# EFFECTIVENESS OF DRAINAGE NETWORKS ON FLOODS IN CALABAR METROPOLIS, NIGERIA

**BY**

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## DECLARATION

I declare that the work in the thesis titled "Effectiveness of drainage network on floods in Calabar metropolis, Nigeria" has been performed by me in the department of Geography under the supervisions of Dr. Joseph O. Folorunsho and Dr. Yusuf Y. Obadaki.

The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

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## CERTIFICATION

The thesis titled "Effectiveness of drainage network on floods in Calabar metropolis, Nigeria" by NDOMA, emmanual efobe meets the regulations governing the Award of Master's Degree of Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

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## DEDICATION

This work is dedicated to almighty God for sustaining me this far and to my loving father Hon Samuel Efobe Ndoma and Mother Mrs. Elizabeth Alo Ndoma who ensured I had the best of education.

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## ABSTRACT

*The study examined the effects of drainage networks on floods in Calabar metropolis, Nigeria. The rapid increase in urbanization without corresponding infrastructures in the city of Calabar has led to increased incidences of flood as the available drainage channels cannot contend with the volume of storm water. In view of this, the study established gauging stations for the measurement of drainage run off using measuring steel tape. And the volume of flood water was measured using stop watch method (Velocity of flow) and copies of questionnaire were administered to 400 households proportionally to the seven sample units. In view of the study objectives, it determine the relationship between drainage width and depth and floods. In addition, varied descriptive statistics tools were used to give a spot on assessment and understanding of the variables of interest. In view of the response of the gauging and physical measurement, it was established that Calabar experience heavy rainfall due to poor drainage facilities The result revealed that about 47% of the respondents said flood occur every year in their zone and 41.75% said it occurred most parts of the year. The frequency of flood is compounded with it's intensity as over 59% of the sampled population agreed that flood of the sampled population agreed that flood intensity is very high in Calabar. The result further showed that the factors of flood occurrence in the study area is linked to heavy rainfall (26.3%), inadequate drainage channel (22%) poor physical planning (15.5%) among others. On the perceived causes of inadequate drainage channel, the result indicated that abuse of land use plans (28.7%) was a major factor followed by poor monitoring and evaluation of project (21.5%). the study also revealed that the drainage were very narrow and shallows as shown in frequent floods in the city. The incessant flood often leads to water inundating compounds (64.5%), preventing people from going out (11.25%), distortion of the scenic beauty of the environment (6.25%), landslide (4.75%). Based on these findings, the study recommended that since Calabar is located in a tropical zone characterized by heavy rainfall the government should take proactive measure to mitigate storm water. The present drainage systems should be cleared with shovel by the people on a regular basis to allow for a free flow of storm water. State department of town planning should live up to their bidding by ensuring total compliance to urban ordinance to forestall incessant floods and destruction of properties in the city of Calabar.*

## TABLE OF CONTENT

## LIST OF TABLES

**Table** **page**

## LIST OF FIGURE

**Figure** **page**

## LIST OF PLATE

**Plate** **page**

# CHAPTER ONE: INTRODUCTION

## 1.1 BACKGROUND TO THE STUDY

Cities the world over are the dominating forces in the organization of human population. As the world most crowded places, cities continue to show increase in urban population. This increase leads to a growing urbanization trend. Duru and Nnaji (2008) defined urbanization as the increase in the population of cities in proportion to the region's rural population. Urbanization is the outcome of social, economic and political developments that lead to concentration and growth of large cities, changes in land use and transformation from rural to metropolitan pattern of organization and governance. Rapid growth of towns and cities has been common feature of the developing world (Aderamo, 2008).

Although urbanization is the driving force for modernization, economic growth and development, there is increasing concern about the effects of expanding cities, principally on human health, livelihoods and the environment. The implications of rapid urbanization and demographic trends for employment, food security, water supply, shelter and sanitation, especially the disposal of wastes (solid and liquid) that the cities produce are staggering (United Nations Conference on Environment and Development, 1992). The process of urbanization is believed to be connected with levels of development and some assert that, for a country to develop there is the need for an increased level of industrialization as it is generally accepted that there cannot be urbanization without rapid economic growth (Tettey, 2005). The pattern of urbanization in developing countries, particularly Africa, however, is creating some concern that it may be generating a lot of development problems in the process of its growth.

One of the daunting challenges facing African countries in the wake of unprecedented urbanization during the last few decades is the planning and management of physical

infrastructure and the urban environment. As urbanization gathered pace in most developing countries, the problem of inadequacy of infrastructure services and deteriorating urban environment became enormous (Sule, 2009). These problems range from poor housing conditions, inadequate infrastructure, to squatter settlements (Arimah, 2002).

Spurred by the oil boom prosperity of the 1970s and the massive improvements in roads and the availability of vehicles, Nigeria since independence has become an increasingly urbanized and urban-oriented society. During the 1970s, Nigeria had possibly the fastest urbanization growth rate in the world (Sule, 2009). Because of the great influx of people into urban areas, the growth rate of urban population in Nigeria in 1986 was estimated to be close to 6 percent per year, more than twice that of the rural population. Specifically, while only 7% of Nigerians lived in urban centers in the 1930s, and 10% in 1950, by 1970, 1980 and 1990, 20%, 27% and 35% respectively lived in the cities (Okupe, 2002). Over 40% of Nigerians now live in urban centers of varying sizes. Like other developing countries, the rapid growth in urban areas in Nigeria is a 'sword of two edges' (Sule, 2009). While increasing human capital increased the economic status of the country, the growths of large centers had outpaced government capacity to meet the increasing demand for the provision of basic infrastructural facilities and services. These are manifested in poor investment in roads, housing, water supply, electricity, waste disposal mechanisms, adequate drainage systems etc. (Sule, 2007; Aderamo, 2008; Jimoh, 2008). These problems have continued to persist and made worst due to non-compliance to planning ordinances (Sule, 2010). Appropriate management of drainage systems requires knowledge relating to the system boundary, system resources, interactions between adjacent systems and allowable limits, or thresholds, for each resource. Each of these elements will be unique to the particular system under consideration, and each system must be assessed on its own merits.

Flooding has been identified as one of the major factors that prevent Nigeria growing population of city dwellers from escaping poverty and stands in the way of United Nations goal of achieving significant improvement in the lives of urban slum dwellers by 2020 (Action Aid, 2006)

Nigerian coastal cities are daily inundated with flood waters, and millions of properties have been destroyed and lives lost (Eze, 2008). Poor drainage systems are often associated with street flooding, and this has become critical environmental problems in coastal cities of Nigeria such as Lagos, Port Harcourt, Ondo, Warri, Uyo, and Calabar (Eze, 2008). These towns which are quite close to the Atlantic Ocean experience heavy flooding especially during the rainy season. However, it is not waters from the Ocean that usually floods these cities but the heavy rains, and the low nature of the topography and the poor drainage networks. Aderamo (2008) listed land use problems, increased paved surfaces, river channel encroachments, poor waste disposal techniques, physical development control problems, gaps in basic hydrological data and cultural problems as major causes of street flooding in Nigerian cities.

## 1.2 STATEMENT OF THE RESEARCH PROBLEM

Worldwide, there has been a rapid growth in the number of people killed or seriously impacted by storms and floods and also in the amount of economic damage caused; a large and growing proportion of these impacts are in urban areas in low- and middle-income nations. For instance, in Nigeria, flooding affected more than three million people in selected urban areas between 1983 and 2009 (Environmental Management Disaster Database). Poor urban infrastructural development and planning is likely to have been a factor in much of this, but even if it was not, it is proof of the vulnerability of urban populations to floods and storms whose frequency and intensity is likely to increase in most places.

Henderson (2004) revealed that the level of risk and vulnerability in urban areas of developing countries is attributable to socio-economic stress, aging and inadequate physical infrastructure. Indeed, according to Satterthwaite, Mark, Saleemul, Reid and Romero (2007), hundreds of millions of urban dwellers have no all-weather roads, no piped water supplies, no drains and no electricity supplies; they live in poor quality homes on illegally occupied or sub-divided land, which inhibits any investment in more resilient buildings and often prevents infrastructure and service provision. A high proportion of this are tenants, with very limited capacities to pay for quality housing – and their landlords have no incentive to invest in better-quality buildings. Most low-income urban dwellers face serious constraints in any possibility of moving to less dangerous sites, because of their need to be close to income-earning opportunities and because of the lack of alternative, well-located, safer sites.

Douglas *et al* (2008) also report that many of the urban poor in Africa face growing problems of severe flooding; they further buttressed the fact that increased storm frequency and intensity related to climate change are exacerbated by such local factors as the growing occupation of flood plains, increased runoff from hard surfaces, inadequate waste management and silted up drainage.

Askew (1999) reiterated that floods cause about one third of all deaths, one third of all injuries and one third of all damage from natural disasters globally. Generally, flood events are attributed to global warming, climate change, ocean swell/surge and torrential rains. Although flood hazards are natural phenomena, damage and lose from floods are mostly the consequences of urbanization without corresponding infrastructural restructuring (Brooks, 2003).

Flooding is the most common environmental hazard in Nigeria (Etuonovbe, 2011). Flood disaster is not an ancient phenomenon in the country, and its destructive tendencies are sometimes enormous. Reports have it that serious flood disasters have occurred in Ibadan (1985, 1987 and 1990), Osogbo (1992, 1996, 2002), Yobe (2000) and Akure (1996, 2000, 2002, 2004 and 2006); the coastal cities of Lagos, Port Harcourt, Calabar, Uyo, Warri among others have severally experienced incidences that have claimed many lives and properties worth millions of dollars (Olajuyigbe, Rotowa and Durojaye, 2012).

The intensity of flood problems over time and space in Nigeria urban centers is closely related to the rapid rate of urban expansion especially where the simultaneous provision of adequate run-off disposal systems are lacking as is the case of most Nigerian cities (Abaje and Giwa, 2008).The implications of recent flooding in Nigerian cities include, among others, loss of life and properties, spread of diseases, deformed livelihoods, assets and infrastructure (Adedeji, Bashir, Bongwa and Oladesu, 2012).

Eze (2008) using both questionnaire and secondary data in the analysis of the history and causes of flood incidence in the city of Calabar opined that no year passes without flooding in the city claiming lives and properties; on the average four lives were lost yearly to flooding. Eze attributed flood occurrence to expansion of residential areas and the multiplications of paved surfaces including roads and sidewalks. Offiong and Eni (2007) using both conventional questionnaire and secondary data corroborated these claim by observing that the damage to materials is quantified to be well over 115.76 million naira per year. The main factors of flooding in the city of Calabar in the view of Ofiong and Eni, are increasing demand for concrete surfaces for buildings which has increased surface runoff, and waste waters that have increased the volume of water in rivers, streams and drainage channels.

Afangideh, Ekpe and Offiong (2012) examined the implication of changing rainfall pattern on building loss in Calabar. Rainfall data for the study were collected from the Nigerian Meteorological Agency (NIMET) and Margaret Ekpo International Airport, Calabar. While data on cost of building loss to flood for the previous 20 years were gotten from the inhabitants of the flood prone areas in Calabar. The result from their study revealed that annual rainfall intensity with beta coefficient of 0.437 has more implication on cost of building loss to rainfall in Calabar than annual rainfall duration, with beta coefficient of -0.063.

Flooding in urban areas is not just related to heavy rainfall and extreme climatic events; it is also related to changes in the built-up areas themselves. In the case of Calabar, the problems of street flooding began when some socio economic and anthropogenic activities gained momentum as a means of face lifting the city as State Capital. The influx of people from both rural and adjoining states led to increased demand for housing. Houses were hurriedly built to meet the burgeoning demand for shelter. This alters the aesthetic image of the city as buildings were erected anyhow and anywhere (Sule, 2004), which degenerated into the 'ugly face of Canaan city' (Iquot, 1982). Today in spite of the fact that Calabar is acclaimed to be one of the cleanest cities in Nigeria, the menace of flooding has more than double.

However, none of these studies measured the dimensions of drainages and their role in flood events as majority of reviewed studies only mentioned poor drainage system as a factor of flood events in Nigeria. This is the gap the research intends to fill. It is against this background that this research intends to answer the following questions:

i. What is the frequency and intensity of floods in Calabar?
ii. What is the spatial distribution and intensity of drainage networks in Calabar metropolis

iii. What is the effect of drainage width and depth on flood in Calabar?

iv. What is the environmental state of drainage network in the metropolitan city of Calabar?

## 1.3 AIM AND OBJECTIVES

The aim of the study is to assess the drainage network in relation to flood occurrences in Calabar. Specifically, the objectives of the study are to:

i. examine the intensity and frequency of floods in Calabar

ii. evaluate the geometry of selected drainage channels in Calabar

iii. determine the relationship between drainage width and depth and floods

iv. assess the drainage system in Calabar

## 1.4 SCOPE AND DELIMITATION

This study was restricted to selected areas of Calabar Metropolis that are prone to flood occurrence and one area with relatively little or no flooding and it assessed the capability of drainage networks to effectively handle run off volume in the area. The study was conducted in seven purposedly selected locations which include the Cross River University of Technology (CRUTECH) staff quarters, Akim Quo, Ediba, Yellow Duke, MCC Road, Esuk Utan Junctions and satellite town as the control. These locations are selected because they have a history of frequent floods especially during the rainy seasons. In addition, flood prone areas are largely characterized by poor planning as compared to the control. The control (Satellite town) could be said to be an area of both high and medium income earners. In this zone, squatter structures are not common. The study covered duration of six (6) month, that is between March to September, 2014 which falls within the rainy season in Calabar (Offiong and Eni, 2007).

## 1.5 JUSTIFICATION OF THE STUDY

Flooding has been identified as one of the major factors that prevents Africa's growing population of city dwellers from escaping poverty and stands in the way of United Nations 2020 goal of achieving significant improvement in the lives of urban slum dwellers (Action Aid, 2006). This is because many African cities lack the infrastructures to withstand extreme weather conditions. Poor urban planning together with other urban governance challenges contribute to making African urban slum dwellers most at risk.

