FLOOD THREAT TO AKURE URBAN SPINE:
Ala River as a case study

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DECLARATION

I, **FADAIRO GABRIEL (ARC/90/2465)** declare that the information contained in this M.ARCH Thesis is the result of honest research undertaken by me which is original and has not been submitted in part or full for publication for any other degree of this or any other University.

Signature.

07/02/2021

Date.

CERTIFICATION

This **M. ARCH (URBAN DESIGN)** Thesis entitled: **FLOOD THREAT TO AKURE URBAN SPINE**: *Ala River as a case study*, by **FADAIRO GABRIEL** meets the regulations governing the award of the degree of **MASTER OF ARCHITECTURE OF FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE**, and is approved for its contribution to knowledge and literary presentation.

Professor E.A. Adeyemi
Supervisor

Signature

13 February 2001
Date

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Co - Supervisor

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09/02/2001
Date

DEDICATION

This Thesis is dedicated to my Children:

Masters **Busayo Francis Oladimeji** and **Bukola Felix Abiodun.**

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ABSTRACT

The Urban environment has always been an area of high population concentration in Nigeria mainly because, people tend to believe that the only hope of improving their standard of living is to live in an Urban environment. Among the problems of high concentration of people in limited Urban space is excessive development on vast lowlands areas of Ala river. Despite the high risk of flooding on the valley lands there, the flood - prone area offers the poor of Akure a place to build the homes.

Floods are the waters which cover an area of land that is normally dry Ala river (a prominent river in Akure) floods annually during the rainny season from July to September. It affects almost every development in the flood - prone area of Akure. The study therefore uses open-end and closed-end types of questionnaire to obtain useful information from the flood - prone area inhabitants and from other individuals. The study also involves field checks and the review of flood related literature to obtain facts and useful information from the local government data bank. Causes of floods in the study area include: inadequate storm drains, dumping of refuse in drains, excessive rain fall, impervious urban land surfaces, and building along water flow path. The effects on the urban dwellers include clogging of drains, damage to household property, damage to landed property, traffic congestion, water po lution and business slow down.

Although floods can never be completely prevented, a variety of measures can be adopted to reduce their devastating impact. This thesis intends to proffer solutions to Urban flood and erosion hazards in Akure through land-use zoning and planning

strategies. Such measures include channelization of Ala river, sewage and drainage facilities provision for areas ripe for urban development as basic urban formulation well ahead of development.

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CHAPTER ONE

1.0 INTRODUCTION

Akure became the capital city of Ondo State in 1976. As a result of its becoming a state capital in the past twenty four years, a noticeable change could be identified in its physical and overall population; with untold implications and demands on the available resources, services and infrastructures. With the changes in its physical development, some rationality, should be brought to bear on the physical development.

It is however gratifying to note the total commitment of the present state government to the improvement, not only in the standard of living of the people, but in a definite improvement of the environment itself. Planning administrations have neglected the planning of our towns more particularly flood threats to the environment. If tackled earlier, the cost of meeting these threat would have been cheaper particularly as the advantages of water resources planning becomes more noticeable or perceivable.

Akure terrain is traversed by numerous streams and the most important of these streams is the Ala river which during the rainy season carries heavy flood. River Ala flows from West to East through the developing urban area to the North of the town. Development by private and public developers is heavy along its course. The development on the flood plain resulted into disastrous flood of July 1978 and the subsequent annual havoc done to urban dwellers in Akure.

From available data and individual experience, flood threats occurs regularly every year in different parts of the country and are repeatedly in the headlines of local and national news. While many floods may cause little damage and are usually soon

forgotten except by those most directly affected, some may result in major disaster involving structural and economic damage and destruction of socio-economic activity and in the contamination of food, water and the environment in general. Urban flood atimes, as overland flow over urban streets cause significant property damage, traffic obstructions, nuisance, and health hazards.

1.1 Need for the Study

The number of streets that experience erosion problem or sudden floods of one hour or more during the rainstorm increases from July to September in Akure. The Ala river valley which at its current level of development is prone to flooding, needs urgent attention in order to reduce future threats on the dwellers. For instance, the inhabitants of the following strategic locations on the Ala valley suffer the consequence of flood threat; namely, Ojomu Otenioro layout junction along Oke-Ijebu road, Isolo Quarters, Araromi Quarters, Isinkan Quarters, Adesida. road, Oyemekun road, and Osinle Quarters among others.

Further development will result in greater run-off into Ala river valley as more building roofs are erected and less opportunity to infiltrate, thus increases the flood potential.

It is imperative therefore that something positive should be done to improve the river course and reduce flood threat.

1.2 Aim

The thesis is intended primarily to determine extent of flood threat and to recommend a workable planning, design and construction or implementation strategies for Ala River flood plain area development.

1.3 Objectives

The objectives of the study are :-

(a) To investigate the development problems on Ala flood plain in Akure;

(b) To determine the planning and design implications of the existing development on the flood plains;

(c) To review the refuse collection from households, as it affects the valley of Ala.

(d) To investigate the existing erosion channels and make appropriate design recommendations for flood plain area development.

1.4 Scope and Limitation of the study

The thesis is basically to determine flood threat to Akure urban spine. The scope will be limited to the flood-prone area (of Isolo/Oke-Ijebu area) of Ala river valley. This involves the study of the strategic locations where flood threat has become as an ecological hazard. The proposal shall go as far as incorporating drains design, which shall meet expanded needs in the next ten years.

Two main problems encountered in the pilot study is inadequate research finding and motorable access along the length of Ala river. This in turn affects the extent of access with all its implications for a much improved study. The only available map for Akure drawn in 1988 is old, outdated and therefore does not

indicate sufficiently areas of recent development. The 1998 reviewed master plan of Akure does not adequately show this e ther.

1.5 Research Methodology

A two-pronged approach to the research had been adopted, using primary and secondary sources of information.

Primary data:- This study uses open -end and closed types of questionnaire to obtain useful information from the river valley inhabitants and from other individuals. Person - to - person interviews were co ducted as well as a field survey of the flood-prone area. In addition, pictorial form of data collection was used that is, the use of photographs to obtain n ar accurate figure of the flooded area.

Secondary data:- The study also involves the review of related literatures to obtain facts and useful information from the local government data bank and vital journals, magazines, weather data from meteorological garden, including published and unpublished books from the library.

The information thus gathered using primary and secondary sources of data, formed the basis for the design proposal. Findings were analyzed and used as basis for future development.

1.6 The study area/catchment area

The study or catchment area of the research is the flood-prone area of Ala river, that is, Isolo Quarter, Araromi Quarter, and Oke-Ijebu Quarters, where the river annually causes havoc to the urban inhabitants of the area in Akure. Illustration of the area prone to flooding is shown in Figure 1 below.

1.7 Plan of Work

To achieve the aim and objectives of this study, the thesis write - up is broken into six chapters for better understanding of the research.

The first chapter which is the introduction discusses need for the study, the aims and the objectives of the study, its scope and limitation. It discusses the methodology and the study catchment area. Chapter two review literature related to flood and erosion hazards. Chapter three concentrates on floods and urban design. Chapter four which is the core of the study describes the Akure physical setting and land use. While chapter five treats analysis of data. The final chapter six contains summary of findings, recommendations, suggestions and conclusions.

