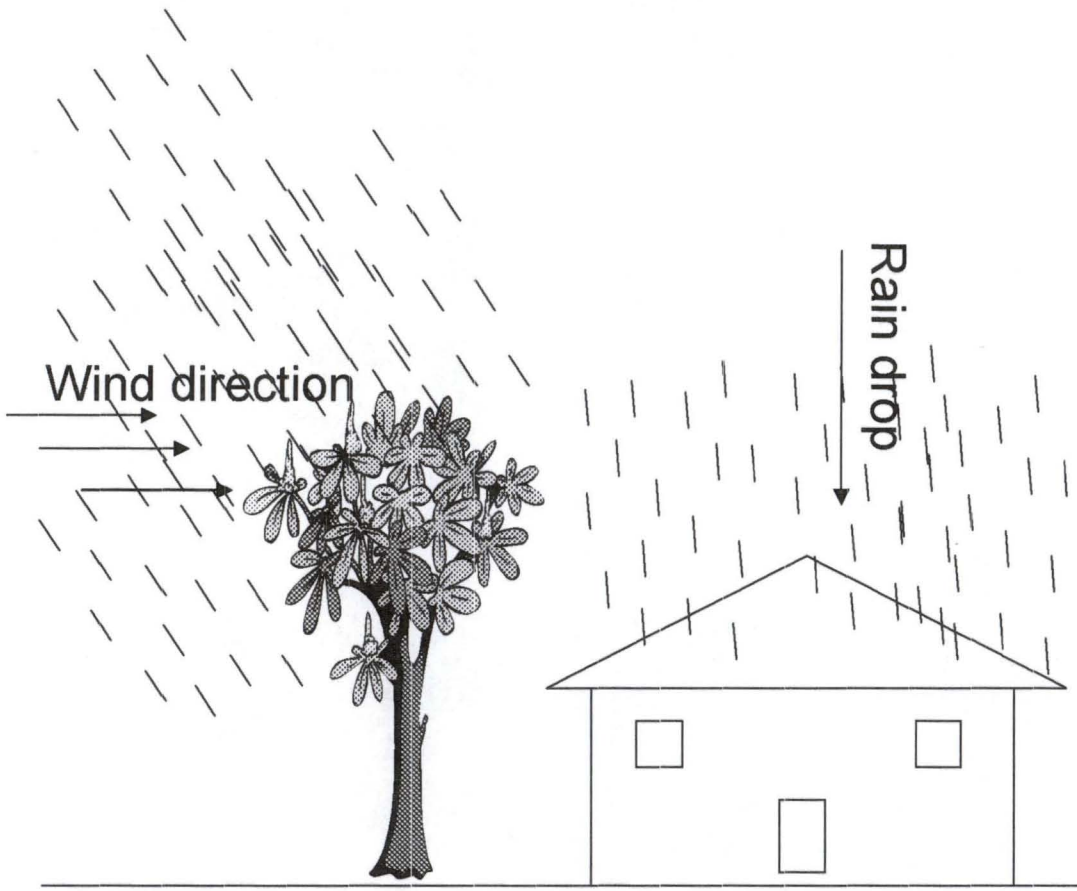
During the survey within Chanchaga, it was observed that most of the buildings have at least 1 to trees planted around them but these trees are not in the direction of wind.

Different exposure conditions within the same climatic zone, may result in varying severity of rain penetration and hence different effects upon durability of materials (Hawson and Yven 1992). The character of the local terrain may have some influences on the final orientation of a building (arrangement of the axis of a building) by the way in which

undulating ground, trees and adjacent buildings create shade and reduce or intensify the effects of the wind.