In Nigeria for instance studies have been conducted to establish the relationship between urbanization and flooding. Many of these studies emphasized the implications of flooding on the environment and socio economic wellbeing of affected cities and the population. Offiong and Eni, (2007) concluded in their study on the effects of urban floods on infrastructure in Calabar that rainfall duration was the major determinant of runoff volume which leads to drainage infrastructure destruction in the city. Researches of Ahern, Few, Kovats and Matthies (2004); Abaje and Giwa (2007); Ladan (2007); Offiong *et.al*, (2008); and Eze (2008) summarise that the twin factors of poor urban planning and increased paved surfaces are the main causal factors that increase the frequencies of floods in Nigeria.

# CHAPTER TWO: CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

## 2.1 CONCEPTUAL FRAMEWORK

This study employed the concepts of sustainable urban development and that of General System theory to analyze drainage networks and floods events in Calabar metropolis. The concept of sustainable development is employed to emphasize that it is as a result of unsustainable development that floods are common in our urban centers. Inherent in this concept is the need to imbibe development controls while the general system theory is employed to underscore urban connectivity. It is only when development practitioners see master plan as a mesh of connectivity that the problems of inadequate drainages and flood occurrences associated with it can either be stopped or reduced in urban centers.

### 2.1.1 SUSTAINABLE CITY DEVELOPMENT CONCEPT

Successful national economies depend on well-functioning and resilient urban centers. Urgent action is needed now both to address urban centers current vulnerabilities to extreme weather and to build into expanding urban centers protection from likely future changes (Satterthwaite *et al,* 2007). The quality of the urban space is vital to sustainable livelihood; it is important to understand the relationship between sustainable development and flood occurrence especially in an expanding city like Calabar. The concept of sustainable urban development was advanced to help cities cope with increasing environmental challenges.

The concept of sustainability was coined in 1972 at the United Nations Conference on the Human Environment in Stockholm. It means that sustainable development is a kind of development that considers supplying todays need without decreasing posterity ability to supply their needs. In fact, sustainable development and management is development that considers

creating, maintaining and increasing life quality of all human kinds in all periods of time (Mannion, 2002).

After the United Nations 2005 World Summit Outcome Document refers to the "interdependent and mutually reinforcing pillars" sustainable development is considered as economic development, social development, and environmental protection (Zhangh, Zhangh, and Yongzhi 2011). As the rapid growth of world population and its concentration in cities around the globe takes place, sustainable urban development has constituted a crucial element affecting the long-term outlook of humanity.

In order to achieve sustainable urbanization, cities need to develop social and economic structures without damaging the environment, and achieve a balance between the human inhabitants and the natural resources (Abu-Ghazalah, 2008). However, urban areas are complex and are constantly changing. Many cities in the developing countries have older forms of planning, and are surrounded by large informal settlements or slums (UN- Habitat, 2009). This is the case in Calabar where most of the traditional houses are without adequate drainages to contend with the volume of storm waters.

A more disturbing issue is the lack of attention to the promotion of sustainable environmental management especially in disaster prone areas resulting in devastations which could have been averted. Sustainable urban planning should avoid harm before the need for mitigation measures. The provision of green infrastructure should be an integral part of the creation of sustainable cities throughout Nigerian towns and cities. Surface water drainage methods that take account of quantity, quality and amenity issues are collectively referred to as Sustainable Urban Drainage Systems (Jimoh, 2008). These systems are more sustainable than

conventional drainage methods because they: Manage runoff flow rates, reducing the impact of urbanization on flooding protect or enhance water quality.

Sustainable urban drainage systems are now a requirement in all but the very smallest of new developments and are a key method of ensuring that existing flooding problems within the area are not made worse. The planning system should take the possible impacts of climate change, for example greater rainfall and increased risk of flooding, into account when taking decisions on the locations of new development and other changes in land use (Aderamo, 2008).

The concept of sustainable urban development calls for effective and efficient planning of urban space. Physical planning involves the reconciliation of land uses, provision of the right site for the right use, control of development, provision of facilities, services and public goods, preservation, protection and conservation of resources, preservation of heritage among others (Oduwaye, 2009). It ensures compatible land uses, guarantees orderly development and provides functional and visually pleasing environment and satisfactory services in a sustainable manner.

It is only when development controls are put in place that sustainable urban development can be achieved. Olajuyigbe *et al* (2012) recognized this fact when they stated that physical planning established the 'ground rules' for sustainable development as it ensures that developments are carried out without harming the environment. Again, the process ensures that such developments are socially just. According to Oyesiku (1997), effective urban land control and management particularly in areas with rapid urban sprawl is crucial to tackling growing land use problems such as slum formation, rising costs of land, accessibility to urban land for housing, incompatible use, flooding, overcrowding and congestion among others purpose of achieving sustainable city development and ensure the safety and health of the people. The forms and patterns of distribution of structures in general to promote the good health, accessibility,

convenience and harmonious land use in environment are a function, to a considerable extent, of the rights and methods of dealing with land. Central to this rights and method of dealing with land is sustainable urban development.

Recurring floods and other disasters are serious threat to sustainable development. The impact can be very high in the urban areas, because the areas affected are densely populated and contain vital infrastructure. A more disturbing issue is the lack of attention to the promotion of sustainable environmental management especially in disaster prone areas resulting in devastations averted.

In addition, it is the poor people that are more vulnerable to disasters. Continuous and increasing occurrence of devastating disaster events such as urban flooding often poses substantive danger to the achievement of both sustainable development and poverty-reduction initiatives (UN habitat, 2009).

More so, the concept of sustainable urban development emphasized the need for integrated approach in management plans. According to the World Meteorological Organization (2008), integrated flood management (IFM) within the overall integrated water resources management promotes an integrated and holistic-rather than fragmented –approach to flood management.

The concept endorses the combination of policy, regulatory, financial and physical measures. These are the pillars of Sustainable urban development. It also requires adequate planning and control to ensure harmonious development and functional land uses and settlements. To achieve this fundamental and acceptable activity, layouts of various land uses such as residential, commercial. Industrial, open spaces and recreation, circulation and institutional uses among others and adequate drainages are undertaken to standardize and control

physical developments and ensure harmonious growth (Sule, 2009). To ensure adequate provision of these use and meet the needs of users of urban facilities and services land allocation and space standards should be specified in all master plans. In addition, as the population of cities becomes more urbanized and cities grow, urban planning becomes more critical (Sule, 2007).

### 2.1.2 The General System Theory

Conceptually, the Von Ludwig Bettalanffy's (1971) General System Theory provides an appropriate framework for comparing the mutual interdependence of land policies, sustainable development and integrated land use management systems. The centripetal nature of the growth of cities creates intense pressure on the economic and spatial structure of urban system which includes service facilities comprising hospitals, educational institutions, housing, transport, telecommunication systems, drainage network systems and energy supply (Ratclif, 1993). Since the provision of these facilities tend to be at rate slower than that of the growth of the urban population in developing countries, a wide margin between the demand and supply of urban infrastructural facilities and services is created (Olayiwola, 2006)

Appropriate management of drainage systems requires knowledge relating to the system boundary, system resources, interactions between adjacent systems and allowable limits, or thresholds, for each resource. Each of these elements will be unique to the particular system under consideration, and each system must be assessed on its own merits.

However, this often is not the case in our urban centers. What obtains is the haphazard and mono-directional treatment of urban development. This nonconformity to the systems approach in urban planning and development is major factor accounting for recurrent flood disasters in towns and cities of Nigeria.

In many developing countries, effective and efficient land use planning and management is not well established. The most patent manifestation of this is the chaotic state of land use systems in the cities. Rapid rates of urbanization have resulted in unplanned and unregulated growth on land. Significantly, the acquisition and development of land is the basis of physical growth (Agboola, 2002). The development control process is subject to plans, regulations and laws. The manifestation of ineffectiveness of the control processes in cities derives to a large extent from the planning, the regulatory and administrative frameworks within which physical development takes place (Sule, 2010).

Nigerian cities are reputed to be the dirtiest, most unsanitary, least aesthetically pleasing and dangerously unsafe for living (Agboola, 2002). They are characterized by non-functioning infrastructure facilities, most poorly governed, intensively dotted with illegal structures while physical growth and development of the cities had not been properly managed or controlled (Askew 1999). In brevity, Nigerian cities are developed without recourse to order especially the observed disconnect between population growth and infrastructural provision.

Urban infrastructure can be generally defined as the set of interconnected structural elements that provide framework supporting an entire structure of development, it consist of basic physical and organizational structures needed for the operation of a society or enterprise that provides services essential to enable, sustain, or enhance societal living conditions (Brooks, 2003; IPCC, 2007).

Consequently, local policies on development should no longer be viewed in their isolationist context, but within the broader framework of constraints and opportunities afforded by the 21st century information technology. As a common factor and denominator in the framing and execution of urban social and economic policies of nations, Ratclif (1993), was of the view

that the allocation, use and management of land should be done to guarantee access and equity, which the Land Use Act (1978), aimed to achieve in Nigeria.

Irrespective of the varying attributes of land, it is imperative that policies be directed towards urban land development to provide the cross-cutting for streamlining and aligning all the countervailing forces affecting its disbursement and management (Raticlif, 1993). From the planning perspective, land represents a mosaic that ought to be regulated to ensure conformity and balance of the built environment (Raticlif, 1993; Brooks, 2003) Inappropriate instruments and weak institutional structures are among the cavalcade of problems plaguing efficient and effective urban land development in Nigeria.

Development involves the purposeful change of the inherently complex environmental systems. Any development process that ignores sustainability and wholesomeness would hardly make any positive and enduring impact that could stand the test of time.

The concepts of sustainable urban development and general system provides a unifying conceptual framework to examine the characteristics of the risks faced by households to floods; emphasizes the need for holistic development plans and implementation and how adaptation responses at multiple levels depend on livelihoods, policies, and institutions; and household vulnerability outcomes.

The two concepts highlight the importance of a multidimensional and equitable approach to urban development policies and the need to include adequate and sustainable infrastructures in the urban development interventions.

## 2.2 LITERATURE REVIEW

This review of relevant literature is presented in the following thematic areas, flooding, causes of flooding, effects of flooding and solution to flooding problems. Urbanization, particularly in developing countries, is an inevitable issue of discourse in most cities because of the rapid and uncontrolled rate at which the process is affecting the fabrics of cities most especially in developing countries (Adedeji *et.al*, 2012). The persistent migration of people from deprived areas; coupled with poor urban governance has put unprecedented pressure on cities' resources and infrastructure. Incessant flood events are common imprints of unprecedented and unplanned city expansion; which is threatening human health, environmental quality and urban productivity in most cities of developing economies.

### 2.2.1 FLOODING

Flood is a large amount of water covering an area that is usually dry. It is an overflowing of a great body of water over land not usually submerged. Nwafor (2006) defined flood as a natural hazard like drought and desertification which occurs as an extreme hydrological event. On the other hand, Abam (2006), defined flood as large volume of water which arrives at and occupy the stream channel and its flood plain in a time too short to prevent damage to economic activities including homes.

Floods occur in Nigeria in three main forms: coastal flooding, river flooding and urban flooding (Folorunsho and Awosika 2001). They noted that coastal flooding occurs in the low-lying belt of mangrove and fresh water swamps along the coast. River flooding occurs in the flood plains of the larger rivers, while sudden, short-lived flash floods are associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period. Urban flooding on the other hand occurs in towns, on flat or low-lying terrain

especially where little or no provision has been made for surface drainage, or where existing drainage has been blocked with municipal waste, refuses and eroded soil sediments (Olagunorisa, 2004).

Floods are the most common and widespread of all the natural hazards. In many parts of the world according to Ocheri and Okeke (2012) floods seem to be occurring more often and they seem to be increasing in size. Floods are generally regarded as extreme hydrological events, where there is excess of water which may have devastating effects. According to Ayoade (1988), floods in tropics are partly or wholly climatological in nature, that is, they result from torrential rainfall.

Floods by nature are complex events caused by a range of human vulnerabilities, inappropriate development planning and climate variability. Normal floods are expected and generally welcomed in many parts of the world as they provide rich soil, water and a means of transport, but flooding at an unexpected scale and with excessive frequency particularly flash floods causes damage to life, livelihoods and the environment. Many factors have been linked to the incidence of floods in many cities of Nigeria.

### 2.2.2. CAUSES OF FLOODING

Within the cities, human activities such as rapid industrialization and urbanization, population growth, exploitation of natural resources and location of infrastructures exacerbate occurrence of floods. Although flood is a natural occurrence, it often leads to disasters as a result of human-created vulnerability, which is a consequence of human-environment interactions. Flooding, is one of the most frequent and widespread of all environmental hazards and of various types and magnitudes, occur in most terrestrial portions of the globe, causing huge annual losses

in terms of damage and disruption to economic livelihoods, businesses, infrastructure, services and public health (Offiong *et al*., 2008).

Olufemi (2008) in a research work titled "Road and urban storm water drainage network integration in Addis Ababa" asserted that urbanization along with its impermeable structures is the major cause of flooding in urban areas. Flood disaster is defined in terms of risk to humans and human society, and is seen as a product of the severity and probability of occurrence of flood hazard and the vulnerability of the population system (Brooks, 2003).

Zabbey (2006) reports of unprecedented flooding that submerged houses, paralyzed economic activities and rendered some residents of Mgbouba, Diobu and Mkpolu areas of Port Harcourt internally displaced. The author attributed this to excessive rainfall associated with climate change. It should be noted that rainfall at that period could have been in excess of ground saturation and resulted in the saturation excess overland flow.