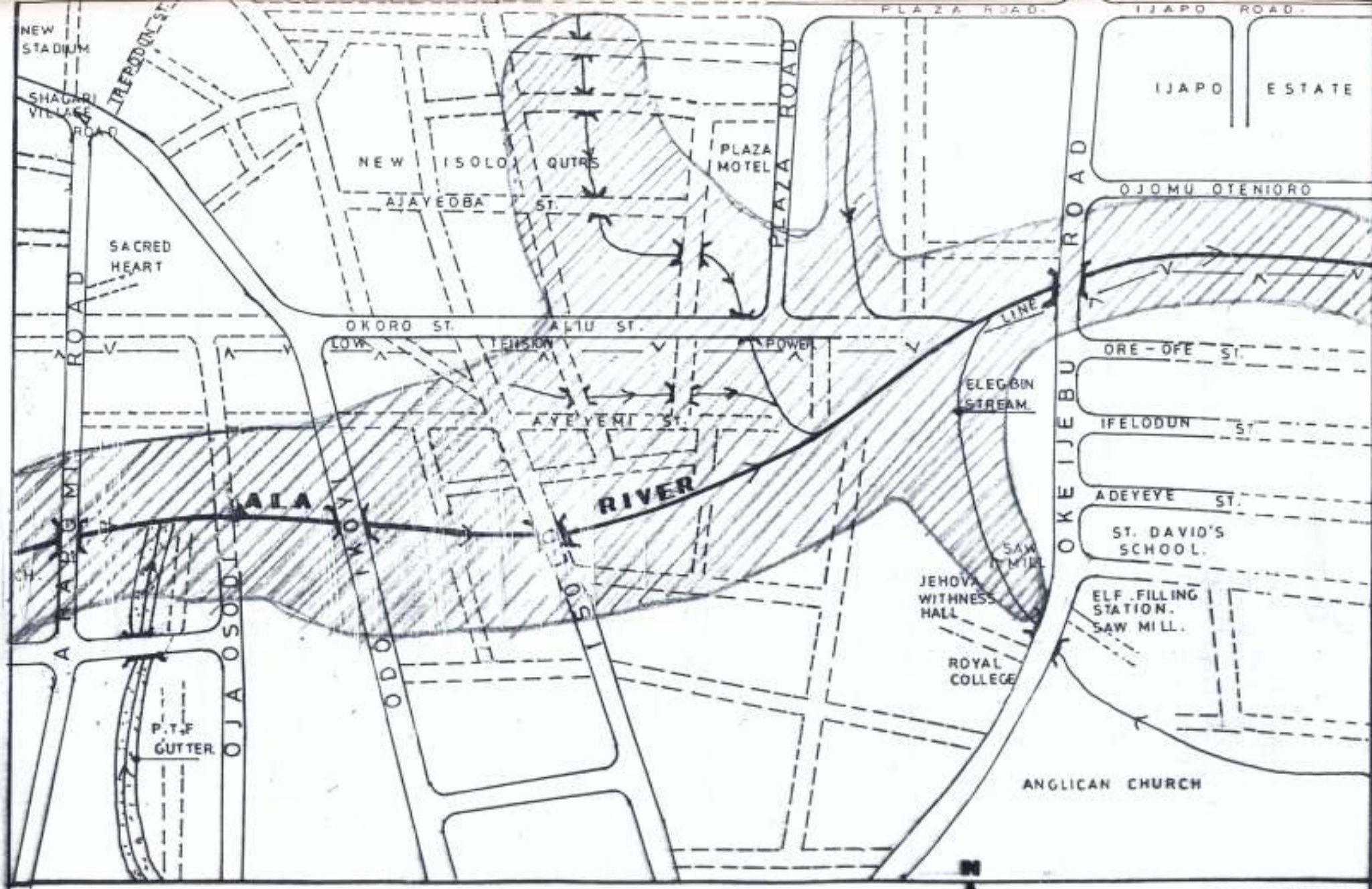


FIGURE 1 : ILLUSTRATION OF THE FLOOD-PRONE AREA.

2.0 REVIEW OF RELATED LITERATURE

2.1 Soil Erosion

Erosion is an act of wearing away of soil according to National Teachers Institute (NTI, 1990). Fadamiro (1977) opines that man deforests the land through various activities such as farming, lumbering, bush burning, building and road construction leading to exposure of the land to climatic elements, particularly rainfall. Rain falls on the surface of the earth; to produce run off in form of torrents or streams and rivers. As the water flows on the bare soil, it detaches the soil particles and washes them down the slopes. Further erosion may result into gully erosion. This devastates the land; thereby limiting man's activities.

Man interacts with his environment and exploits the environment to cause some problems. Such problems may include erosion. There are many types of erosion, namely glacial erosion which occur in cold regions, wind erosion which is dominant in the desert region and the third type is the water erosion which is aggravated by man.

Fasakin (1996) defines erosion as devastating natural processes aided by the action of man. He stressed that erosion and flooding are quiet crises, in siduous hydrological process which involves the action of water on both sub surface and land surfaces that brought disasters to man worldwide.

Givoni (1981) opines that erosion is a function of excess surface flow resulting from rainfall, which in turn affects buildings. In townships, this excess flow of water can be reduced per unit time, if the roofing patterns of houses are modified especially in area of high intensity rainfall.

Fadamiro (1977) concludes that human activities contributed largely to the soil erosion processes. These include quarrying and mining operations, road and building constructions, advanced channelizatlor., and indiscriminate destruction of vegetation cover.

Oxford advanced learners dictionary of current English (1974) defines erosion as wearing away or eating into the soil by wind, ice and rain. Erosion problems involving urban, farmlands and shorelines areas have become serious issues of national concern that should not be tackled through a crisis approach. This is because of all the large-scale effects of environmental degradation and hazards resulting from erosion.

2.2 Process of Erosion

When rain falls some of it runs off the surface forming streams and rivers; some of it evaporates directly or indirectly via plants; some of it soaks into the surface rocks. The amount of run-off, evaporation and percolation depends upon the nature of the soil, the slope of the land, and the climate. Run-off on steep slopes is greater than on gentle slopes. Evaporation in dry climate is greater than in humid climates, and water percolates into sands more easily than into granites. Clay is porous water enters it, but it is impermeable.(Bunnett , 1973)

Rain action is an aspect of erosion because it involves movement. It produces many types of features of which gully, earth pillar, soil creep, and landside are the most common . Gully occurs when rain water falls on gently sloping land, which has, little or no vegetation moves down hills as a sheet of water. The slope is quickly eroded into deep grooves called gullies . They develop on a small scale on

embankments and cuttings and also tip heaps; and developed one large scale where the landscape becomes cut up into gull es and ridges of all shapes and sizes.

A region of steady rainfall or in a spring forms a river's source. A river's source is the place at which it begins to flow. And a rivers mouth is the place where the river ends. This is usually in the sea

Rivers are one of the greatest sculpturing agent at work. A river does three types of work. It erodes, it transports, and it deposits in process of time, river erosion transport and deposition turns the original surfaces into almost level plain.

A river usually has three sections along its reach: the upper course, middle course where transport is the dominant process, and the lower course where the main process is deposition.

The amount of erosion that a river can achieve depends on its energy. A river energy increases with its volume and with its velocity and with its regime (seasonal flow). This means that a large fast flowing river will have more power to affect erosion in times of flood than the same river will have in times of drought when it flows sluggishly with little water in its channel.