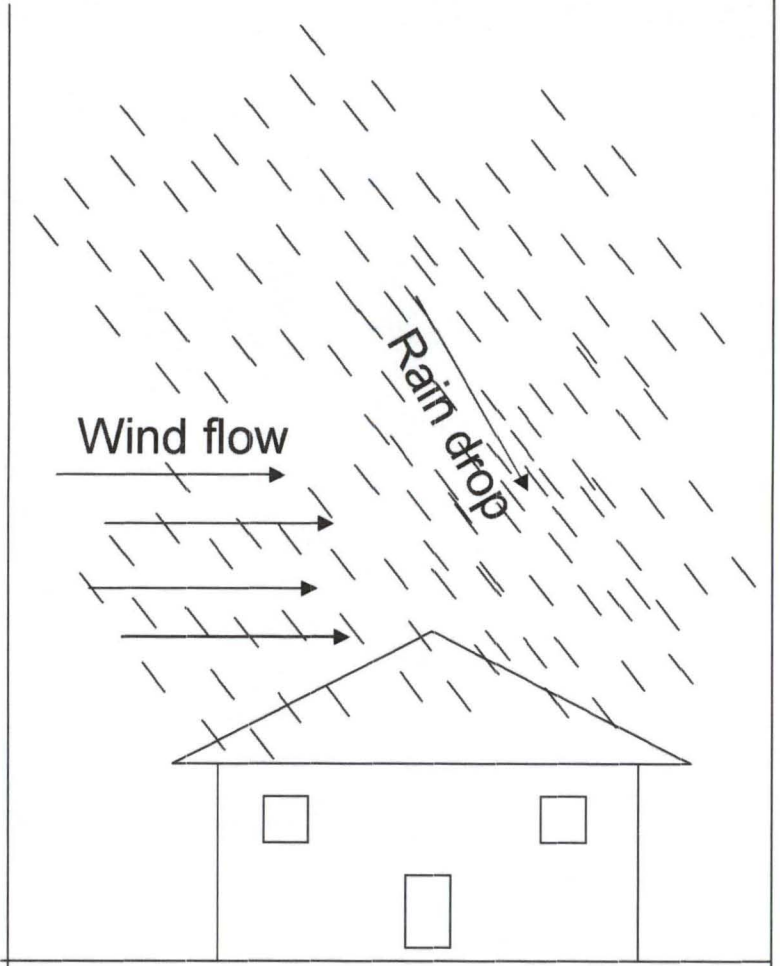
The roof should be the dominant element in houses within the Study Area to act as large umbrella to shade off rainstorm (Rain and wind). Large roof overhangs present an easy target for strong wind. Flat or low pitched roofs will experience a much greater uplift than the more steeply pitched roofs (Kelechi 2000).

High pitched roofs will be very suitable for Chanchaga buildings. From the illustration below, because of the trees planted at the direction of the wind in house A, the effects of rainstorms will be reduced to some extent on the buildings. Because the trees break the wind flow so that rain droplets do not strike the buildings directly also in house A, the trees reduce the speed and pressure of wind that may try to lift the roofing sheets off the buildings. While on the other hand, house B will be affected seriously by the rainstorm because there are no trees to break or reduce the speed and pressure of wind. So the building surfaces will receive more raindrop strikes that will damage the rendering materials e.g. paint, dampen Fascia boards, ceiling boards and walls. The wind speed can result in the lifting off of the roofing sheets.



A

Fig. 5.1 shows that the tree act as a wind breaker to the wind direction.



B

Fig.5.2 shows the effect of wind on rain drop

Plate 1: The effect of rainstorm on a house; Wind has blown off Part of the roof, discoloured paint surface, corroded metal gate, roofing timber, fasica, board and ceiling board decayed due to moisture.