Ogba and Utang (2008) reviewed the problems of flood in the Niger Delta, it was reported that increasing built-up areas without proper recourse to urban planning rules, and additional concretion, could have accelerated infiltration excess over-land flow. A combination of saturation and infiltration excess overland flow could have been responsible, with the proximate determinants being the rainfall and topography. Although rainfall may have been higher than previous years, this could still have been lower than some other years prior to the present urbanizing phase of development that is being experienced.

Poor drainage network remains a contributing factor to flood occurrence in Nigeria. It is estimated that the required drainage channel is short by about 61.78%; and the existing ones are only about 30% maintained, (Amaize, 2011). There is nowhere the estimated shortfall in the drainage channels is less than 50% except at Abuja (27%) and Calabar (48%). It is as high as

78% and 76% at Onitsha and Jalingo respectively (Aderogba, 2012). Flood disasters result from human-created vulnerability which is an outcome of our interacting with the environment by some human activities such as designing and locating our infrastructure, exploiting natural resources, concentrating our population and so on (Hualou, 2011).

Urbanization and lack of good local governance have been regarded as a major creator of urban flood risk (UN-habitat, 2009, Darteh, 2011). Urbanization exacerbates the damages caused by flooding by restricting where flood or storm waters can go. Large parts of the ground with roofs, roads and pavements are covered, obstructing sections of natural channels and building drains that ensure that water moves to rivers faster than it did under natural conditions. In an urbanizing environment like Nigeria, the infiltration capacity is reduced by the replacement of ground cover with impervious urban surfaces (Odemerho, 1993).

Adeleye and Rustum (2011) analyzed the causes of the flooding problem encountered in Lagos to recommend sustainable management solutions to them. Data on climate, drainage infrastructures and physical planning regulations were collected and extensively analyzed. These were combined with evidence from field inspection and discussion with stakeholders, including relevant government departments, university researchers and selected resident. The investigation revealed that, contrary to popular wisdom, climate change or unusually high rainfall is not the primary cause of flooding problem in Lagos. Rather, the increased urbanization, lax planning laws in relation to the city are to blame. It is augured that a lasting solution to flooding problems will require the incorporation of sustainable drainage system within the existing flood management strategy for the city and planning for this must start now.

Nwafor (2006) identified 12 causes of urban flooding; these include surcharges in water level due to natural or man – made construction on flood path, sudden dam failure, inappropriate

land use, mudflow, inadequate drainage capacity to cope with urbanization, excess encroachment in flood ways, ice jam, rapid snow fall, deforestation of catchment basins, reclamation, construction sites and solid waste.

Odemerho (1993) also identified three factors accentuating flood problems in Benin City, Nigeria namely: land and physical development problems, gaps in basic hydrological data, design and implementation problems and cultural factors. In Nigeria, apart from the Ogunpa stream in Ibadan that killed several people and completely grounded socio-economic activities in 1980, in August, 2008 the residents of Makurdi were thrown out of their residences and their farmlands left impoverished after two days of heavy down pour of rainfall. Taiwo (2008) described it as very disastrous. He also reported in this day (August 18th) page 20 that "at least five hundred people were rendered homeless and properties worth several millions of Naira were destroyed when a flood, occasioned by torrential rainfall ravaged Babura, a town in Jigawa State in a period of two days".

Akanni and Bilesanmi (2011) also reported how a Lagos flood forced Lagosians to relocate as a result of heavy rain of 7th and 8th of July 2011 not knowing there was going to be a more devastating torrential rain that will result in more disastrous floods in Lagos Metropolis in the following week (Amaize, 2011; Mordi, 2011)

Ochere and Okeke (2012) assess the social impacts and people's perception of flooding events in Makurdi town which has almost become a yearly occurrence. The results of analyses show that floods in Makurdi occur mostly at the event of rainfall intensity and amount and especially at the peak of rainy season (August/September). The study further revealed that factors other than rainfall that substantially influenced flooding in the study area are: Lack of and poor drainage networks, dumping of wastes/refuse in drainage and water channels, topographic

characteristics, overflowing of river banks, low infiltration due to high water table and degree of built up areas leading to increased runoffs, and climate change.

In similar study elsewhere, Oreola (2003) revealed that high intensity of rainfall, unturned road, dumping of refuse on drainage channels, poor construction of drainage channels and poor town planning practices are the main causes of urban flood problems in the study area in Ado-Ekiti town. The problems of flood in Nigerian urban centers have been attributed to anthropogenic and natural factors. Olufemi (2008) observed that, it is evident from research, that residence contributes greatly to flood problems of their area and their act jeopardizes the environment which attracts many people for economic, social and recreational facilities.

Olagunorisa (2004) however, stated that flood is caused by rainfall, snow, melting ice and hurricanes. The researcher further stated that the common feature of flood is the destruction of lives and property. In several countries, a distinction is made between direct and indirect damage. The direct losses include those which result into loss of lives and properties. While indirect losses consist of damage resulting from the limitation or breakdown of human activities during flood.

Oreola (2003) noted that various socio-cultural activities have promoted flooding in many of the Nigerian urban environment. These activities are characterized by stream or river channel encroachment and abuse, increased paved surface and poor solid waste disposal techniques, ineffective town planning laws and poor environmental management etc.

The problem of flood in Gombe according to Daniel, Juji, Nwosu and Omilolo (2012) has spanned over a long period, and is associated with many factors. Among these factors are the increase in population and rapid urbanization aggravated by urban sprawl, unplanned

development, overgrazing, excessive land cultivation and inadequate urban infrastructure. The study concluded that urbanization dynamics is the major factor responsible for flood in the city.

Similarly, Abaje and Giwa (2008) study of urban flood in Kafanchnan town of Kaduna state revealed that flood waters often jump artificial drains which are inadequate in some cases. It was also observed that the intensity of flood problems in the city is related to the rapid rate of urban expansion; especially where the simultaneous provision for adequate urban run-off is lacking, is often the case in most Nigerian cities (Onokerhohaye, 1995).

Ladan (2007) also reported the incidence of floods due to rapid urbanization in Katsina metropolis. In his study, it was observed that there were inadequate drainages to drain storm water. The result is that the existing drainages become overloaded leading to flooding. In addition, he identified other factors that are precursors to flood in the area to include; heavy rainfall, improper waste disposal, unplanned nature of settlements, population increase, and construction problems.

Most importantly, demographic and socio-economic trends are playing a role in increasing city's exposure to weather and climate-related damage, through factors such as housing developments in areas vulnerable to flooding and other risks (Jimoh 2008).This twofold expansion increases the exposure and vulnerability of Calabar streets to flooding, and also, as a consequence, the social and economic damage in case of a catastrophic flood event (Offiong *et al.*, 2008).

Jimoh (2008) assessed drainage problems in the tropical environment of Ilorin. The results of the finding include: the dimensions of drainage channels are adequate to permit free flow of water bodies given a good culture of drainage system maintenance, various types of waste materials but in different proportions have been found to be blocking the drainage

channels, the problems of drainage channels ranges from the occurrence of street flooding to environmental deterioration and the splashing of water on other road users. And he concluded that an obvious method for managing drainage channels is the adoption of environmental education with emphasis on the technique for drainage channel management.

Flood problems within cities of the Niger Delta appear to be increasing. This does not necessarily imply increasing rainfall but changing landscapes are the underlying culprit. Built-up areas are spreading across the city and increasing much faster than the provision of accompanying infrastructures. Structures are erected anyhow and anywhere. In a study of drainage systems and urban sustainability in Calabar, Eze (2008) concluded that flooding was observed to be the principal consequence of poor drainage systems. This is compounded by the rapid growth and development of the city though not with commensurate infrastructural development especially drainage networks. This is why this study becomes imperative.

### 2.2.3 EFFECTS OF FLOODING

According to Askew (1999), natural disasters, such as the occurrence of floods, cause much misery, especially in developing countries where low-income earners undergo great stress. Losses due to floods reduce the asset base of households, communities and societies through the destruction of standing crops, dwellings, infrastructure, machinery and buildings, in addition to tragic loss of life. From Lagos, Ibadan, Abeokuta, Calabar, Port-Harcourt and Warri in the southern region through Ilorin, Abuja, Lokoja and Minna in the Middle belt to Kano, Kaduna Jalingo, Maiduguri and Gombe in the North, the rains came down and floods came-up, washing away streets, battering dams, collapsing bridges, submerging buildings, killing people, trapping some in their homes and separating thousands of others from theirs. Nothing is spared by the marauding floods (Adedeji, Adeola, Adeyemi and Kuyoro, 2011).

Adedeji *et. al* (2012) similarly argued that flooding is a phenomenon that sometimes has devastating effects on human livelihoods. Impact of floods is more pronounced in low-lying areas due to rapid growth in population, poor governance, decaying infrastructure and lack of proper environmental planning and management. Flooding is also exacerbated by climate change and inadequate preparedness. Damage and lose from floods are mostly the consequences of urbanization without corresponding infrastructural restructuring (Brooks, 2003).

Flooding, as one of the most frequent and widespread of all environmental hazards and of various types and magnitudes, occur in most terrestrial portions of the globe, causing huge annual losses in terms of damage and disruption to economic livelihoods, businesses, infrastructure, services and public health. Long term data on natural disasters suggest that floods and wind storms (which frequently lead to flooding) have been by far the most common causes of natural disaster worldwide over the past 100 years (Ahern, Few, Matthias and Kovats, 2004).

Worldwide, there has been rapid growth in number of people killed or seriously impacted by flood disasters (UN-Water, 2011). Indeed, the amount of economic damages affects a large proportion of people in low-lying coastal zones or other areas at risk of flooding and extreme weather condition. According to UN-Water (2011)floods, including urban flood is seen to have caused about half of disasters worldwide, and 84% disaster deaths in the world was attributed to flooding. Askew (1999) reiterated that floods cause about one third of all deaths, one third of all injuries and one third of all damage from natural disasters.

According to the International Federation of Red Cross and Red Crescent Societies, in 10 years from 1993 to 2002 flood disasters affected more people across the globe (140 million per year on average) than all the other natural or technological disasters put together (IFRC, 2003);with an increasingly urbanizing world, flood disasters are reportedly increasing in urban

areas and particularly negatively impacting on poor people and urban development in general (Alam, Herson, and O'Donnel, 2008).

Hendersons (2004) study of vulnerability to the impact of flood in developing countries revealed that the level of risk and vulnerability in urban areas of developing countries is attributable to socio-economic stress, aging and inadequate physical infrastructure. Indeed, according to Satterthwaite *et al* (2007), hundreds of millions of urban dwellers have no all-weather roads, no piped water supplies, no drains and no electricity supplies; they live in poor-quality homes on illegally occupied or sub-divided land, which inhibits any investment in more resilient buildings and often prevents infrastructure and service provision.

However, according to Mantua and Lebel (2005), climate change compounds the existing challenges of managing floods review of climate change impacts on urbanization by the international institute of environment and development (Huq, Kovat, Reid and Satterthwaitte, 2007) found that the floods are already having severe impacts on cities, smaller urban centers and rural areas in many African Nations. Examples cited include floods in Mozambique in 2000, which displaced around 4000 people in Maputo alone and crippled transport networks, breaking market links (Christie and Hanlon, 2001); heavy rains in East Africa in 2002 that brought floods and mudslides and forced tens of thousands to leave their homes in Rwanda, Kenya, Burundi, Tanzania and Uganda (Huq *et al.*, 2007).

More common, but less often reported, such as the many small floods that affect neighborhoods in cities and small towns such as the 2$^{nd}$ June, 2003 storm that led to flooding in the western region of the Gambia destroying houses in Darsilameh village and affecting 300 people (IFRC, 2003).

### 2.2.4 SOLUTIONS TO THE PROBLEMS OF FLOODING

It has been argued that to date, the challenge of addressing urban floods and reducing urban flood vulnerability has received little attention (Zevenbergen, 2007). This is partly because in the traditional flood management approach, responses to mitigate urban fluvial and coastal flood risks have often been set outside the realm of the urban system (i.e. where confined to the catchment level), but also because responses at the city level were predominantly passive, using robust solutions such as urban defenses and increasing the capacity of major culverts. Adedeji *et al*., (2012) argued that the prevailing effects of climate change, particularly flooding affecting almost everything in cities demands urgent attention in form of environmental and infrastructure planning, effective policy, improved and effective management of ecological fund, enhanced environmental disaster insurance, effective professional practice, enhanced public enlightenment programmed, integration of environmental planning and education to curriculum of schools at all levels, capacity building towards adaptation and mitigation of climate change impact. It also argued for the need to reinvent Nigerian cities through good governance towards creating sustainable cities in the country.

The following major bottlenecks have been identified, which hamper the adoption and effective implementation of flood-risk management in urban planning practices according to Sz¨Oll¨Osi-Nagy and Zevenbergen (2005); lack of understanding of current and future risks and implications at the city scale, lack of long-term planning, poorly integrated and comprehensive planning, and inadequate controlling roles of local and regional authorities, and the conservative nature of the building sector.

Urban environments are complex - socially, economically and physically. This complexity multiplies the risk which comes from increasing poverty and inequality and failures in governance, high population density, crowded living conditions and the sitting of residential areas close to hazardous industry or in places exposed to natural hazard (including the modification of environments which generates new hazard, e.g. through the loss of protective mangroves to urban development, or subsidence following ground water extraction) (Pelling, 2008).

This combined with the cumulative nature of many environmental problems, makes it difficult to identify causal relationships when considering risk and vulnerability (Oelofse, 2002). Urban risk and vulnerability need to be understood in terms of the nature of risk, the causal mechanisms that shape people's response to them and the contingent conditions that provide the context within which they occur. Many risk problems sit at the interface of the natural and social environment, such as flooding, which occurs as the result of the inadequate provision and maintenance of drainage systems, the location of people on marginal sites, and the physical characteristics of an area (Oelofse, 2002; Olufemi, 2008).