Energy is the ability to do work, and the amount of energy, which a river has, determines whether it can effectively erode its valley and transport the material it is carrying, or whether it drops the material in the form of deposition. However, not all the energy in a river is used for erosion. Some are needed to overcome frictional resistance both externally along the bed and banks; and internally when currents caused by turbulence, splash and toll against each other. Energy is also needed to transport the pebbles; sand silt and the dissolved minerals in the water.

The rivers channel shape determines how much energy a river will have for erosion. A flat, wide channel is very inefficient for transporting water, while a narrow,

same cross-sectional area the same volume of water.

In upper part of a river's course, the gradient of the channel is steeper, but the volume of water is less. It is used to be true that a river flowed fastest at this point with maximum velocity and at average speed. In the middle and lower section of a river's course, the average flow of the rivers could be equal to and even greater than the speed at the upper course. This is because of the greater loss of energy to overcome internal friction in the turbulent upper section.

A river transports its load by: dragging (traction of the bed-load of pebbles along its bed; by suspension of light sediments such as silt and lime in the water; and by solution of chemicals which are dissolved in the water. Sediments are transported by a river unit it has insufficient energy to move them further. It then deposits them.

A river may lose energy when there is either a decrease in gradient , or a widening or meandering of its channel (for example in its lower course), or where there is a decrease in volume, for instance after a flood.

Erosion in a river is caused by attrition which is the process whereby pebbles are eroded by striking together as they are rolled along a river's bed; by corrosion which is the wearing away of the bed and the banks by a river's bed; by hydraulic action which is the wearing away of the bed and the banks of a river by the sheer weight of water hurled against them which is effective in fast-flowing rivers; and chemical solution is the dissolving of minerals from the rocks, and it is particularly effective with soluble minerals.

2.3 Characteristics of Erosion

The force of erosion partly depends upon its size and partly upon its gradient, that is the distance it has to fall before it reaches base level, which is the surface of a stream or a river into which it flows.

Erosion has a life-cycle, like an animal or a plant according to Bunnett (1973). In the beginning, when it is in the youth stage, it flows turbulently in a narrow, steep-sided valley whose floor is broken by pot holes and waterfalls.

As time passes, denudation widens the valley and lowers its floor. Now that the gradient is reduced the erosion has less energy to erode and the initial bends that it had, because of the nature of its valley floor becomes more pronounced. It is now in the stage of maturity. As denudation continues the valley is opened out more and more. The gradient is further reduced and deposition now becomes active. Layers of sediments are dropped by the path and these ultimately extend over the entire floor of its valley where they build up a gently sloping plain called a flood plain.

The erosion wanders in great meanders or loops across this plain and it often becomes divided into many channels by its own deposition. The erosion is now in the old stage. The upper course represents the youth stage, the middle course represents the maturing stage, and the lower course represents the stage of old age.

Rain wash, soil creep and undercutting at the head of erosion combine to extend the valley up the slope. Erosion valley is deepened by vertical erosion and widened by lateral erosion.

Adeleke and Leong (1978) confirms that when rain falls, part of it sinks into the ground, some would be evaporated back into the atmosphere and the rest runs off as rivulets, brooks, streams, and tributaries of river that flow down to the sea. This running water forms a potent agent for denuding the earth's surface. The effect of running water is felt all over the globe wherever water is present.

Running water is thus the most important single agent of denudation. The seasonal variation in the volume of water in a river is known as the regime. A knowledge of the regime of a river is important to man in controlling possible floods , storing up water for irrigation and human consumption. Also in planning hydro-electric production.

The regime of a river will depend on the seasonal distribution of precipitation, the rocks nature, the size of the catchment area, and the vegetation cover.

Ayoade (1988) opines that water is essential to life and is infact the basis of life. The distribution and availability of water have influenced the development of human society through the course of human history. Water in the oceans, the atmosphere and the land as being linked together in a circulation system in which water is evaporated from the sea into the atmosphere when the vapour condenses and falls as precipitation on the land and subsequently runs off the land surface into the sea. That is to say that precipitation was the source of surface runoff.

The Bible supports the assertion by saying that

'All the streams run. Into the sea, but the sea is not fill;

to the place from where the stream flow; there they flow again'. (Eccl. 1:7)

2.3.1 The importance of Water

Water makes life possible as without it life and civilization cannot develop or survive. Water forms the largest part of most living matter according to food and Agriculture Organization of United Nation (FAO, 1996).

FAO further stresses that an average man is two-third water and would weight only 13kg when completely without water. Plants on which man depends for food

cannot grow without water. They need it for photosynthesis and they take their nutrients from the soil in solution.

Three-quarters of the surface materials on the earth's crust consist of water. Water is vital need to man just as air and food are. He can survive longer without food than without water. An average man require about 1.5lltres of water dairly for drinking. Man requires water for various other uses such as cooking, industrial production, hydro-electric power, transportation, among others.

Early civilization flourished around river valley such as those of the Nile in Egypt, indus in india, Hungotto in china and Euphrates and Tigris in ancient Mesopotania . Modern civilization are as dependent on water for survival as the early ones.

2.3.2 Measurement of Precipitation and Runoff

Rain is measured with the aid of the rainguage. The rainguage collects rain fall over a known area (limited by its rim) the amount of water collected is then measured and expressed in units of depth such as millimetres.

There are two main types of rainguage, thus the self-recording (or autographic) rainguage and the non-recording (or mannual) rainguage. Two main objectives in rain guaging for hydrolopical purposes are; to obtain an accurate measurement of precipitation at a given point and to obtain an accurate estimate of precipitation over an area (such as catchment).

Runoff is known by several terms such as stream flow, stream or river discharge and catchment yield. Runoff represents the excess of precipitation over evapotranspiration losses of allowance has been made for infiltration and surface detention.

Values of water shed runoff one expressed in either two ways: as flow rate at the collecting or measuring point (in litres second), and as equivalent depths over the area, usually the catchment contributing to the runoff (in millimetres per day, mouth or year).

2.3.3 Components of Runoff

There are four major components of catchment runoff. These are channel precipitation, overland flow, inters flow, and ground water flow (called base flow).

Channel precipitation is rain that falls directly onto the surface of rivers and lakes and immediately enters the stream flow. Overland flows is rain water that flows over the ground surface as rill or sheet flow. And does not inflitrate into the ground. Overland flow increases with decreasing infiltration capacity of the surface.

Interflow consists of rain water which after infiltrating into the soil surface, moves laterally through the upper soil horizon towards the stream channel. Actually the routes takens vary a great deal and interflow may occur at various levels below the surface.

Ground water flow, some of the rainwater that percolates to reach the underlying ground water eventually flows into the rivers and streams as ground water flow through the saturation zone. Ground water flow is shov's and it takes days weeks or even months after the rainfall which caused it

The total runoff from a catchment thus consists of the direct runoff (quick flow) and base flow or runoff. Direct runoff can consists of channel precipitation, surface runoff and rapid inter flow. Base runoff consists of groundwater flow and delayed inter-flow.

Characteristics flow of a river or stream depends largely on the amounts of quick-flow and base-flow and the relationships between these two components of total runoff.

2.3.4 Classification of Streams or Rivers

Streams and river can be classified into three categories, namely ephemeral, intermittent and perennial.