Source: Field Survey

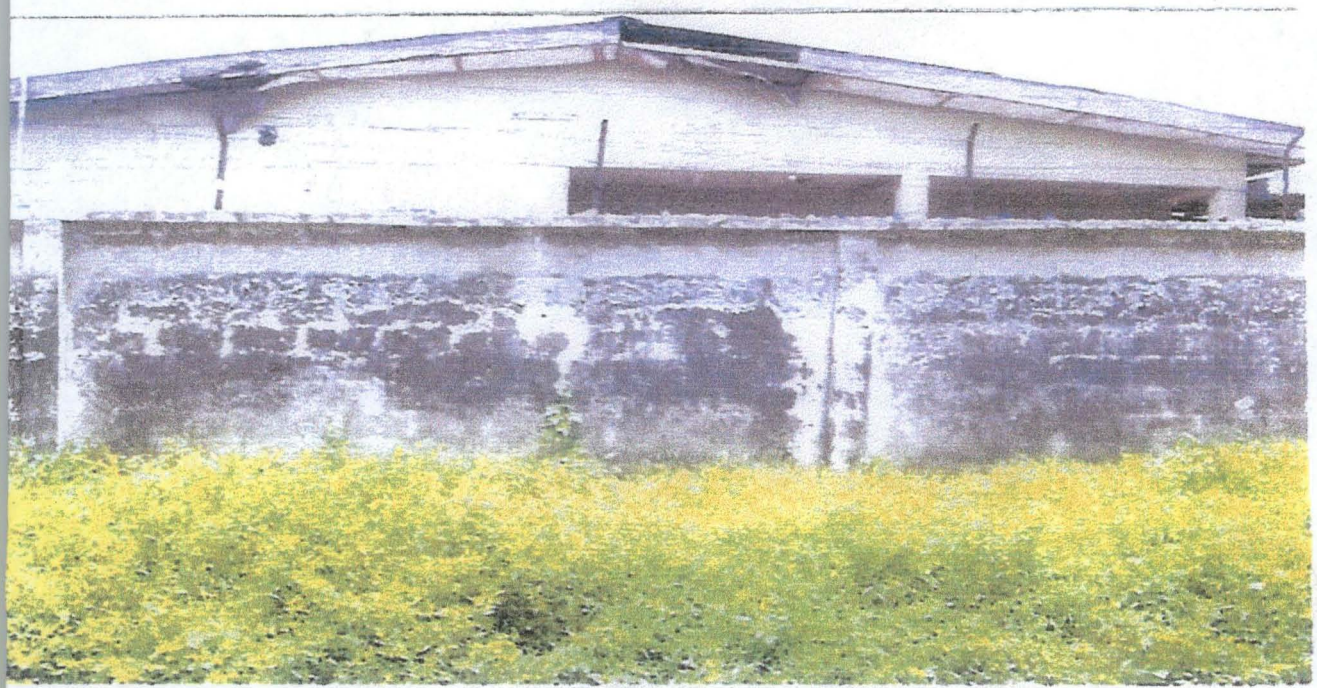


Plate 2: *Shows the effect of rain on wall surface resulting to discoloured* paint wall, rendering flaked exposing the blocks with part of fascia board and ceiling decayed and falling off.

Source: Field Survey

Plate 3: *Shows discolouration of painted wall, peeled off rendered surface and weak edges of roofing sheets, due to the effect of rain and wind within chanchaga town.*

Source:. Field Survey

Plate 4: Shows the effect of rain which have wash off the paint and peel of the rendering exposing the mud and sandcrete block in Chanchaga town.

Sourve: Field Survey

Plate 5: Shows the effect of wind blowing off roofing sheet of *classroom block in Government Technical College* Minna in Chanchaga town.

Source: Field Survey

Plate 6: The effect of rain washing away the paint on wall and Wind blowing off part of the roofing sheet. Also part of Fascia board and ceiling board completely falling off in G.T.C. Minna.