Infrastructure is one of the indispensable elements in the process of urbanization and emergence and continuity of an urban growth. It is considered as motor/engine for economic development (Olufemi, 2008). In situations where urbanization is not matched with corresponding urban infrastructure, hazards such as flood disaster are often inevitable. This is largely responsible for flood incidences in Nigeria. It is even made worst as by nature it is complex events caused by a range of human vulnerabilities, inappropriate development planning and climate variability (Olufemi, 2008).

One major aspect of urban problem with respect to housing is the poor state of the infrastructures (Sule, 2007). Urban infrastructure and housing provision are interwoven. Without infrastructures, housing cannot be sustainable and hence should be treated integrally (Sule, 2004). An ideal urban neighborhood should be provided with good roads, drainage networks, electricity and portable water supply, good waste management system and security. The condition of these services in Nigeria urban neighborhoods contradicts the principle of sustainability in urban housing (Aderamo, 2008).

Adedeji *et.al* (2012) submitted that in many cities in Nigeria there is lack of inadequate infrastructural provisions to curb flooding. Urban areas in the Nigeria are particularly vulnerable to flooding due to inadequate capacity of drainage structures; changes to ecosystem through the replacement of natural and absorptive soil cover with concrete; and deforestation of hillsides, which has the effect of increasing the quantity and rate of runoff, and through soil erosion and the silting up of drainage channels.

Nigerian urban areas are typical examples of this high level of risk and vulnerability (Olufemi, 2008). Many risk problems sit at the interface of the natural and social environment, such as flooding, which occurs as the result of the inadequate provision and maintenance of drainage systems, the location of people on marginal sites, and the physical characteristics of an area (Olufemi, 2008).

However, flooding in most Nigerian cities is a major environmental challenge that has continued to defy solution as more people are rendered vulnerable to hazards involved. The implications of recent flooding in Nigerian cities include among others; loss of life and properties, spread of diseases, deformed livelihoods, assets and infrastructure.

Community has different perceptions on disaster and develops different efforts to overcome the floods. The capacities to cope with the disaster impact is however different depending on social groups; poor and rich, men and women, young and old, indigenous or non-indigenous, etc. Many have struggled to relocate out of their flood-prone neighbourhoods to better areas without success mostly due huge cost of rent. Being located in the flood-prone area, majority of the people are aware of the danger involved and they have tried to protect and cope with flood effects. There are many ways or of coping mechanism employed by the local people to deal with the negative impact of flood.

The provision of drainages in most parts of Calabar is inadequate both in number and in sizes. This is evident in the incessant reports of flood events in the city. In addition, where drainages are provided, unapproved structures are erected in the storm water right-of-way (Sule, 2009). These unsustainable growths remain a major factor of flood occurrence in most parts of Calabar. From the literature reviewed, it is generally observed that most of the studies looked at the qualitative aspect of drainage network inadequacies and flood events; Aderogba (2012) described such an approach as journalistic and non-quantitative, being superficial and lack directions for professionals and policy makers. This study is aimed at making up for the identified gap through the quantitative and qualitative analysis of drainages and floods using the conceptual lenses of the city of Calabar.

# CHAPTER THREE: STUDY AREA AND METHODOLOGY

## 3.1 STUDY AREA

### 3.1.1 LOCATION AND SIZE

The study is confined to Calabar Metropolis that lies between latitudes $4^{0}46^{1}$ - $4^{0}58^{1}$North of the equator and longitudes $8^{0}15^{1}$ - $8^{0}$ $26^{1}$ East of the Greenwich meridian with an approximate area of 1480 $km^{2}$. It covers Calabar Municipality and Calabar South Local Government Areas of Cross River State. The area is bordered in the North and West by Odukpani Local Government Area, in the east by Akpabuyo Local Government Area and in the South by the Atlantic Ocean (Fig. 3.1).

### 3.1.2 CLIMATE

Calabar is located in a coastal zone within the humid subtropical region and it is affected by weather systems originating from all sides. The city experiences the full influence of the over head sun through out the year which provides abundant and constant insolation. Consequently, the atmospheric temperature within the area as observed by Mannion (2002) are constantly high and changes slightly with the year and according to Udo (1975) the mean daily temperature remain around $37^{0}$C all year round excepts during the raining season due to the cooling effects of rains and clouds cover that curtails the amount of insolation (incoming radiation).

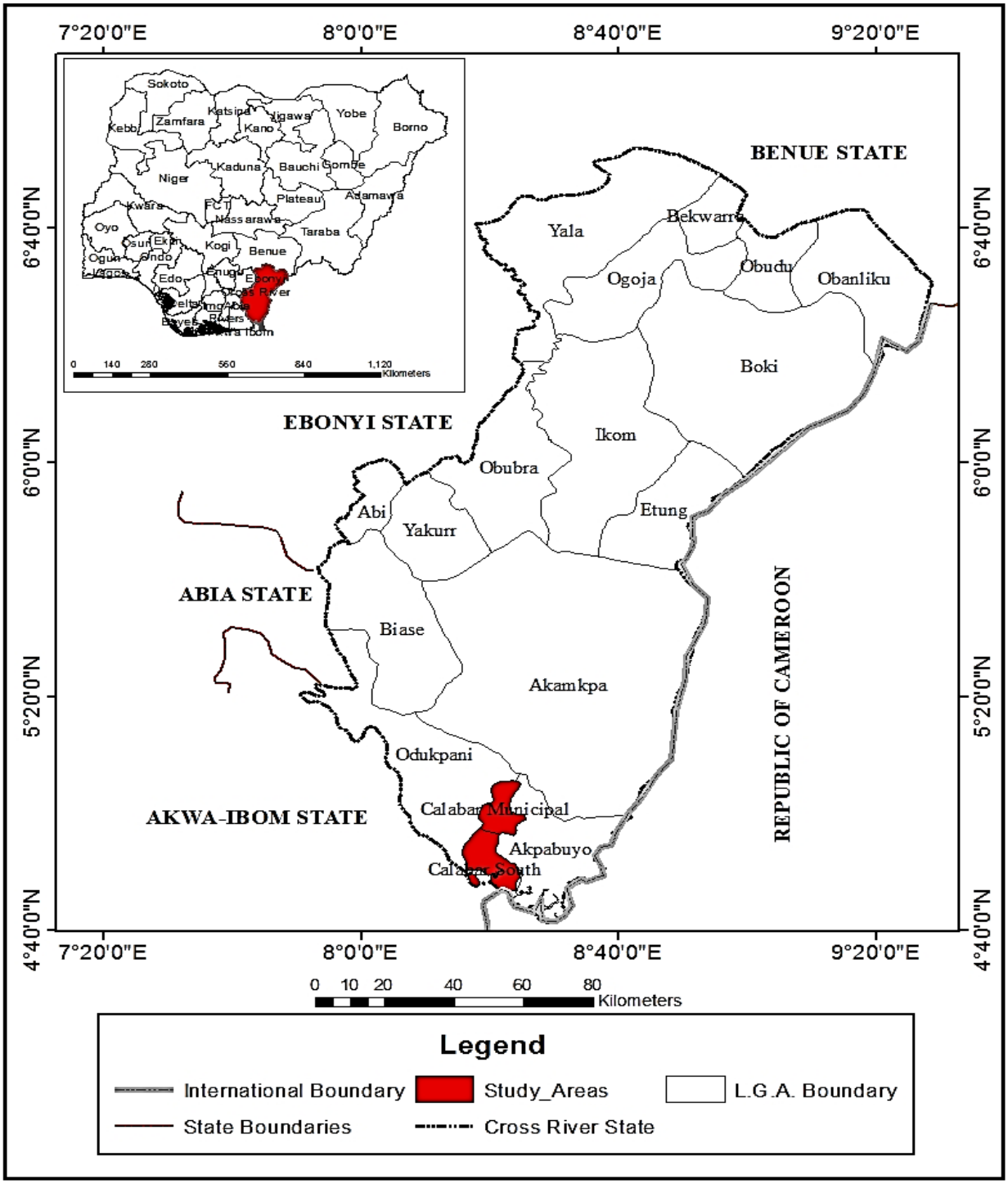


**Figure 1: Cross River State Showing the Study Locations.**
**Source; Modified from Map of Cross River State**

Rainfall in Calabar is however influenced by the interaction between two air-masses blowing over the area. the warm moist (rain bearing) tropical maritime (mT) air mass, which originate from the Atlantic ocean and the dry dusty tropical continental (cT) air mass which originated over the Sahara desert. These two air masses alternate seasonally with each other, but the tropical maritime (mT) has domineering influence over the area because of the nearness of the area to the sea which has resulted in rain falling throughout the year.

Rainfall is therefore very high in Calabar. With an annual rainfall average of 2000mm to 3000mm (NAAR, 1995), Calabar ranks very high among stations receiving heavy precipitation in the coastal zone of Nigerian and West African sub-region (Inyang, 1980). The rainfall distribution shows that it is characterized by double maxima rainfall regime which starts from the month of April to October, reaching its climax in the months of July and September.

The area has a relative humidity that is high throughout the year except during the short dry harmattan spell. Calabar has an average of eighty (80 %) percent relative humidity that is sometimes one hundred (100 %) percent much higher in the morning and with an average vapour pressure in the air of 29 millibars throughout the year (NAAR, 1995). Udo (1975) reported that Calabar has the highest amount of relative humidity in Nigeria. Generally, the major air masses which are separated by the Inter-Tropical Convergence Zone (ITCZ) or Discontinuity (ITD) oscillate north and south to give the two distinct seasons of the area.

### 3.1.3 GEOLOGY AND DRAINAGE

The area is an inter-fluvial settlement, built on a high land between two rivers adjacent valleys of the Great Qua River on the east which flows into the Cross River State estuary and the Calabar River on the west. Calabar is moderately undulating with land descending rather

abruptly to the Calabar River at the western boundary of the town while the slope is towards the Qua River to the west (Inyang, 1980). The crest of the coastal range of hills rising from the coastal plains about 40km to the Atlantic sea shores, with height of 60 to 70m above sea level in some places. The coastal plains is linked with undulating hinterland on which the rest of the town is built by a number of channels and gaps, open primarily by head ward erosion of formal streamlets.

### 3.1.4 POPULATION AND HUMAN ACTIVITIES

Calabar metropolis, going by the 2006 census figures of the National Population Commission (NPC, 2009) has an estimated total population of 371,022 and is made of two local government areas; Calabar Municipality and Calabar South Local Government Areas. The population of Calabar Municipality is 179,392 with 91208 males and 88, 184 females. Calabar South on the other hand has a total population of 191,630 made up of 95,399 males and 96,231 females, with a projected annual growth rate of 2.8 percent.

The major source of population growth in Calabar is in-migration (Eze, 2008). The population mix in the city is quite heterogeneous which invariably tied to its history of early contact with the western World and the then trans-continental trade spear headed by the Lebanese. It was also the capital of the then southern Nigeria. This inter-mixture of population form neighboring communities of the Igbo, Yoruba, and Hausa extractions including a good number of non-Nigerian immigrants has translated into a fusion of cultures which according to Ebong (1980) has brought in the adoption of alien architecture in styles and layout of the city.

Currently, Calabar is witnessing a seasonal surge in both vehicular and human population especially during the yuletide seasons when the Christmas carnival takes place. This singular

event has great incentives for increased development of new properties (especially in the housing and hospitality sectors), maintenance, decoration and re-decoration of existing ones. This interface leaves a casual visitor with the erroneous impression that the entire city is buoyant and luxurious.

In addition, the increase of people in the city and associated human activities affects the urban ecology of the city. These factors helps to increase flood events in Calabar especially where non-conformity to land use abound.

### 3.1.5 LAND USE

Before the advent and growth of the petroleum industry, Nigeria export trade was dominated by agricultural and forestry products such as palm produce, cocoa, rubber and timber, much of which were produced in Calabar. In recent times, agricultural activities have even increased and expanded tremendously due to increased in human population.

Disparities however, exist in production systems in the urban and rural areas. While agricultural activities are more pronounced in the rural areas (hinterlands), commercial and industrial activities are largely in the urban centers. The human use of land which often has economic significance is reflective of the function of land units. Land use change is occurring constantly on a temporal and spatial basis. These changes are linked basically to the vibrant socioeconomic activities in Calabar (Mannion, 2002) identified certain anthropogenic factors that are responsible for urban ecological change to include agricultural activities, industry and energy consumption and agglomeration of people (urbanization).

## 3.2 RESEARCH METHODOLOGY

The survey research design was used in this study. The design involves the collection of data about a phenomenon with a representation sample by the use of questionnaire, interview and appraisal approach (Ndiyo, 2005).

### 3.2.1 RECONNAISSANCE SURVEY

A Reconnaissance survey of Calabar was undertaken to identify flood prone areas. Using information obtained from literature on flood in the city of Calabar, couple with verbal discussion of residents of the city, the researcher identified areas that are often flooded whenever it rains. The reconnaissance assisted in the determination of suitable location for the establishment of the measurement points. At the end, a distinct area with well-defined boundaries was identified. Thus, flood volume data were collected from the following locations; IkotAnsa, EsukEdiba, Henshaw Town, Anangtigha, CRUTECH, MCC and a control was established at Satellite Town. Questionnaire were administered to residents of the selected streets in accordance with the guide outline in the procedure for data collection.

### 3.2.2 TYPES OF DATA

Poor drainage system is exhibited in the structural degradation of the form and pattern of already existing urban social facilities. Therefore the following physical and social facilities which form the main component of the urban facilities were considered as data required for this research.

Majorly, six types of data were collected in the study. They included

i. Data on the socioeconomic characteristics of the respondents
ii. Data on flood frequency and intensity
iii. Data on drainage characteristic (drainage width and depth)

iv. Data on runoff volume (Direct field measurement)

v. Data on the causes of poor drainage systems as perceived by the residents,

vi. Data on effects of poor drainage systems on the urban environment.

These data sets are considered relevant given that flood episodes are often linked to the poor state of drainage system as exhibited in the structural degradation of the form and pattern of already existing urban social facilities.