Ephemeral streams flows only during or immediately after rainfall or snowmelt. There is no base flow as the water table is well below the stream bed. An ephemeral stream flows consists of only of quick-flow or direct flow. Ephemeral streams are common in arid and semi-arid environment and do not usually have permanent or well defined channels.

Intermittent streams flow only during a part of the year and dry up during the remaining part. These are commonly found in tropical areas characterised by a well defined dry season.

Base-flow contributes to the total runoff only during the wet season when the water – table is high. During the dry season, the base flow virtually stop and because of lack of rainfall, the quick-flow also dries up. Intermittent streams are also found in high latitude areas where base flow stops in winter when the ground water becomes frozen.

Perennial streams are those that flow throughout the year because the climate is humid and the various sources of subsurface flow can contribute to total runoff at all times particularly during dry spells. It could be noted that the whole length of a stream cannot usually be fitted into one of the above categories.

A stream may be ephemeral in its upper course and intermittent down streams. Similarly a stream may be intermittent in its upper course and perennial down stream.

2.3.5 Runoff Control Factors

The major characteristics of the runoff leaving a catchment are the total volume of discharge and the distribution over time of this discharge . The hydrograph is a graph obtained by plotting discharge against time. We have water year hydrograph and flood hydrographs for a particular rainfall events.

The major factors which control the runoff characteristic of a catchment are: climatic factors which includes precipitation characteristics (intensity, duration, area distribution, frequency of occurrence, antecedent rainfall conditions, total amount, form of precipitation), interception, evapotranspiration and soil moisture content.

Catchment characteristics includes basin characteristics (size, shape, slope and elevation, orientation, stream density, land use and cover); channel characteristics (size and shape of river cross-section, channel slope, channel storage capacity). Some of these factors are relatively permanent while others are transient notably climatic and related factors. The most important single factor that influences the stream hydrograph is the nature of the rainfall causing the runoff, especially the magnitude and time distribution. All things being equal a heavy rainfall will give a greater runoff then a slight one. Similarly a rainfall of high intensity. This is because less of the high intensity rainfall will infiltrate into the soil in contrast to the low intensity rainfall which has better chances of infiltration.

Duration of rain is also important. The longer the duration of rainfall the larger the total rainfall amount. Also, long duration rainfall can make the soil more saturated with excess rainfall appearing as runoff as the progresses.

The frequency of occurrences of rain storms and the antecedent rainfall conditions are important because they influence the proportion of the falling precipitation that is likely to infiltrate rather than runoff. Runoff peak occurs during the rain followed by low runoff during much of the dry season.

2.3.6 Mans Influence on Runoff

Hewlett and Hibbert (1967) said that there are very few areas of the world in which runoff is not affected to some extent by the influence of man. In the tropics, vast areas of rainforest have been deforested, swamps have been drained, and every where there has been a great increase in urbanization. Moreso, the resulting spread of artificial, impermeable surfaces.

In all these ways the response of catchment areas to rainfall and consequently the pattern and distribution of runoff has been charged . The flow of many of the world's large rivers is controlled by dams and reservoirs which have been constructed for pure water supply, irrigation or flood control purpose.

Stream flows may also be affected by artificial modification to stream channels, especially in areas that are proned to flooding. Such modifications commonly include straightening and enlargement, the construction of relief and bypass channels in order to reduce both discharge and water levels at critical points.

Diversions of flow from one river to another are now an accepted and commonly implemented strategy in water resources development. The reversals of flow are of even greater significance which have been implemented or are planned in areas where the topography is suitable.

2.4 WATER RESOURCES

Water is the basis of life and therefore the development of water resources is an important component in the integrated development of any area water is a unique resource, having no substitute. Its quality and quantity vary over space and time.

However, economic development of necessity involves the development of water resources for the multifarious purpose to which they can be put. Planning and proper management are therefore necessary to achieve some convergence in both space and time in water availability and water demand in any given area. For instance, used water from the kitchen sink and bath tub have to be channelized to a pit to prevent horrid and offensive smell in the building surrounding. Therefore there is need for channel control of excess water run-off in our street erosion that can lead to flood.

2.4.1 Resources Management

Resources management is concerned with the control of direction of resources development. Resources development represents the actual exploration of a resources to satisfy human needs. During the process of development, natural resource (neutral matter) is transformed into a usable commodity or service.

O'Riordian (1971) defines resources management as a process of decision making whereby resources are allocated over space and time according to the needs, aspirations and desires of man within the framework of his technological inventive his political and social institutions, and his legal and administrative arrangements. Resources management may therefore involve the overall planning if the development and use of a resource. There could be no proper management without planning.

Water resources planning aims at achieving an orderly development of water resources to meet present and future demands. And this resolves into the extent of available water resources; the future requirement of water for various purposes and how these can be met.

2.4.2 Water Resources Characteristics

Water resources characteristics which must be taken into account to ensure good management includes:

The flow characteristics that allow successive down stream uses of the same water and also cause upstream obstruction or discharge to have downstream effects;

The natural linkage between ground water and stream-flow demand that the two sources of water supply be managed with close reference to each other; water resources are unevenly distributed over space because of spatial variations in precipitation and occurrence of aquifers; and there is incongruence of water resources and water demands both spatially and temporally.

2.4.3 Evaluation Of Surface Water Resources.

Linsley (1992) confirmed that it is necessary to carry out an inventory of available water resources, that is sources, existing uses and characteristics of the water, especially quantity, quality and its spatial and temporal distribution patterns.

The evaluation of water resources in a given area is best done within the frame work of the hydrologic or water balance equation usually expressed as $P = Q + E \pm \Delta s \pm \Delta G$. Where P is precipitation, Q is runoff, E is evaportransportation, Δs is change in soil moisture storage, and ΔG is change in ground water storage.

The hydrological appraisal of water resources is a fundamental requirement for the planning, design, construction, and operation of water resources project.

In the development of surface water resources the sediment load of rivers cannot be ignored. The amount of sediment load will determine, among other things, the need for soil conservation work, the design of reservoirs and diversion works and the possible need for channel control, works to control sediment deposit or bank erosion in the channel.

2.4.4 Water Resources Problems.

Water resource problem arise from the simple fact that the hydrological cycle does not adapt itself to man's space, time and quality requirements for water. This in a given location, available water may be insufficient for the need of man, while in another location the problem is excess water in the form of floods and poor drainage. Also the quality of available water may not be right for the envisaged use. Three main types of water problems are too little water, too much water, and polluted water.

CHAPTER THREE

3.0 FLOOD AND URBAN DESIGN

3.1 FLOODS

Excess water (floods) is as bad as lack of water (droughts). Excess water is expressed in form of floods and poor drainage. Flood control and improvement of drainage are important aspects of water resources management.

Ward and Robinson (1989) explained that a flood is said to occur when a body of water rises to over flow, which is not normally submerged. There are other definitions of flood, most of them relating to river floods. Any meaningful definition of flood will however incorporate notions of damage and inundation.

Ward pointed out that flood are natural phenomena rather than natural disasters. It forms part of the normally occurring range of stream flow conditions. Flood disasters are man-made as they occur where and when man puts himself at risk by developing and occupying floodable areas. Also, the process of developing and occupying river flood plains often causes or intensifies flood plain at risk of flooding out of ignorance or for economic reasons.