Source: Field Survey

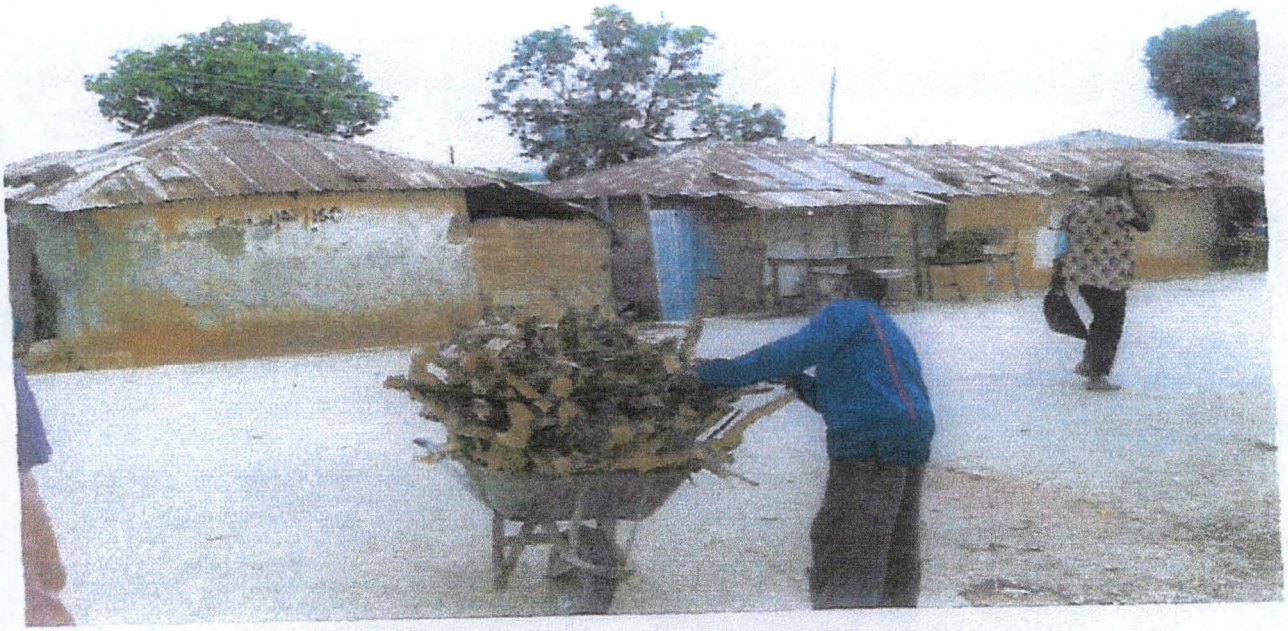


Plate 7: Shows large stone and block placed on roof top to prevent roofing sheet from been blown off by wind. Also shown the effect of rain on wall discolouring and flaking the rendered wall

Source: Field Survey

Plate 8: Shows buildings with large stone and block laid on the roofing sheets to prevent lifting in the event of rainstorm within Chanchaga town.

Source: Field Survey

Plate 9: Shows the effect of rain on a storey building washing of the paint and damp penetration at the top part of wall surface.

Source: Field Survey

Plate 10: Shows a storey building affected by rainstorm causing discolouration *of the wall at the first floor of the building and underground moisture* at the ground floor in Chanchaga town.

Source: Field Survey

Plate 11: Shows the effect of rain on wall surface washing off the paint on a workshop block in G.T.C. Minna in Chanchaga town.