### 3.2.3 SOURCES OF DATA

Two data sources were relied upon; primary and secondary data sources. The primary sources of data involved data obtained through questionnaire administration, measurement of the attributes of interest, analysis of topographic maps, direct observation to extract the necessary information in the field.

Secondary Sources basically included, residential map, population trend data obtained from the National Population Commission (NPC), existing literature on the research topic from journal articles, textbook, magazines and gazettes.

## 3.3 Methods and Procedure of Data Collection

### 3.3.1 Data on drainage width and depth:

The dimensions of the drainage were measured directly from the field with a measuring steel tape and the volume of flood water was measured using stop watch method (Velocity of flow). Seven streets were purposively sampled. Along a given street, a number of measured points were established along the drainage paths. The values obtained were further subjected to statistical manipulation to determine depth to width ratio.

### 3.3.2 Data on flood volume (direct field measurement)

To determine flood volume in the sampled streets. A gauging station was established at predetermined points (Ayoade, 1988). The velocities were estimated and together with the cross-sectional area at each runoff gauge level they were used to estimate the runoff from the urban drainage catchment. The assumption is that the area where runoff was sampled is taken to be representative of the entire urban catchment of the city of Calabar.

### 3.3.3 Questionnaire administration and Sampling techniques

The construction of questionnaire focused on the factors of poor drainage systems, the effects of poor drainage systems on the urban environment, socio economic characteristics of respondents (income, education, and household size), inadequacy of drainage systems, causes of flooding, frequency and intensity of flood events in Calabar, and the socio economic implications of flooding

Systematic random sampling technique was used in the administration of questionnaire on household heads per housing units, selected along the streets of the sampled residential districts. Systematic random sampling technique involves the picking of members of a sample at a predetermined regular space/time interval. Consequently, the first element is picked randomly from the first five houses to determine the starting point of questionnaire administration, and others are then picked at regular intervals predetermined by the researcher (every ten houses). This way every relevant household was given a chance of being picked and none repeated.

For instance, house number 4 was randomly picked at first, and on the upper side, house numbers 14, 24, 34 were picked and so on. In this way the whole street and sampling locations is covered to obtain a truly representative sample.

Given the Yamene(1964) formula

$$n = \frac{N}{(I + N(e)^2}$$

Where

n = Sample Size

N = Sampled population

e = Level of precision or confidence level at 0.05 significance

Where $n = \frac{6553}{1 + 6553\ (0.05)^2} = 400$

From the figure obtained, 400 copies of questionnaire were administered proportionately among the six districts in relation to their specific population figures as shown in Table 3.1 below with the following formula;

$$\frac{p}{P} \times 400$$

Where p = Proportionate population

P = Overall population

400 = the calculated (n)

**Table 3.1: Sample districts, sample size distribution according to proportionate population**

| | Sample locations | Estimated houses | Proportionate samples | % |
|---|---|---|---|---|
| A. | IkotAnsa | 2204 | 86 | 21.5 |
| B. | EsukEdiba | 1326 | 52 | 13 |
| C. | Henshaw Town | 788 | 31 | 7.8 |
| D. | Anantigha | 2131 | 84 | 21 |
| E. | CRUTECH | 986 | 39 | 9.8 |
| F. | MCC | 2345 | 92 | 23 |
| G. | Satellite town | 104 | 16 | 4.0 |
| | **Total** | **6553** | **400** | **100** |

**Source: Researcher field survey, 2013.**

### 3.3.4 Technique of Data Analysis

The data collected were analyzed using descriptive statistics of mean, Frequency, tables, and charts. The use of descriptive statistics to analyze the data and add value to the over all work

# CHAPTER FOUR: RESULTS AND DISCUSION

## 4.1 INTRODUCTION

This chapter is concerned with the presentation, analysis and discussion of data obtained from the field through direct field measurement, questionnaire administration and secondary data analysis.

## 4.2 SOCIOECONOMIC PROFILE OF RESPONDENTS

The socio-economic characteristics of the respondents are very important in determining the degree of urban growth. The channels which were essentially constructed or created by the storm water drains to let flood waters pass freely are being tress-passed by slum dwellers, small shopkeepers, motor garages, garbage dumping among others result in obstruction of water flow and thus contributed immensely to the fury of floods in the city of Calabar. Most of the drains in Calabar are characterized by such trespassing and garbage dumping. The socioeconomic characteristics of the people could possibly be linked to their disposition to environmental management.

Information gathered on educational background reveal that more than half of the inhabitants in the area have acquired one form of education or another as 48.84% of the respondents in Ikot Ansa have acquired a tertiary education certificate. The respondents in Henshaw town have the least distribution in terms of tertiary education. As shown on Table 4.1, out of 400 respondents interviewed, 147 of them said they have obtained senior secondary certificate. The distribution in the table further shows that majority of those with secondary education certificate were found in Henshaw town. The highest number of those who claimed to have no formal education was found in Esuk Ediba (15.38%), while the least was found in Satellite town with 0.00% which also has the highest recipient of tertiary education.

**Table 4.1: Educational level of respondents**

| Educational level | Ikot Ansa | | Esuk Ediba | | Henshaw | | Anangtigha | | MCC | | CRUTECH | | Satellite | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| No formal education | 13 | 15.12 | 8 | 15.38 | 2 | 6.45 | 9 | 10.71 | 4 | 10.26 | 3 | 3.26 | 0 | 0.00 |
| Primary education | 8 | 9.30 | 6 | 11.54 | 4 | 12.90 | 13 | 15.48 | 3 | 7.69 | 12` | 13.04 | 2 | 12.5 |
| Secondary education | 23 | 26.74 | 14 | 26.92 | 17 | 54.84 | 28 | 33.33 | 17 | 43.59 | 45 | 48.91 | 3 | 18.75 |
| Tertiary education | 42 | 48.84 | 24 | 46.15 | 8 | 25.81 | 34 | 40.48 | 15 | 38.46 | 32 | 34.78 | 11 | 68.75 |
| **Total** | **86** | **100** | **52** | **100** | **31** | **100** | **84** | **100** | **39** | **100** | **92** | **100** | **16** | **100** |

**Source**: Field survey (2014)

The nature of occupation determines their level of income and possible areas to live as 32.56%, 29. 92%, 25.81%, 33.33%, 15.38%, 17.39%, and 12.5% (Figure 4.1) engage in trading activities in Ikot Ansa, Esuk Ediba, Henshaw town, Anangtigha, CRUTECH, MCC and Satellite town respectively. Majority of the respondents claimed to be civil servants (133 out of 400) with the highest number observed in MCC (62.5%). The least number of people claiming to be civil servants were recorded in Esuk Ediba (19.77%).

On household size, majority of the households were made up of between 3 to 6 people. This accounts for about 49.0% in the entire sampled zones, while 29.5% of the sampled population had household size of 1 to 3. Specifically, 39.5% of the sampled respondent in Ikot Ansa accepted to have household size of 1 to 3, 32.6% in Eusk Ediba. Majority of the sampled population in Satellite town (81.25%) have occupancy ratio of 1 to 3 (Table 4.2). The general observation in the seven sampled district is that the control (Satellite Town) have the least

occupancy ratio compared with the other six zones. This could be due to the fact that the zone is occupied mostly by people with advanced degrees and good paying jobs like lecturers, medical doctors and nurses.

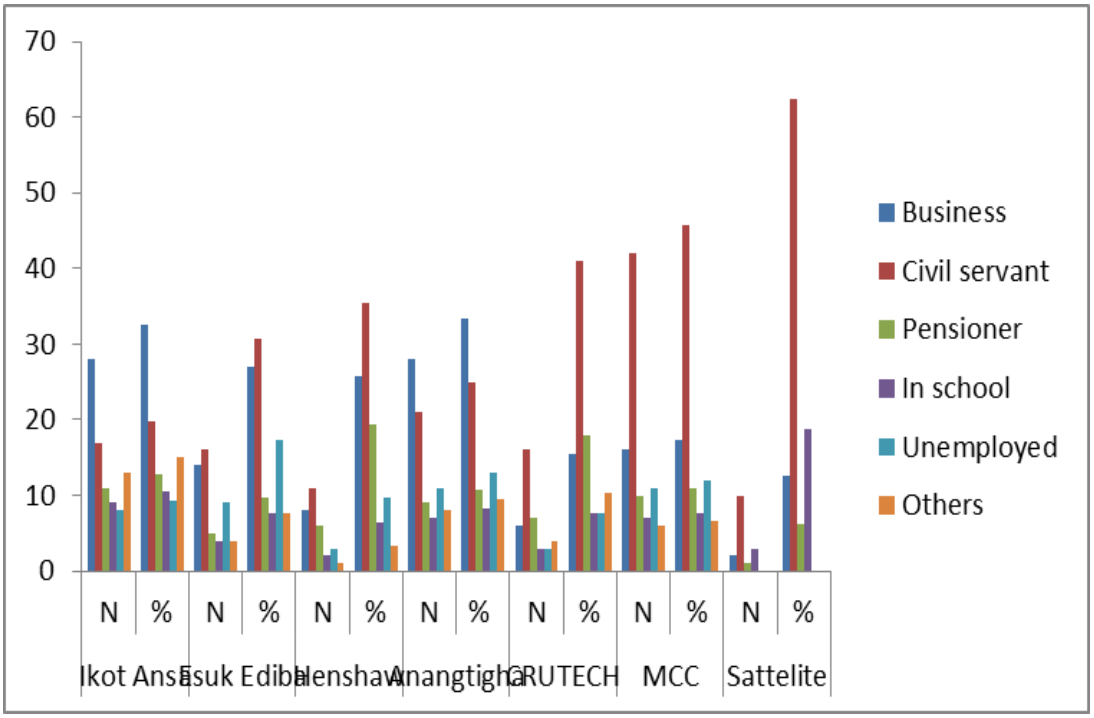


**Figure 4.1: Occupation of respondents**
**Source: Analysis (2014)**

**Table 4.2: Household size in the study area**

| Household size | Ikot Ansa | | Esuk Ediba | | Henshaw | | Anangtigha | | CRUTECH | | MCC | | Satellite | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| 1-3 | 34 | 39.53 | 17 | 32.69 | 4 | 12.90 | 21 | 25 | 13 | 33.33 | 16 | 17.39 | 13 | 81 |
| 3-6 | 36 | 41.86 | 24 | 46.15 | 19 | 61.29 | 46 | 54.76 | 16 | 41.03 | 53 | 57.61 | 2 | 12.5 |
| 6-9 | 12 | 13.95 | 8 | 15.38 | 5 | 16.13 | 10 | 11.90 | 4 | 10.26 | 13 | 14.13 | 1 | 6.25 |
| 9 & above | 04 | 4.65 | 3 | 5.77 | 3 | 9.68 | 7 | 8.33 | 6 | 15.38 | 10 | 10.87 | 0 | 0.00 |
| **Total** | **86** | **100** | **52** | **100** | **31** | **100** | **84** | **100** | **39** | **100** | **92** | **100** | **16** | **100** |

**Source**: Field survey (2014)

This study have buttressed the fact that flood occurrence in the city of Calabar is a linked to varied factors from both physical and socioeconomic variables particularly, inadequate drainage network and building housing and other infrastructures without recourse to planning ordinances in the area. From the sampled households, different opinions were expressed on the frequency of flood. About 47.25% of the sampled population said flood occurs in the zone every year. Similarly, some of the respondents (41.75%) agreed that they experience flood most parts of the year while 1.75% of the interviewed people were of the view that flood has never occurred in their zone. It was also observed that 6.25% of the sampled population agreed that they experience flood in their area every month of the season.

Ogba and Utang (2008) reviewed the problems of flood in the Niger Delta, it was reported that increasing built-up areas without proper recourse to urban planning rules, and additional concretion, could have accelerated infiltration excess over-land flow. A combination of saturation and infiltration excess overland flow could have been responsible, with the proximate determinants being the rainfall and topography. Although rainfall may have been higher than previous years, this could still have been lower than some other years prior to the present urbanizing phase of development that is being experienced.

**4.3 FREQUENCY AND INTENSITY OF FLOOD IN CALABAR**

Table 4.3a presents the frequency of flood in the city of Calabar. From the table, about 47.25 (189) of the respondents in the sampled zones claimed that they experience flood events every year. The table also revealed that over 40 percent of the sampled population in the study were of the view that flood do occur in most parts of the year. On further probing it was discovered that the months that usually record flood disasters over the last ten years are between March and November. The table also indicates that 41.75% of those interviewed said flood occur

most part of the year while 1.75% of the sampled population said they have never experience flood in their area. These are mostly people who live in the Satellite axis, as this zone has plan layout with most of the needed drainage facilities.

Flood occurrence in the city of Calabar according to similar studies by, Offiong *et.al* (2007) and Eze (2008) is a recurrent phenomenon. It has assumed a devastating dimension as it has become an annual event which leads to the destruction of roads, traffic obstruction, and poses a serious health hazard to the inhabitants of the city. The findings of this study was earlier corroborated else where by Abaje and Giwa (2007). In their study, it was reported that the increasing frequency of flood goes beyond heavy rainfall as urbanization rate and poor land use planning are the main precursors to flood episodes in most Nigerian cities.

On flood intensity 50.9% of the respondents said flood occurrence in Calabar is often very high while 40% of the sampled population agreed that flood use to be fairly high and 0.5 percent said flood is low(table 4.3b). These respective views point to the high incidence of flood in Calabar which could be traced largely to nonconformity to land use (Sule, 2010).