He further stressed that flood hazard is more than a physical phenomenon and also a socio-economic one. Flooding itself is basically a natural phenomenon, human activities can intensify or even cause it in some cases. When floods impinge unfavorable upon human activities, they become hazardous. The phenomenon of flood hazard thus comprises several aspects including structural and erosional damage, loss of life and property, contamination of food, water and other material, disruption of

socio-economic activities including transport and communication, and the spoiling of agricultural land and loss of crops.

Ayoade (1988) opines that most floods result from causes which are wholly or partly climatological in nature. Intense and heavy rains account for the majority of the floods that occur in the tropics. The rain may be derived from tropical cyclones or may just be from a large thunderstorm or may be monsoonal.

According to the Bible

"And rain fall upon the earth forty days and

forty nights this resulted into the great flood

which lasted for forty days upon the earth". (Genesis 7:12)"

Floods which are partly climatology in origin includes floods arising from coastal storm surges or the estuarine interaction between stream flow and tidal conditions in the sea. Such floods are limited to coastal areas and the lower reaches and estuaries of rivers draining into the sea. However, they are very disastrous because such areas are usually densely populated.

Other types of floods are due to non-climatological causes such as earth-quakes, volcanic eruptions and landslides which disorganise river flow patterns and often temporarily dam rivers making them flood the surrounding flood plain. Floods also frequently occur as a result of failure of dams and other control works.

Floods which are climatological in origin derive from excess of precipitation over natural infiltration. The actual characteristics of flood often vary from one catchment to the other even when the flood generating mechanism are identical. This is because of differences among catchments in the flood intensifying conditions as indicated by basin network and channel characteristics in figure 1 and 2 below respectively.