Source: Field Survey

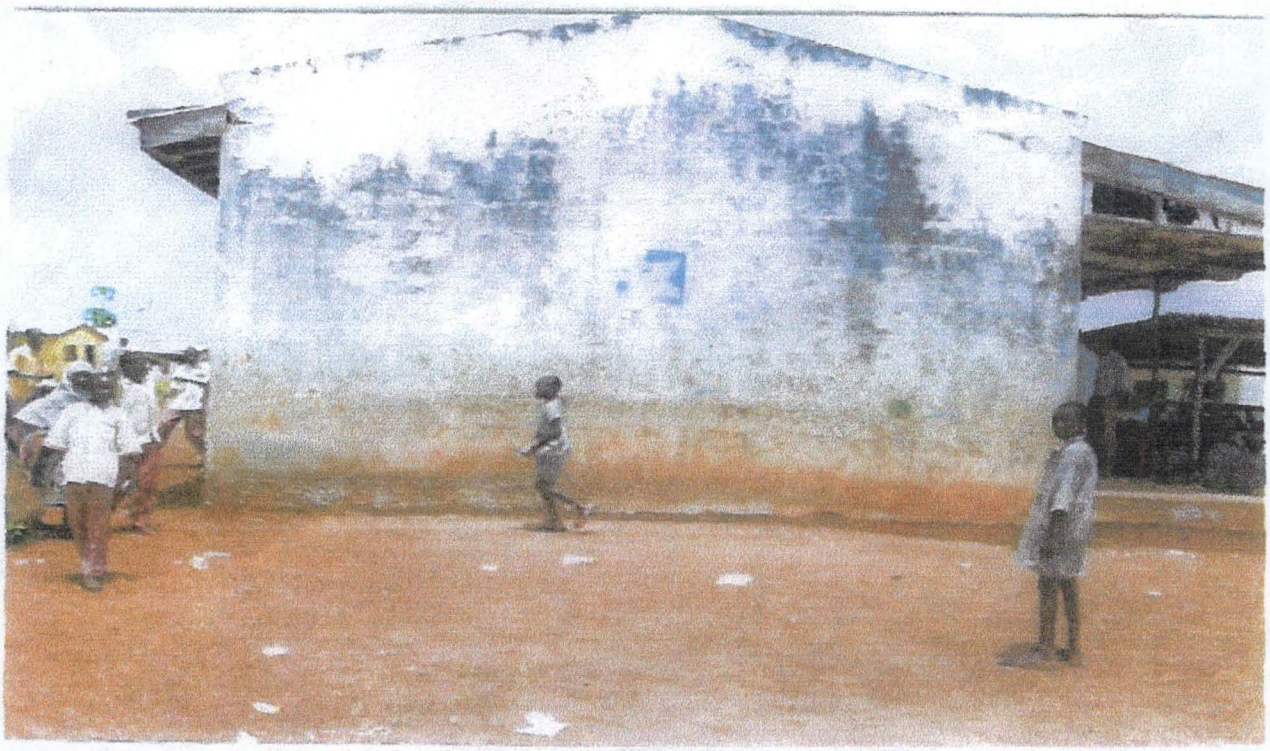


Plate 12: Shows the wall of a Primary School in Chanchaga with washed off paint surface, flaked rendered wall and damped fascia board with decayed ceiling board.

Source: Field Survey

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY

This Study was centred on the effects of rainstorms on buildings using Chanchaga town, the Head-quarter of the newly created Minna West Local Government Area in Niger State as case. Chanchaga lies below 300 metres in the low-land area of the guinea savannah region of Nigeria. The Area is interspaced with hilly land forms, Chanchaga vegetation cover is made up of tall grasses and trees. The Area is located on a sandy-loamy soil.

The climatic condition of Chanchaga is characterised by hot and humid dry seasons, which occur between November to March/April with maximum temperature of about 24^0-27^0 C and humidity of about 50% to 60% throughout the year. The wet season commences from April/May to October with a relatively high annual rainfall of about 100-120 cm concentrated in the month of July, August and September respectively. The mean daily maximum temperature is 32^0C.

The rainy season commences with strong winds and also towards the end of the season. This has had serious consequences on the buildings within the Study Area. Such consequences include; blown off roof tops, washed off paint surfaces, peeled or flake rendered walls, damped and decayed Fascia boards, ceiling boards and products of timber used on the external surfaces of the buildings, also, metal materials used for the construction of the buildings are corroded. These have to a large extent contributed to the deterioration of not only the buildings but also the environment as a whole. Deteriorated buildings are environmental hazards. Lack of maintenance

culture, landscaping, building orientation, were observed as other factors that intensify the effects of rainstorms on buildings within the Area.

6.2 CONCLUSION

In conclusion, since the impacts of rainstorms in buildings are multi dimensional, it requires both direct and indirect measures to proffering solutions. Various weather control techniques are already in application, such techniques like tree planting, good building orientation, landscaping e.t.c. require an in-depth knowledge of the prevailing climatic condition and ways they relate with buildings that are affected by rainstorms.

From the survey carried out by the Researcher through the questionnaires and reconnaissance survey, the common problem experienced by buildings in Chanchaga town is centred on deterioration due to rain and wind. Rain is probably also the agent with the greatest influence on the properties of materials, in many cases moisture is a prerequisite for physical, chemical or biological reaction to take place (Howson and Yven).

Further more, wind can cause dampness by driving moisture into or through building fabrics leading to deterioration. For example, rain, especially when driven by strong winds can erode and dissolve certain soft materials like paint, cement mortar of rendered wall e.t.c. Therefore, various weather techniques already in application can take care of the rainstorms variable adequately since rainstorm itself cannot be controlled.