**Table 4.3a: Frequency of flood in Calabar**

| Frequency of flood | Number in sample | Percentage distribution |
|---|---|---|
| Every year | 189 | 47.25 |
| Every month of the season | 25 | 6.25 |
| Most parts of the year | 167 | 41.75 |
| Once in two years | 0 | 0 |
| None at all | 7 | 1.75 |
| Others | 12 | 3.0 |
| Total | 400 | 100 |

Source: Author's survey (2014)

**Table 4.3b: Flood intensity in Calabar**

| Level intensity of flood | Frequency | Percentage |
|---|---|---|
| Very high | 238 | 59.5 |
| Fairly high | 160 | 40.0 |
| Low | 02 | 0.5 |
| Total | 400 | 100 |

Source: Author's survey (2014)

## 4.4 DRAINAGE WIDTH, DEPTH AND FLOOD (RUNOFF) IN CALABAR METROPOLIS

Table 4.4 presents the geometry of the drainage channels and runoff estimation in the study area as observed and measured. The drains consist majorly of channels with open trenches, which are rectangular in shape with concrete lining and covering; however, most of the drainage channels in the interior of the city are left open. It is important to note that drainage channels along important routes like IBB way, around the Transcorp Hotels, Government House (Diamond), and those around Bank clusters (Post Office axis) were observed to be covered and maintained regularly.

From the Table, it can be seen that the drainages are characterized by different dimensions. For example, the width of drainage channels ranges from 61.3cm to 107.6cm and the total mean width of the drainage channels is 75.8cm. For the depth of the drainage channels, it ranged from 38cm to 69cm with a total mean depth of the measured drainage channels being 52.2cm. Similarly, the range of the runoff is $9m^3/s$ to 49.8 with mean values of $35.03m^3/s$.

On a zone by zone basis, the mean width in Ikot Ansa was 64cm while the mean depth in the area was 58cm. However, the width to depth ratio was 1.10. In all, 7 drainage channels were surveyed. The total mean value of runoff measured during rainstorm in three months (March to May 2014) in Ikot Ansa was 38.12$m^3$/s. In Esuk Ediba, the mean value of the drainage width is 84.8cm; depth was 63cm while the width to depth ratio is calculated to be 1.34 with the total of 4 gutters measured and runoff 42.10$m^3$/s.

In Henshaw town, one of the traditional settlements of the Efik Kingdom, the average width was 75.3cm; depth of drainages in the zone had mean values of 45cm and total of 6 gutters were measured with runoff of 36.0$m^3$/s. Similarly, in Anangtigha, mean values of the drainages width was 61.3cm, the depth was 38cm with a width to depth ratio of 1.6 and runoff of 38.01$m^3$/s was recorded in the area during the specified period. The total numbers of channels measured were 8.Table 4.4 also revealed that CRUTECH have the highest number of drainage channels as about 13 drainage channels were counted and measured. The mean values of the width and depth of the drainages was calculated to be 107.6cm and 69.0cm, while the width to depth ratio is given as 1.55 and runoff was about 49$m^3$/s.

The Table further indicates that the zone with the least number of drainage channels is MCC. The mean width and depth of the drainage channels was 82cm and 56 cm respectively. The width to depth ratio was 1.46 and a total of 3 channels were observed and measured and 32.2$m^3$/s volume of runoff was recorded. In the satellite town, the average value of the width was 55.5 cm while the depth was 36 cm and the width to depth ratio is 1.54 and runoff was 09$m^3$/s.

**Table 4.4: Drainage Length, width and Length to width ratio and flood volume**

| Sampled zones | Mean Width of drainage (cm) | Mean depth of drainage (cm) | W/D ratio | Number of drainage channels in the clusters | Mean value of runoff ($m^3/s$) |
|---|---|---|---|---|---|
| Ikot Ansa | 64 | 58 | 1.10 | 7 | 38.12 |
| Esuk Ediba | 84.8 | 63 | 1.34 | 4 | 42.10 |
| Henshaw | 75.3 | 45 | 1.67 | 6 | 36.0 |
| Anangtigha | 61.3 | 38 | 1.61 | 8 | 38.01 |
| CRUTECH | 107.6 | 69 | 1.55 | 13 | 49.8 |
| MCC | 82 | 56 | 1.46 | 3 | 32.2 |
| Satellite | 55.5 | 36 | 1.54 | 4 | 09 |
| Total | 530.5 | 365 | 1.45 | 45 | 245.23 |
| Mean | 75.8 | 52.2 | 1.45 | 6.4 | 35.03 |

**Source:** Author's survey (2014)

On the relationship existing among the three variables drainage width, depth and runoff volume, it is clear that drainages that are wide tend to contain larger volume of runoff, but this was not consistent across the sampled drainages. Little variations were recorded in some zones. In the case of CRUTECH, the mean width of the drainage is 107.6cm with 49.8 $^S$/cm runoff volumes was recorded. It was also observed that the same situation was replicated in Esuk Ediba where the mean width of the drainage channel is 84.8cm with runoff volume of 42.10$^S$/cm. However, the different pattern was observed in the remaining drainages. For instance, in Satellite Town, the width of the drainage is 55.5cm while runoff recorded was 09 $^S$/cm

In the study sites, it was evidenced that the drainages were not wide and deep enough to contend with the high volume of water that pass through them hence the regular incidences of floods. This was particularly observed in areas like CRUTECH where even after days of heavy rainfall stagnant water can still be seen on the area (Plate 4.2).

**Plate 4.2: Stagnant water in CRUTECH environ after days of rainfall.**
**Source:** Author's survey (2014)

Similarly, in the traditional settlement zones (Henshaw Town, Esuk Ediba,and Ikot Ansa) where the drainages were constructed during the colonial administration and few years after independence, the drainages were also observed to be narrow and dilapidated (Plate 4.3). During rainstorm, the water passing through often overflows the drainage bounds removing some concrete surfaces which have become weak due to aging and constant erosion by water. It was

also observed that most of these drainages are blocked by waste products which also hamper the free flow of water in the area (Plate 4.4).

**Plate 4.3: Narrow and dilapidated drainages in henshaw town**
**Source:** Author's survey (2014)

**Plate 4.4: Waste dumped in drainage channels in MCC.**
**Source:** Author's survey (2014)

In settlements like Anangtigha and MCC which were developed 30 years back (Sule, 2009), the drainages were also very narrow and shallow. It is unfortunate that the city like in other parts of Nigeria, development plans are often neglected and poor government supervision do not help in checking whether contractors and other developers are working according to specifications. This poor attitude to urbanization growth uniform trend has led to many ills in the society particularly in our environment.

In these recently developed towns, one would have expected the town planning department of the state to learn from what floods have caused in the traditional settlements by ensuring that all the drainages are wide and deep enough to allow for adequate volume of water during and after every down pour. Unfortunately this is not the case as floods have become constant at every rainfall season. Plate 4.5 revealed that in Anangtiha, the narrow gutters and squatter structures impeded the free flow of water during and after every heavy rainfall. This has led to many economic loss.

**Plate 4.5: Narrow drainage and presence of squatter settlements in Anangtiha**
**Source:** Author's survey (2014)

On flood intensity, majority (59.5%) of the sampled population agreed that flood events are often very high while 40.0% of the sampled households said level of flood intensity in the city is always fairly high and only 0.5% accepted that flood intensity is often low in the city. It is imperative to note that the findings of this are similar to previous studies on flood menace in Nigeria. For instance, in a study by Daniel *et.al*, (2012) in Gombe state of Nigeria it was held that flood incidences have become a perennial problem in Gombe metropolis as the city experience flood during the wet seasons (61.2%). Even though the average annual rainfall figure (114.3cm) is low, yet every year there is a record of flood incidence. The authors attributed the high frequency and intensity of flood to poor drainage infrastructures.

In a similar study by Abdulhamid and Ibrahim (2011) on episodic disaster events occurrence in Zaria urban area of Nigeria, it was reported that between 2007 and 2008, flood occurrence was the second highest disaster after fire outbreaks. The authors noted that floods occurred 28 times within the said period while 37 fire outbreak incidences were reported. The menace of flood respects no state irrespective of climatic features as the studies of Daniel *et.al* and Abdulhamid and Ibrahim have shown.

## 4.5 ENVIRONMENTAL STATES OF DRAINAGE SYSTEMS IN CALABAR

### 4.5.1 FACTORS OF FLOOD OCCURRENCE

The incidence of floods in Calabar was attributed to diverse causes. Calabar like other cities in Nigeria lack adequate storm water way. This is evident in the recurrent waves of flood events in the study area. Table 4.5a revealed that heavy rainfall was claimed to be the main factor of flood occurrence in Calabar (26.3%). Statistical evidence from the Nigerian Meteorological Agency (NIMET), Calabar shows that the mean annual rainfall for the city based on 1912-2011 rainfall data of the area is 245.78mm. These will mean volumes of water running

off roofs and paved surfaces from such storms are enormous. All too often, drains and culverts cannot cope and localized flash flooding occurs. These flash floods happen suddenly, with little lead time for warning; they are fast-moving and generally violent, resulting in threat to life and severe damage to property and infrastructure; and they are generally small in scale with regard to area of impact.

The table further indicates that 22% (88) of the sampled population attributed flood events in the city to inadequate drainage channels. In a similar vein, poor physical planning was also identified as another factor of flood occurrence with a response intensity of 15.7 percent. Despite the efforts of the Cross River State government to keep the city of Calabar clean, waste can still been seen strewed in gutters and road junctions (Plate 4.6).

**Table 4.5a: Factors of flood occurrence**

| Factors of flood occurrence | Number of responses Frequency | Percentage distribution |
|---|---|---|
| Building on water channels | 21 | 5.3 |
| Poor Physical Planning | 63 | 15.7 |
| Inadequate Drainage Channel | 88 | 22 |
| Heavy rainfall | 105 | 26.3 |
| Nature of Terrain | 34 | 8.5 |
| Dumping of wastes on channels | 56 | 14 |
| All of the above | 19 | 4.7 |
| Others | 14 | 3.5 |
| Total | 400 | 100 |

**Source**: Author's field survey (2014)

**Plate 4.6: Waste strewed in gutters and road junctions in CRUTECH**
**Source:** Author's survey (2014)

In fact waste management among most residents is rather too poor. Refuse and other wastes are usually dumped into available open spaces, including drainage channels and river plains and valleys. This practice has led to the blockage of the drainage channels at various points which could account for 14% of the households interviewed agreeing that flooding is usually a product of such blockages.

In general, during heavy rainfall which usually leads to flooding of low land areas because the waste dumped along the drainage channels obstruct the free flow of storm water. The drainage channels cannot therefore accommodate the flow of the fast running storm water hence it spills into streets and houses (Sule, 2009). Flood incidence is further compounded by the fact that most buildings were built right within and in the right of way of storm water as 5.3% of the respondents said building on drainage channels was another factor that often leads to flooding in their neighborhood and 3.5% of the sampled households attributed flooding to other factors (Figure 4.2a).

The state of the drainage (with regard to the prevalence of flood incidence cannot be over emphasis because of the poor observance (Plate 9) of frequent flooding in the area. It was observed that most of the buildings especially the illegal structures are built either the drainage channels path or too close to the drainage. This is a common feature in almost all the sampled zones. More so, it was observed that during rainfall streets in areas like IkotAnsa, Henshaw Town, MCC, Esuk Ediba are often strewed with all kinds of waste including human excreta. The presence of human excreta on streets posses' serious health hazards to the people around these areas.

The respective views on the quality of the drainages across the sampled areas clearly points to the fact that the drainages are in poor state. Plate 9 is an evidence of what one can

easily find in most of the streets in the sampled area. As the plate indicates, the persistent rain couple with the poor materials and engineering works has made these gutters to look like rabbit holes.

**Table 4.5b: Factors of flood occurrence in Calabar**

| Factors of flood occurrence | Number of responses Frequency | Percentage distribution |
|---|---|---|
| Building on water channels | 21 | 5.3 |
| Poor Physical Planning | 63 | 15.7 |
| Inadequate Drainage Channel | 88 | 22 |
| Heavy rainfall | 105 | 26.3 |
| Nature of Terrain | 34 | 8.5 |
| Dumping of wastes on channels | 56 | 14 |
| All of the above | 19 | 4.7 |
| Others | 14 | 3.5 |
| Total | 400 | 100 |

**Source: Author analysis (2014)**

On drainage dimension, the study, it was shown that the drainage dimensions vary from one study zone to another. However, the general observation is that the width and depth of the gutters in most of the sampled zones are narrow as exemplified by frequency flood episodes. Jimoh (2008) made a similar observation in a study of drainage dimension in Ilorin Nigeria. In the study it was reported about 31.5% of the respondents were of the view that one of the effects of drainage channel problem is the incidence of temporary street flooding. In addition, in a study by Daniel *et.al*, (2012) in Gombe also observed that 42.5% of the respondents agreed that lack of drainage facilities constitutes the major factor that is causing flood in Gombe.

This study also revealed that factors of flood occurrence in the sampled zone is linked to building on water channels, poor physical planning, inadequate drainage channels, heavy rainfall, nature of terrain, dumping of refuse on drainage channels. However, different weighted responses were given in the respective factors of flood occurrence. For instance, 26.3% of the respondents attributed the frequency of flood in the city to heavy rainfall. In the same way, 22% of the sampled households traced the problems of flood to inadequate drainages while 15.7% of the people interviewed said flood occurs because of poor planning.

Other factors like poor planning, inadequate drainage channels, heavy rainfall, nature of terrain, dumping of refuse on drainage channels, only aided the incidence of flooding in tropical urban areas of Nigeria. This has been confirmed by several studies (Oreola 2003; Olagunorisa 2004; Abam 2006; Etuonovbe, 2011; Aderogba 2012). It is therefore important that in the construction of drainages the authority should take note of the fact that Calabar is located within the tropics characterized by prolong and intense rainfall to avert or reduce flood events that has become a recurrent decimal in today. However, in a study by Ole (2013) in Bombay India, floods were observed to be mainly caused by inadequate existing drainage paths and their improper operation and maintenance.