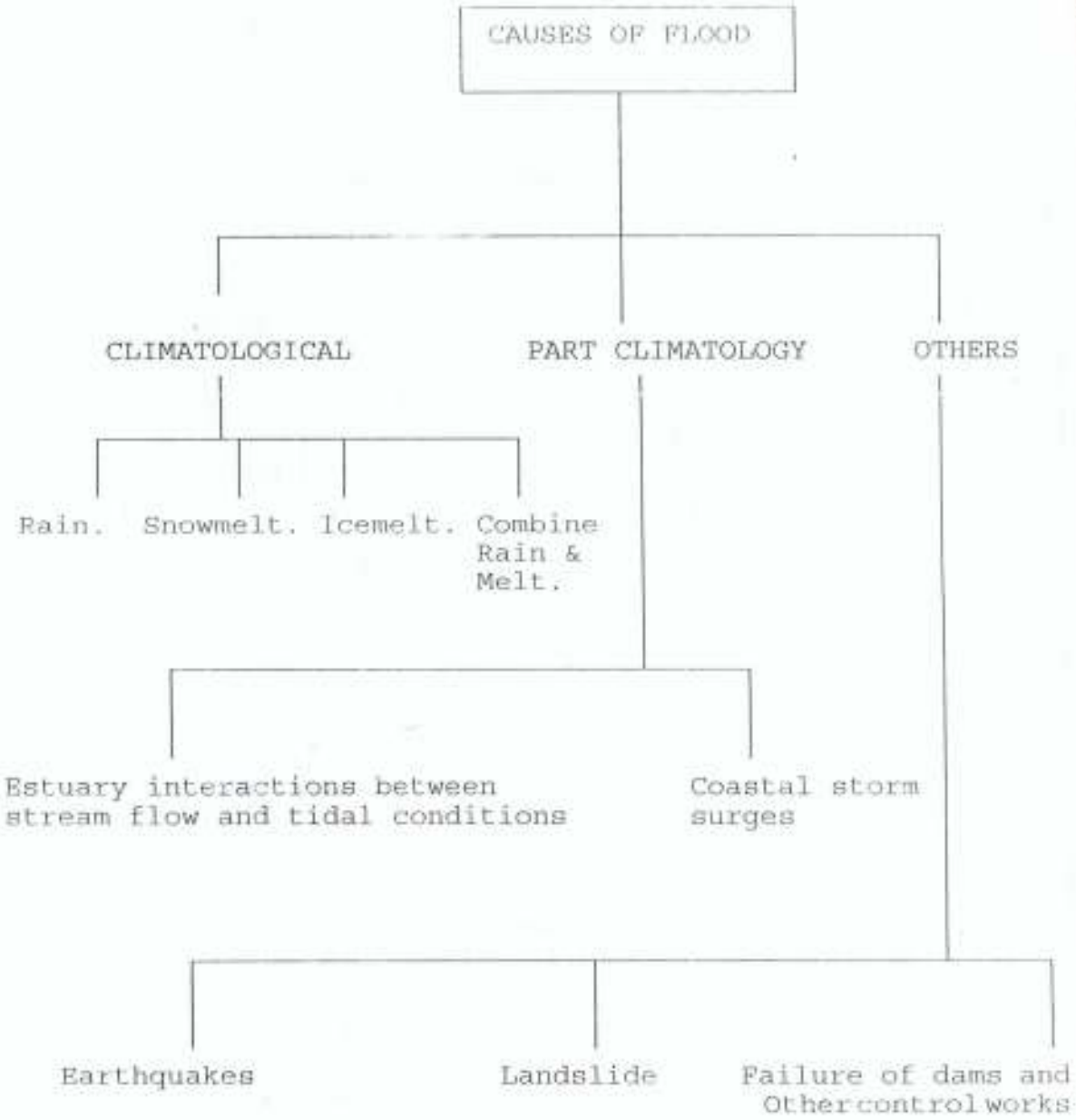


FIGURE 2: CAUSES OF FLOODS

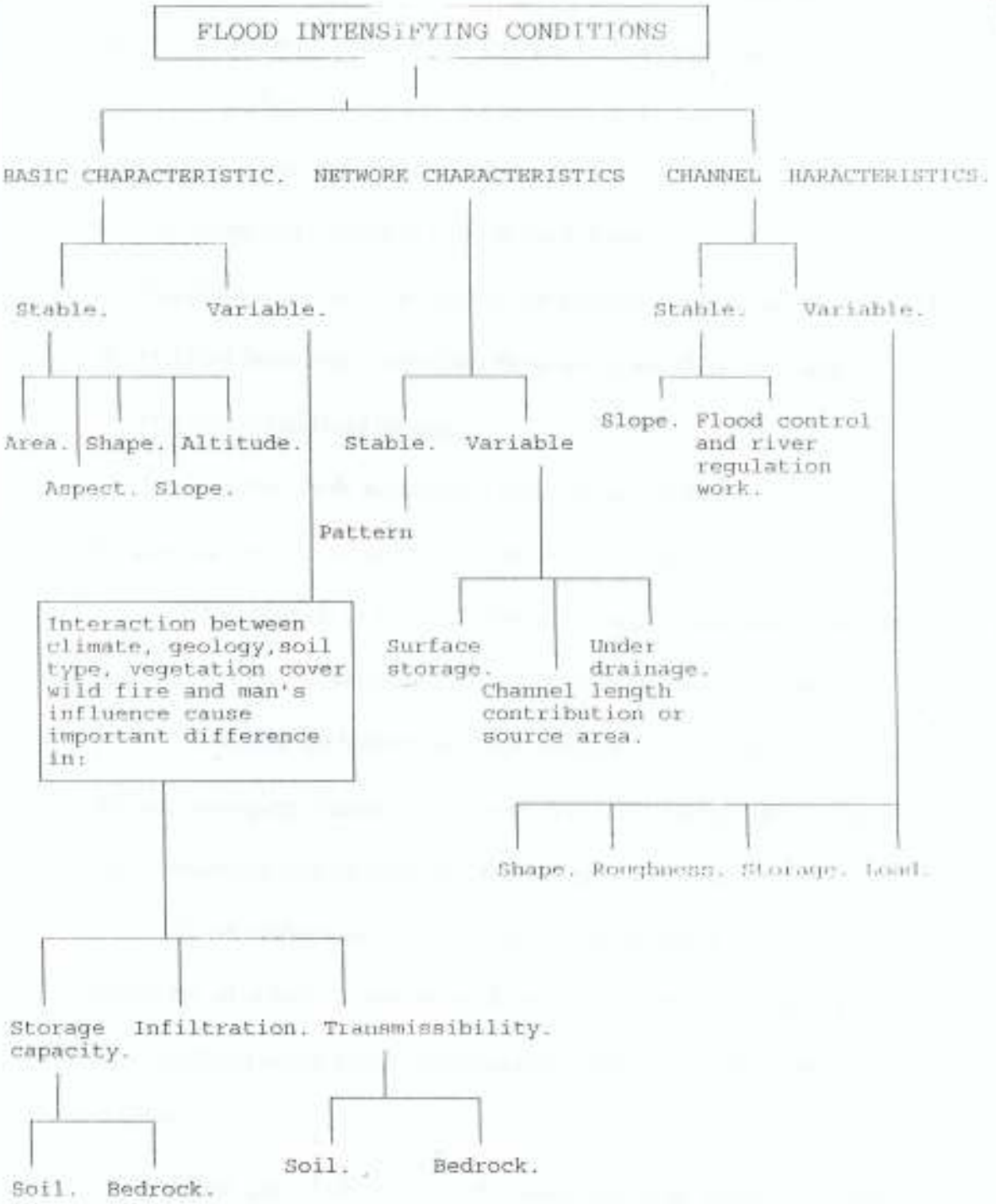


FIGURE 3: FLOOD INTENSIFYING CONDITIONS

3.2 ADJUSTMENT TO FLOOD HAZARD.

Studies of floods and flood damage have been carried out n advanced country like in North America and many European countries Ayoade (1988) report revails this. Such studies are few and far between in the tropics. Yet to combat the flood problem we require information which includes

i. The extent and location of areas liable to flood;

ii. The physical and socio-economic characteristics of these areas;

iii. Previous flood events especially flood levels and discharges; and

iv. Previous actual flood damage.

From the above information estimate can be made of potential flood damage for given levels of flood and / or amounts of discharge.

Man responds to the flood hazard through adjustment; flood abatement, and flood protection. Adjustment, to flood hazard covers any action taken on the flood plain to minimize the hazard and these includes land use regulation, taking insurance policies, emerging evacuation and so on. Thus adjustment refers to the ways in which man's behaviors may be controlled to ameliorate the effects of flood.

Flood abatement refers to land use modification or some other action taken within the river basin, upstream of the location where it is proposed to reduce risk of flooding. Such action usually involves afforeslation and other water shed management practice.

Flood protection involves the construction of physical controls in the river channel or along the coast when appropriate and other actions taken to reduce peak discharge depth of flood water or the area of inundation.

3.3 WEATHER MODIFICATION.

Weather modification refers to all actions or activities undertaken by man which have the effect of altering or changing weather artificially. It may be in advertent or deliberate. Inadvertent weather modification occurs when man through his various activities modifies weather unknowingly, for instance, weather modification caused by urbanization, lumbering, land drainage among others.

Deliberate weather modification is weather modification purposefully carried out to achieve some objectives. It includes all activities undertaken to alter locally unpleasant and disastrous variations of the weather or to improve weather on a local basis.

3.4 URBAN DESIGN.

Design is a confused word in environmental planning. Spreireger (1965) said that a city is an assemblage of buildings and streets, systems of communication and utilities, places of work, habitation, leisure and meeting. The process of arranging these elements together both functionally and beautifully, is the essence of urban design.

One of the purpose of urban design is to allow it to move back and accommodate all our vast new constructions in a pleasing and harmonious manner. Sticks and stones, nails and glass make a house, if they are assembled with art, the same materials become architecture.

Urban design is a matter of arranging objects, it is a plastic art, concerned both with how things appear and with how they actually operates.

The purpose of urban design is to make the city humane, to make the extent of the city comprehensible; to relate urban forms to settings, to weave new centres into

the urban fabric, to complement the monumental with the mundane, to complement the urban with nature, to create key focal sites, and to make the city a harbour of diversity.

Godman (1968) said that design in urban is directed at the distribution, over a whole settlement of buildings, activities and open spaces rather than at single objects or with systems of public facilities.

Principles and practice of urban planning provides a framework for better understanding of current urban problems as well as a guide for local government administration of planning.

The urban environment obviously means many things to different people. It is organic, metropolitan , overcrowded, value-laden, pluralistic, and diverse. It is the centre of population growth and mobility and make possible most of the education and technology that are remarking our country.

When communities do not plan ahead or urban think in terms of meeting future needs, mounting urban growth problems can create crises and rob urban living its many qualities. Water pollution, air pollution, transportation bottlenecks, power failures, water shortages, over loaded septic tanks, over crowded schools and over taxed central cities are some of the more prevalent problems arising from rapid growth on the urban periphery coupled with the abandonment of older areas of established municipalities.

Planning and programming for optimal use of land, water, air and human resources are thus becoming a vital instrument for guiding urban growth; providing a healthful and aesthetically pleasing community environment.

In urban planning, concepts and emerging trends are covered as well as methods and techniques. It has been widely used as a continuing guide to the complex problems of urban development known as local planning administration.

An urban designer take a longer look at the nature of his contribution to the society. An urban designer is seen to be making a mark in at least four directions, namely: quantitative techniques, aesthetic considerations, political-behavioural imperatives and social welfare concerns.

CHAPTER FOUR

4.0 THE STUDY

4.1 AKURE PHYSICAL SETTING

Akure is located in the equatorial zone, within latitudes 10° North and South of the equator. This zone is characterized by the following climate features: the hot, wet equatorial climatic type; An approximate annual precipitation of 2413mm; All year round rainfall with double maximal in June and September; conventional predominant type of rainfall ; North East trades and south west provision prevailing winds; A mean annual temperature of 27°C; An appropriate mid-summer temperature of 27.5°C and mid - winter temperature of 26°C; A mean annual temperature range of approximately 1.1°C; A high uniform temperature, and heavy well distributed rainfall throughout the year; Equatorial rainfall type of vegetation, characterized by evergreen broad learned trees of luxuriant growth; vegetation species include: Mahogany, Meranti, Chengal, Ebony, Iroko, Obeche, Orchids e.t.c.

Akure is located on a relatively flat land. The big rock outcrops which were still now at the outskirts of the towns are now within the range of development as a result of rapid urban growth.

4.1.1 Location

Akure, the Ondo State Capital, is located on latitude $7^{0}15^{1}$ north and longitude 15^{0} 15^{1} east at a height of about 370 metres above the sea level. The town is bounded in the north by Ita-Ogbolu, Owo to the east, Ondo to the south, and Owena to the West.