6.3 RECOMMENDATIONS

Having researched into the effects of rainstorms (wind and rain) using Chanchaga as a case study, I hereby make the following recommendations:-

1. That weather control measures such as landscaping, tree planting and good orientation of buildings can be incorporated into the existing buildings with defects in Chanchaga. This will help to achieve optimum performance of the buildings.

2. The Chanchaga community should be educated on the important of planning trees around their buildings. The trees should be planted considering the prevailing wind direction in relation to the buildings. The trees should not be too close to the buildings because if trees are too close, raindrops from the buildings can dampen the building materials close to them. The leaves that fall on the roof top can cause corrosion of the roofing sheets.

3. The planning authority in Chanchaga should ensure strict compliance of all building regulations as regard to design plans. Apart from functional and aesthetic requirements, designs should take into consideration environmental factors arising from above ground conditions and below ground conditions. For example, weather conditions such as rainfall, wind, temperature and atmospheric humidity of the proposed site of buildings.

4. Materials selected for buildings within Chanchaga should be governed by the prevailing climate condition, e.g. their ability to withstand the effects of the climate-rain and wind, their reactions with materials e.t.c.

5. Building owners, Government, and tenants should be educated and encouraged to carry out regular maintenance/repair work to reduce these defects on buildings as a result of rainstorms so that we will have environmental-friendly buildings.

6. Deforestation should be checked within Chanchaga most especially when new buildings or roads are constructed. Only trees within the area that will be constructed should be cut down.

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APPENDIX 1

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

DEPARTMENT OF GEOGRAPHY

POST GRADUATE DIPLOMA IN ENVIRONMENTAL MANAGEMENT

QUESTIONNAIRE

ASSESSING THE EFFECT OF RAINSTORM ON BUILDINGS WITHIN CHANCHAGA AREA IN NIGER STATE

SECTION A

DESCRIPTION OF BUILDING

1. Building/house number.....
2. Type of construction.....(A) Traditional (B) Conventional
3. Type of Building.....(A) School (B) Residential
4. Type of residential building.....(A) single-bedroom apartment (B) double-bedroom apartment (C) Self-contained apartment
5. Type of material used for block work.....(A) Brick block (B) Sand Crete hollow block (C) mud block
6. Ownership of the building.....(A) Personal (B) Rent (C) Government property

SECTION B

STRUCTURAL CONDITION OF THE BUILDING

1. When was the building constructed? (A) 1-5 years (B) 5-10 years (C) Above 10 years
2. Is your building affected by rainstorm (Rain and Wind)? (A) YES (B) NO
3. Which external part of the building is having problem because of rain and wind?

.....

4. What is the level of damage on the external area of the building as a result of rain and wind? .....

Defect/problem	Quite fair	Fair	Not fair	Deplorable condition
a) Rendering/plaster	☐	☐	☐	☐
b) Roofing sheets				
c) Roofing timbers				
d) Fascia board	☐	☐	☐	☐
e) Ceiling board	☐	☐	☐	☐
f) Windows and frames (timber/metal)	☐	☐	☐	☐
g) Doors and frames (timber/metal)	☐	☐	☐	☐
h) Gates (timber/metal)				
i) Wet Wall (block)	☐	☐	☐	☐
j) Floors	☐	☐	☐	☐
k) Paint	☐	☐	☐	☐

SECTION C

OTHER RELEVANT QUESTIONS

1. Do you have trees planted around your buildings? (A) YES (B) NO
2. If YES how many? (A) 1-3 (B) 3-6 (C) 6 and above
3. If the building is your personal property where there trees on the land before the building was constructed? (A) YES (B) NO
4. What happened to the trees? .....

   .....
5. Are you aware that the trees around your buildings can protect the buildings from the direct effects of rain and wind? .....

   .....
6. Who is responsible for repairing the building when there is a problem? .....

   (A) Personal (B) Landlord (C) Government
7. How regular is repair work carried out on the building? .....

   (A) when there is any problem (B) every 2 years (C) every 4 years (D) every 6 years and above (E) Never since construction