### 4.5.2 PERCEIVED CAUSES OF INADEQUATE DRAINAGE NETWORKS IN CALABAR

Table 4.5b presents the perceived causes of inadequate drainage network in the city of Calabar. It can be observed that non-conformity to land use planning was identified as a major factor responsible for inadequate storm water channels in the study area. About 28.7% of those interviewed linked poor drainages to non conformity to land use zonation. Closely following this factor was poor monitoring and evaluation of project as high as 21.5% of those sampled accepted

that poor monitoring and evaluation is a serious problem that affects the standardization of drainages in the city. In addition, 17.3% of the sampled population attributed inadequate funding as a factor that hampered the provision of adequate drainages in the city.

Figure 4.2b also revealed that government don't often prioritize the provisions of drainage channels as about 18.2% of the respondents claimed government neglects this segment of urban infrastructure development. Even when provisions are made for drainage channels in road construction contracts, the contractors often construct the roads without recourse to drainage provisions (Offiong *et.al* 2008). This has persisted because governments pay little or no attention to contract specification. This is compounded by the weak institutions in the state.

Another 12% of the respondents claimed government negligence, inadequate funding, nonconformity to land use planning and poor monitoring and evaluation are all responsible for inadequate drainage channels in the city. Table 5 also indicates that the estimated required drainage channel for the entire country is short by about 61.78%; and the existing ones are only about 30% maintained, (Amaize, 2011). However, in the city of calabar Aderogba (2011) study concluded that the estimate shortfall of drainages was less than 50.00% (48.75%). This finding does not reflect the reality in the city as the drainages are either too narrow or too shallow to contend the volume of runoff like Ikot Ansa, Henshaw town and Esuk Ediba.

**Table 4.6a: Perceived causes of inadequate drainage systems in Calabar**

| Causes | Number of responses | Percentage |
|---|---|---|
| Government negligence | 73 | 18.2 |
| Inadequate funding | 69 | 17.3 |
| Poor monitoring and evaluation of projects | 86 | 21.5 |
| Nonconformity to land use planning | 115 | 28.7 |
| All of the above | 48 | 12 |
| Others | 09 | 2.3 |
| Total | 400 | 100 |

**Source**: Author's field survey (2014)

**Table 4.6b: Perceived causes of inadequate drainage networks in Calabar**

| Causes | Number of responses | Percentage |
|---|---|---|
| Government negligence | 73 | 18.2 |
| Inadequate funding | 69 | 17.3 |
| Poor monitoring and evaluation of projects | 86 | 21.5 |
| Nonconformity to land use planning | 115 | 28.7 |
| All of the above | 48 | 12 |
| Others | 09 | 2.3 |
| Total | 400 | 100 |

## Table 4.6c: Estimated shortfall in drainage channels in town and cities in Nigeria

| Cities and towns | Estimated short fall in drainages (%) |
|---|---|
| Abuja | 27.25 |
| Abeokuta | 63.48 |
| Aba | 68.75 |
| Ibadan | 56.78 |
| Owerri | 59.45 |
| Warri | 78.86 |
| Benin city | 83.75 |
| Jalingo | 76.65 |
| Enugu | 48.75 |
| Kano | 54.45 |
| Kaduna | 67.55 |
| Katsina | 62.45 |
| Sokoto | 56.75 |
| Bauchi | 64.65 |
| Akure | 58.55 |
| Ondo | 56.75 |
| Ogbomosho | 54.58 |
| Osogbo | 59.35 |
| Onitsha | 78.75 |
| Calabar | 48.75 |
| Markudi | 65.25 |
| Maiduguri | 69.50 |
| Ilorin | 63.00 |
| Gombe | 68.65 |

Source: Aderogba, (2011)

### 4.5.3: QUALITY OF DRAINAGE NETWORKS

Table 4.5d presents data on the quality of drainage networks in Calabar metropolis. From the table, it can be observed that there was an overwhelming agreement across the sampled flood prone areas that the dimensions of the drainages is well below the volume of storm water that is often experienced in the area. Specifically, in Ikot Ansa, 65.11 %of the respondents believe the gutters are very narrow just like 75% were of similar view in Esuk Ediba. In Henshaw Town, Anangtigha, CRUTECH and MCC, 54.83% (17), 64.28% (54), 79.49% (31) and 77.17% (71) respectively of the sampled households accepted that the drainage channels in their area were very narrow.

The table further revealed that some of the respondents were of the view that the drainages were not well plastered. These views were unevenly distributed in the sampled zones. For instance, in Ikot Ansa, 10.46% (9) of the respondents said the gutters were not plastered properly, while in Esuk Ediba, 7.69% of the sampled population held similar views. In the same vein, 22.58% of those sampled in Henshaw Town said the drainages were not well plastered. While in Anangtigha, 16 of those interviewed agreed that drainages around their neighborhood were not done properly. It was observed also that in CRUTECH axis, only 5.12% of those interviewed held the view that the drainage channels were not well plastered. Surprisingly, Satellite town which is purported to be a high brow area have very high responses in favour of the fact that drainages within their zone were not well plastered too. Specifically, out of the 16 people sampled, 9 representing 56.25% gave such responses. Relating it now to the present dimension of the drainage, It was observed that the channels are without concrete at the base and walls. Over time, the force of the torrential rain will cut off the road as is the case in IkotAnsa (plate 4.7).

**Table 4.6d: Quality of drainage network**

| | Ikot Ansa | | Esuk Ediba | | Henshaw | | Anangtigha | | CRUTECT | | MCC | | Satellite | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quality of drainage | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Very narrow | 56 | 65.11 | 39 | 75.00 | 17 | 54.83 | 54 | 64.28 | 31 | 79.49 | 71 | 77.17 | 4 | 25.00 |
| Not well plastered | 9 | 10.46 | 4 | 7.69 | 7 | 22.58 | 16 | 19.04 | 02 | 5.12 | 14 | 15.21 | 9 | 56.25 |
| Not well designed | 18 | 20.93 | 6 | 11.53 | 5 | 16.12 | 9 | 10.71 | 5 | 12.82 | 6 | 6.52 | 2 | 12.5 |
| Highly fractured | 3 | 3.48 | 1 | 1.92 | 2 | 6.45 | 1 | 1.19 | 01 | 2.57 | 01 | 1.08 | 1 | 6.25 |
| Not present at all | 0 | 0.0 | 2 | 3.84 | 0 | 0.00 | 4 | 4.76 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 |
| Total | 86 | 100 | 52 | 100 | 31 | 100 | 84 | 100 | 39 | 100 | 92 | 100 | 16 | 100 |

Source; Author's survey (2014)

**Plate 4.7: Torrential rain in yellow duke Road**

### 4.5.4 EFFECTS OF POOR DRAINAGE NETWORK ON THE ENVIRONMENT/INFRASTRUCTURE

In figure 4.2c, 64.5 % of the respondents have their houses flooded, 11.25 % of the respondents said they are prevented from moving out, while 6.25 % of the sampled population accepted that flooding distort the beauty of the environment. More so, 3% said houses often collapsed during flooding, 11 people out of the 400 interviewed said flooding of houses, landslide/erosion, collapsing of buildings, prevention from going out, pollution of water sources, silting of streams and compounds, and distortion in the beauty of the environment are agoning effects of poor drainage channels in the city.

Generally, beside the personal effects of flooding, all the respondents noted that flooding has affected public infrastructures such as roads been submerged, electric and telephones pulled down, markets, schools and churches flooded and drainage channels blocked with wastes. It was also observed that majority of the buildings do not obey established meters setback to the drainage channels and from one building to another.

The observation has been corroborated else where in Nigeria. According to Etuonovbe (2011), floods are the most devastating natural disasters, claiming more lives and causing damage to properties than any other natural phenomena. In Nigeria, though not leading in terms of claiming lives, flood affects and displaces more people than any other disaster. It also causes more damage to properties and at least 20% of the population of Nigeria is at risk of one form of flooding or the other (Ochere and Okeke, 2012). The observation has also been corroborated in Calabar. According to Eze (2008), poor drainage network are often associated with street flooding and this has become critical environmental problem in coastal cities of Nigeria

especially in Calabar metropolis. However, it is not water from the ocean that usually flood these cities but the heavy rains, and the poor drainage network (Aderamo, 2008).

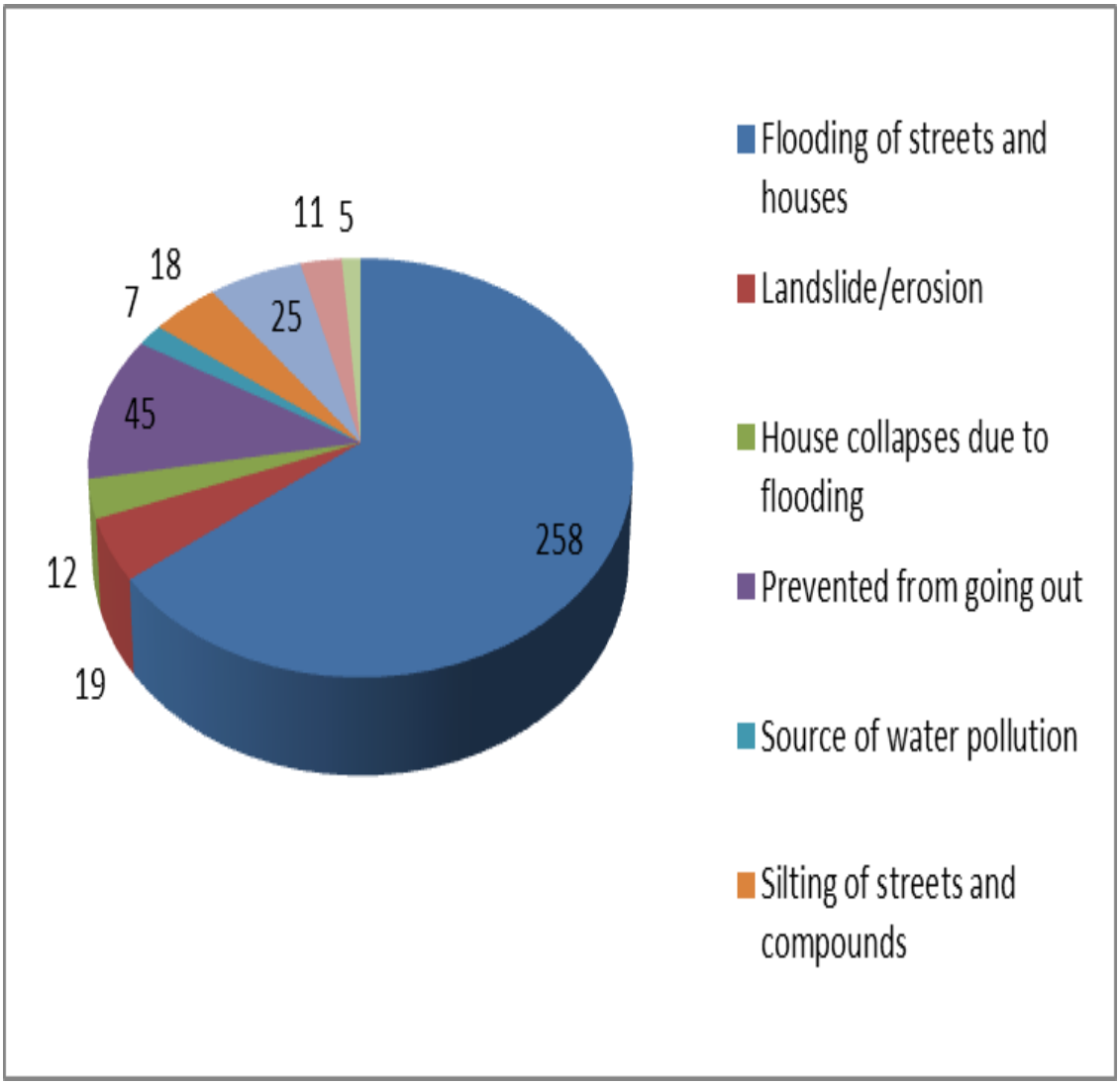


**Figure 4.2: Effects of poor drainage network (2014)**

**Source**: Author's survey (2014)

On perceived causes of inadequate drainages in Calabar, 28% of the respondents said nonconformity to land use planning is the major cause in adequate drainage network in the city of Calabar. Others were of the opinion that poor monitoring of drainage projects account for the prevalence of inadequate drainage conditions in city. It was also observed that 18.2% of those interviewed linked the problem of inadequate drainages to government negligence while 17.3% said poor funding of such projects was responsible for the problem of poor drainage networks in the city of Calabar.

The study also revealed that the effects of flood in Calabar include streets inundation by flood waters, landslide/erosion, distortion of the beauty of the environment, silting of streams, prevented from going out among others. The finding of this study is line with the studies of Offiong *et.al*, (2008), Offiong and Imoke (2008), Eze (2008), Jimoh (2008), Adedeji *et.al*, (2012), Aderogba (2012a, 2012b), Olajuyigbe *et.al* (2012), Ocheri and Okeke (2012), Bariweni *et.al* (2012). These studies listed the effects of flood in most southern and northern parts of Nigerian to include both not limited to death of people especially children and the aged, damage to properties, displaces people prevented from moving out, houses collapsed, pollution of sources of water especially hand dug wells, flooding also affects public infrastructures such as roads been submerged, electric and telephones pulled down, markets, schools and churches flooded and drainage channels blocked with wastes.

# CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.1 SUMMARY

The frequency of floods episode in the city of Calabar is not unconnected to the problem of inadequate drainage networks as the study has revealed. The study indicates that about 47% of the respondent said flood occurs every year in the city of Calabar while 41.75% were of the view that they do experience flood most parts of the year. However, only 1.75% of the sampled residents claimed they have never experience flood. This response is likely to have come from those who live Satellite Town which is high brow residential area with relatively adequate drainages. On the frequency of flood, 59.5% of the sampled population supported the view that flood events are often very high while 41.75% of them said flood episode is fairly high and only 0.5% claimed flood intensity is low in the city.