Figure 4 : MAP OF NIGERIA SHOWING ONDO STATE IN RELATION TO OTHER STATES.

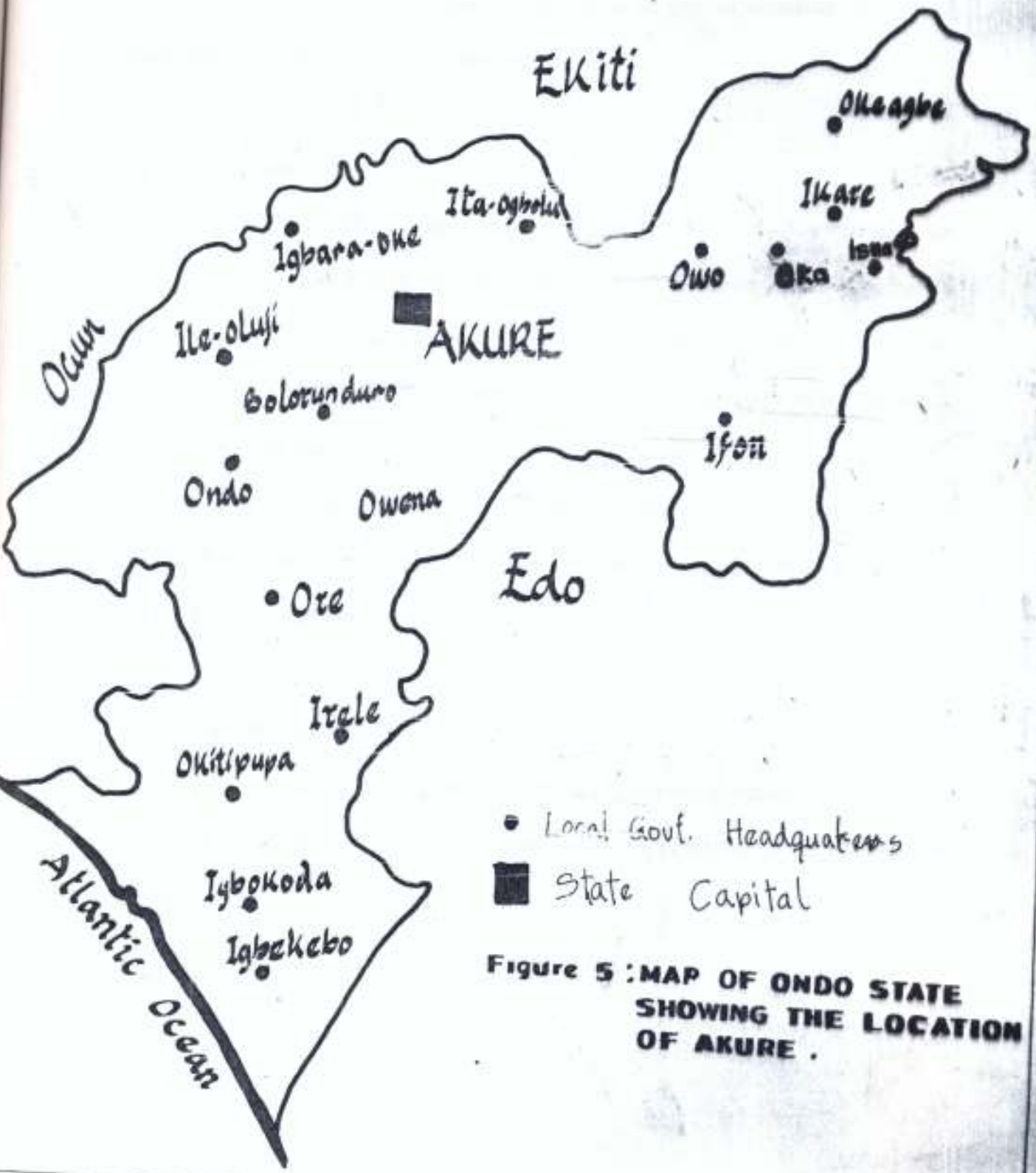


Figure 5 : MAP OF ONDO STATE SHOWING THE LOCATION OF AKURE .

4.1.2 Topography

The topography of Akure is fairly uniform except for some rock that dot the entire landscape. The terrain however becomes rugged towards Idanre to the south west, Ijare to the north west, and Ita-Ogbolu towards the north.

The soil texture varies from sandy-clay nature in the northern region to loamy clay to the south. Akure's location is unique in respect of abundant land in all directions whom is subjected to competing demands.

4.1.3 Drainage

Akure is heavily bisected by numerous streams of which Ala stream is the most prominent followed by Elegbin stream. The Ala stream with its numerous tributaries bring along heavy flood annually during the Rainy season. The Ala with its numerous tributaries drains the northern section of Akure, that is the catchment area of the study area.

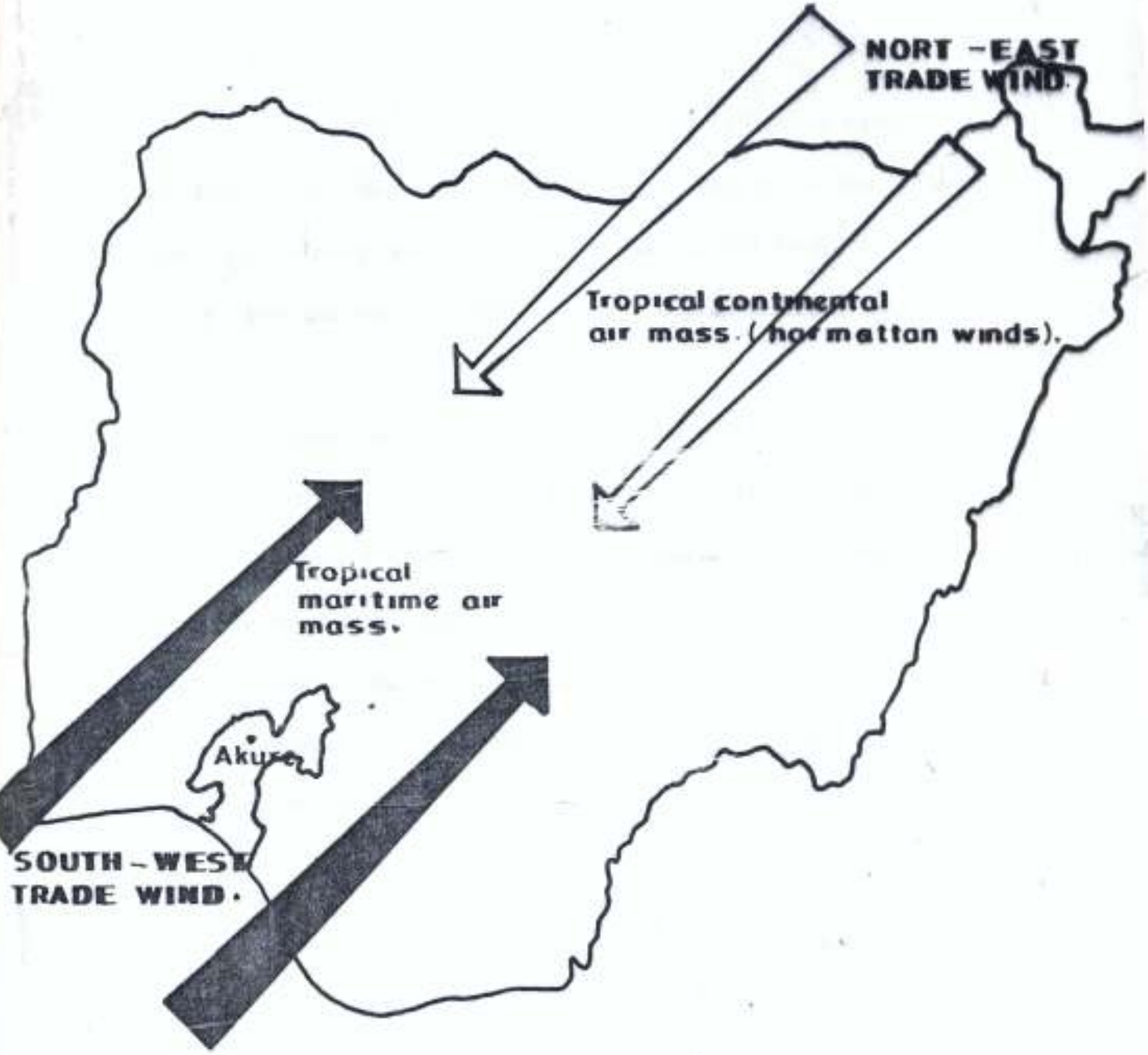
River Ala flow from West to East through the developing urban area to the North of the town centre. Over three quarters of the built - up area of Akure form part of the extensive catchment area of River Ala.