The also observed that drainage dimension in the study zones vary but generally the depth and width of the drainages are not adequate for the runoff volume flowing through them hence the incessant overflowing of the banks. Specifically, the mean width of the drainages in Ikot Ansa is 64cm, depth is 58cm while the width to depth ratio is 1.10 and a total of 7 drainages were measured. On runoff volume in the station along one of these drainages, 3812% was recorded.

Similarly, in Esuk Ediba, the width, depth, and width to depth ratio is 84.8cm, 63cm and 1.34 respectively. The runoff volume was 42.10% while 4 channels were used for the study. In Henshaw Town, the dimensions of the channels is 75.3% (width), 45% (depth), width to depth ratio is 1.67 while the mean runoff volume for was 36.0%. The study also observed that in Anangtigha, the measured channels have width mean values of 61.3%, depth of 38%, and width

to depth ratio of 1.61 while the runoff volume was 38.01%. A total of 8 channels were observed in Anangtigha.

CRUCTECH zone has the highest numbers of drainages (13) and the dimensions are larger compared to other zones. The mean width of the drainages in this zone is 107.6 $^{S}$/%, the mean depth is 69%, width to depth ratio is 1.55 and the average runoff was 49.8%. In MCC zone, the width, depth and width to depth ratio is 82%, 56%, 1.46 respectively. A total of 3 drainages were surveyed while the average runoff volume in MCC was 32.2%. Satellite Town is high brow area where most of the University of Calabar staff live relatively good drainages that are maintain on a regularly basis. The drainage width is 55.5%, depth 36% and the runoff volume was 9$^{S}$/%. A total of 4 channels were studied. This area has little or no flood as rainstorm water flow freely without any impediments.

The study also indicates that heavy rainfall was the main factor responsible for flood occurrence in Calabar as 105 out of the 400 numbers of people interviewed blamed flood on heavy rainfall. This was followed by inadequate drainage, poor physical planning among others. It is imperative to note that different views were expressed as the perceived cause of inadequate drainage in Calabar. On the bases of this, many of the sampled population blamed it on non conformity to land use zoning, poor monitoring and government negligence.

The sampled head of households claimed that the quality of the drainages in their zone is very narrow and not well plastered. In Ikot Ansa, 65.11% of those interviewed supported the view that the have narrow drainages in their zone. In Esuk Ediba the same high response was given (75%). In Henshaw Town, 54.83% of those sampled accepted that the quality of the drainage in their area is narrow and 19.04% of the people in the same area said the gutters are not

plastered properly. In Anangtigha, CRUTECH, MCC and Satellite Town, 64.28%, 79.49%, 77.17% and 25.00% of the sampled people said their gutters are narrow. On the quality of the finishing in the gutters in Anangtigha, CRUTECH, MCC and Satellite Town, the percentage distribution of the responses were 10.46%, 7.69%, 22.58%, 19.04%, 5.12%, 15.21%, and 56.25% respectively. It can be observed that a very high proportion of those interviewed in Satellite Town claimed the drainage channels are very narrow but well plastered.

The lapses in the drainage characteristics have varied effects on the environment of the study area. According to the respondents, one of the most pervasive environmental problems traced to flood is flooding of streets which prevent them from going out to do carry out daily activities. The study also revealed that whenever flood occurs, it destroys the beauty of their surrounding. In some occasions, landslide and erosion do take place and destroy their properties. The menace of flood in the city of Calabar is increasingly becoming worrisome in recent time. Poor planning and inordinate development of properties in Calabar often exacerbate the problems of flood. This is why this study makes the following recommendations.

## 5.2 CONCLUSION

Flood remains a very serious environmental problem in Calabar. Recurrent flood events in the city of Calabar have been traced to in inadequate drainage channels. Many properties have been destroyed, lives lost and this has subjected the people to unquantifiable trauma. More so, the menaces of flood have been on the increase as a result of incipient and prolong weather conditions.

The findings of this study was to assess drainage network and floods occurrence in Calabar Metropolis. The data collected from the field and extant literatures were used to achieve

the outlined objectives. The result revealed that flood occurs every year and most parts of the season while the flood intensity ranges from very high and fairly high. On the dimension of the drainages across the seven sampled zones, only two zones hard consistent patterns of drainage width and runoff. That is, high drainage width correlated positively with runoff volume in CRUTECH and Esuk Ediba. However, other zones showed irregular patterns in drainage width and runoff volume. For instance in Henshaw Town, the drainage width is 75.3% while run was $36.O^{S}$/m. this may explain by the undulating drainage beds in some sections of the drainage as the concrete floor has been washed away by the storm water.

The study also recorded similar observation in MCC, Ikot Ansa, and Satellite Town. On the whole, it was observed that flood intensity is very high in CRUTECH zone even when very large and wide drainage channels exist in the area. The presence of waste and other household items like furniture in the gutters might have been responsible for the storm water over flowing it bounds.

Many factors were identified as being responsible for flood occurrence. Some of them include building on storm water drainages, poor physical planning, inadequate drainage channels, heavy rainfall, dumping of waste on drainage networks and nature of the terrain. This flood causing factors have created series of environmental and socioeconomic problems in Calabar. Some of which include flooding of streets, lost of life, pollution of domestic water sources, distortion of the beauty of the environment, prevented from going out among others.

In view of these, the study put forward some recommendations which when implemented will help in mitigating flood incidence in Calabar. Some of the recommendations are; the government should award contract to a competent company for the construction of underground

drainages covering the entire city of Calabar, as surface drainages have created many problems to the resident including the lost of lives, the present drainage systems should be cleared with shove is on regular basis to allow for the free flow of storm water and the government and NGOs should carry out massive awareness campaigns on the need for the people to stop dumping waste in the drainage channels. In addition, government should put in place flood early warning signal system with the capability to deliver reliable timely and effective flood information at an appropriate response time. This will help to reduce the lost of lives and properties in the city.

## 5.3 RECOMMENDATIONS

1. Giving that Calabar is located in a tropical zone characterized heavy rainfall; the government should take proactive measure to mitigating the storm waters by clearing the drainage channel on regular basis.
2. The government contract should be awarded to a competent company for the construction of under drainages covering the entire city of Calabar, as surface drainages have created many problems to the resident including the lost of lives.
3. The government and NGOs should carry out massive awareness campaigns on the need for the people to stop dumping waste in the drainage channels.
4. The cross River State government should re-enact the monthly sanitation exercise which will help in the total removal or reduction of waste in the drainage channels. This will not only stop flood occurrence but will also enhance the beauty and health of the people.
5. Government should put in place flood early warning signal system with the capability to deliver reliable timely and effective flood information at an appropriate response time. This will help to reduce the lost of lives and properties in the city.

6. Building without plan approval in every part of Calabar should be unacceptable. In fact, all structures built on drainage way of right should be demolished to reduce the carnage caused by flood.

7. All roads constructed in Calabar should be provided with adequate drainages to avoid constant flooding especially during the rainy season.

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## APPENDIX

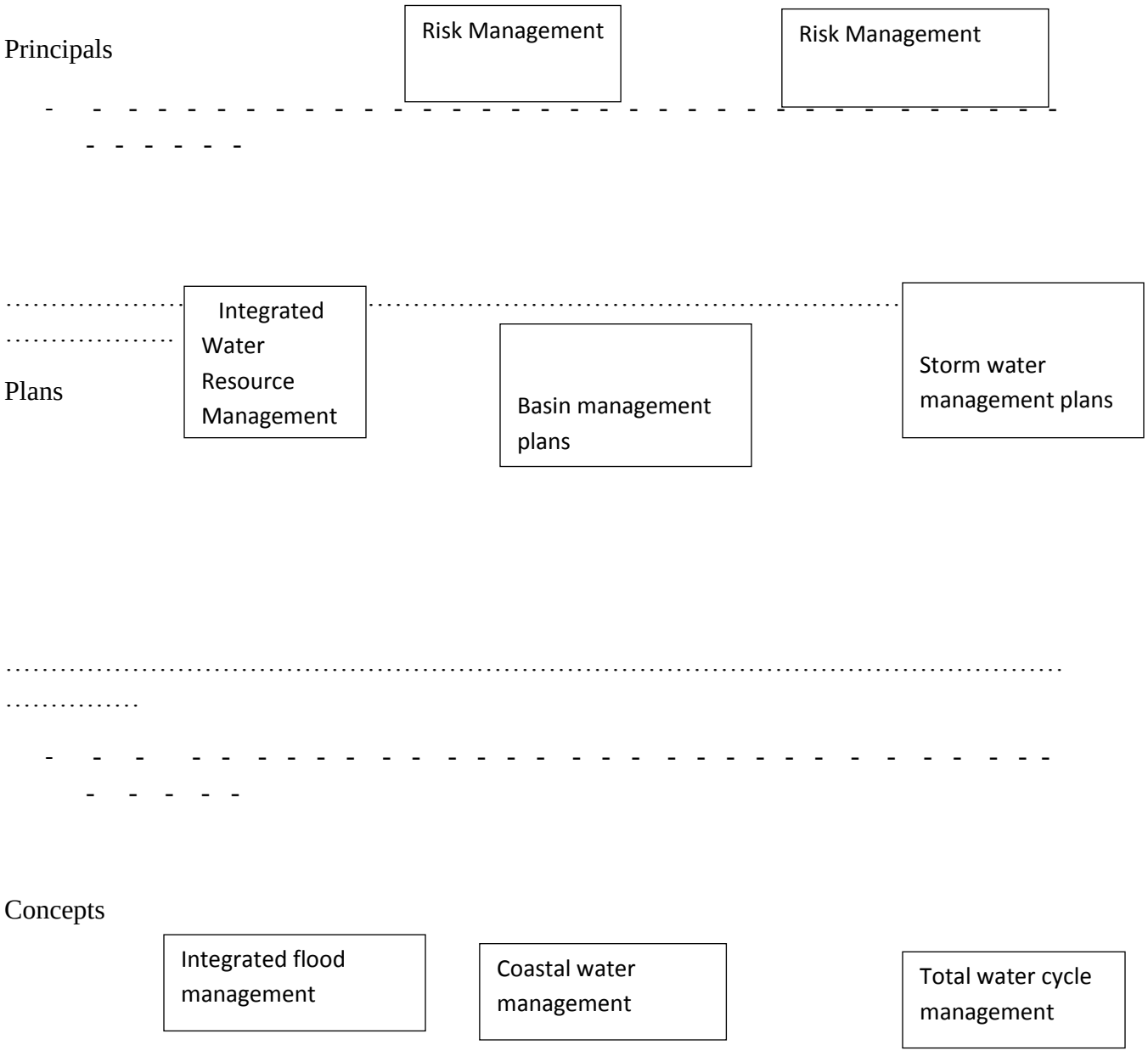


**Figure 1: Conceptual framework of urban flood management after WMO/GWP (2008)**

Source: Global strategic outlook, water security and growth futures.

**DEPARTMENT OF GEOGRPAHY,**

**AHMADU BELLO UNIVERSITY, ZARIA**

**RESEARCH QUESTIONNAIRE**

Good Day, my name is Mr. Ndoma, Emmanuel Efobe. I am a post graduate student of Ahmadu Bello University Zaria carrying out a research on Drainage Networks and Floods in Calabar Metropolis.

I would like to interview you. This interview is purely for academic purposes, and your answers would be confidential. There will be nothing in my records to identifying you in person, so fell free to give me any information.

Do you agree to be interviewed Sir/Madam?

**SECTION A: Personal Data (please tick [√] in the box provided/ fill in the required answers in the dotted lines)**

**Background**

1. Are you the head of the household? **(**a) Yes [ ] (b) No [ ]
2. Sex (a) Male [ ] (b) Female [ ]
3. Occupation (a) Business/Trader [ ] (b) Public or Civil Servant [ ] (c) Pensioner [ ] (d) In School [ ] (e) Fishing (f) Unemployed [ ] (g) Others (Specify)…….
4. Educational Status (a) No Formal Education [ ] (b) Primary Education [ ] (c) Secondary Education [ ] (d) Tertiary Education [ ].
5. Income per Month (a) Less Than 10,000 Naira [ ] (b) 10-20,000 [ ] (c) 20-30,000 (d) 40,000 and Above [ ].

6. Name of street----------

**7.** Household size (a) 1-3 [ ] (b) 4.6 [ ] (c) 7 and above [ ]

**SECTION B: Environmental state of drainage networks in your street**

8. What is the quality of drainage network within your area?

(a) Very narrow [ ] (b) Not well designed [ ] (c) Not well plastered [ ] (d) Highly fractured

[ ] (e) Not present at all [ ] (f) Others (Specify) ----------

9. Do have adequate drainage networks within this street?

(a) Yes [ ] (b) No [ ]

10. If your answer is No, what could be the cause of this inadequate drainage networks?

(a) Government Negligence [ ] (b) Inadequate funding [ ] (c) low level of technical knowhow [ ] (d) poor monitoring and evaluation [](e) lack of information and communication on the state of drainage facilities [ ] (f) all of the above [ ]

10b. what are the main causes of poor drainage system in your street? (a) Disposal of solid waste into drains [ ] (b) poor drainage connectivity [ ] (c) use of substandard materials for construction [ ] (d) the drainages are not wide enough [ ] (e) heavy rain (f) All of the above [ ]

11. What are the environmental effects of poor drainage systems in this street?(a) Flooding [] (b) Erosion [ ] (c) Silting of streams [ ] (d) Distortion of the beauty of the environment [ ] (e) all of the above [ ] (f) others (specify) ----------

12. Building Setback from the river plain

(a) 1m – 10m [ ]
(b) 11m – 20m [ ]
(c) 21m – 30m [ ]

(d) 31m – 40m [ ]

(e) 41m and above [ ]

13. What is the Estimation of the effects of flood on lives and properties?

(a) Very high [ ]

(b) Fairly high [ ]

(c) Low [ ]

Thank you.