4.1.4. Climatic Features

The climate of Akure is influenced by two major trade winds. The south west trade winds which are warm and moist; and the North East trade winds which are hot and dry.

Figure 6 : AKURE STREET GUIDE SHOWING ALA RIVER

Figure 7 : MAP OF NIGERIA SHOWING TADE WINDS IN RELATION TO THE LOCATION OF AKURE, ONDO STATE.



These two prevalent winds bring about the two major seasons (rainy and dry) every year. The rainy season starts in April and ends in October while the dry season starts in November through March.

4.1.5 Rainfall

Akure enjoys abundant rainfall of over 1500 millimetres annually and the south westerly winds throughout most of the year. During the months of December, January, and February, the cooler dry continental and strong dust ladden air (hamattan) from the north-east prevails.The rainy season lasts from March ending to October.

Akure enjoys double maximal rainfall around the months of June and September every year. Virtually rainfalls every day within these maximal months. Rainfall of this area is mainly conventional, is well distributed throughout the year with barely any month within the rainy season without down pours. Minimum rainfalls are recorded December and January.

Consequently, the two predominant seasons experienced in this area are characteristically marked by the two trade winds types.

Table 1: Mean Monthly Rainfall of Akure for 15 years (1983-1998)

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall (mm)	11.90	35.30	110.50	142.20	162.30	191.80	187.50	114.50	191.60	175.00	54.70	22.60

Source : FUTA Meteorological Garden.

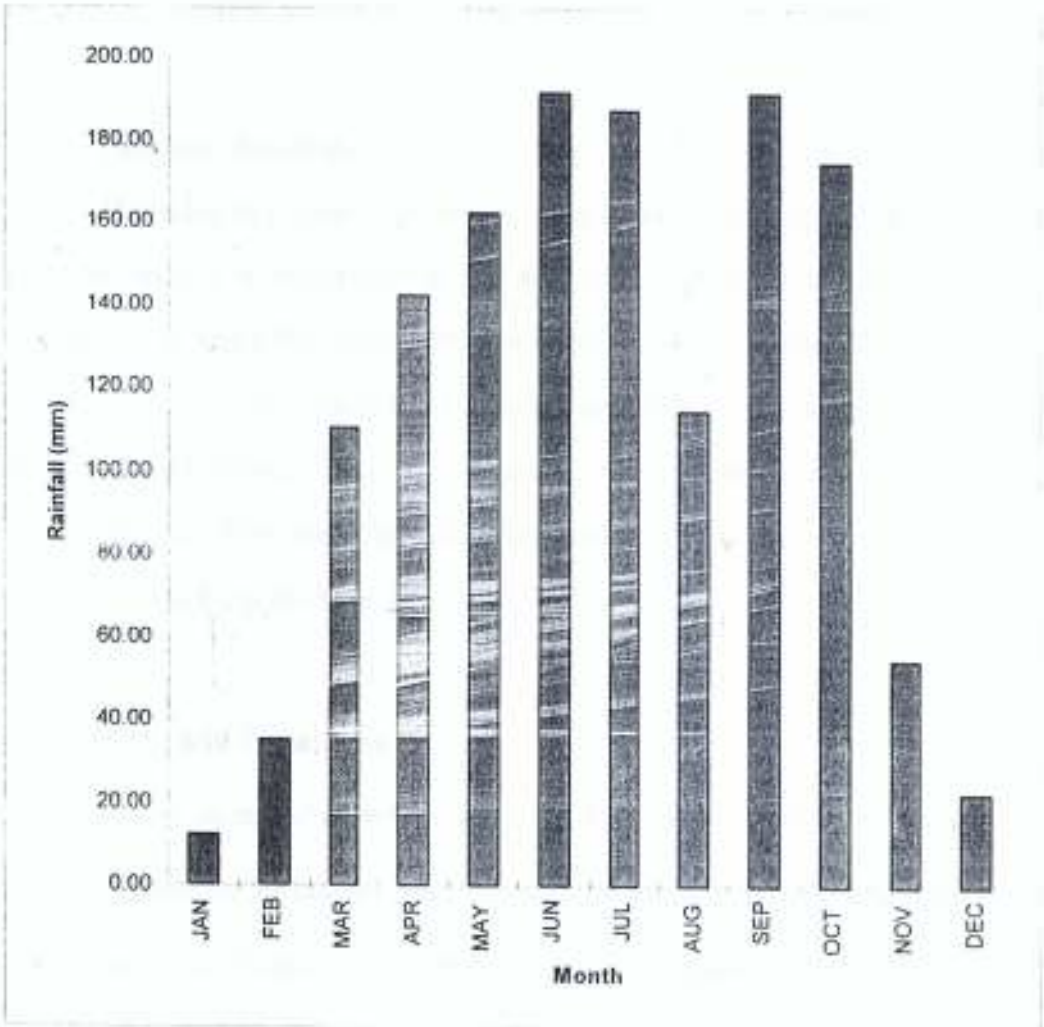


Figure 8: Bar Chart of monthly rainfall of Akure for 15 years (1983-1998).

4.1.6 Temperature

Temperature of Akure is moderately high throughout the year, with the hottest month being February and August recording the lowest temperature reading. Daily temperature range reading is generally low, with a yearly average of 30.70c. Akure experience a vertical overhead mid-day sun with a much concentrated solar insolative.

4.1.7 Relative Humidity

Humidity is a measure of the dampness of the atmosphere which varies from place to place at different time of the day. Akure relative Humidity is high, ranging between 64% and 87%. Over 80% is common in the morning. During rainy season, two factors that control humidity is rainfall and temperature compromised to keep the air heavy with humid. It may rain continuously for a whole day while the sun keeps off the sky for that long. At other time however, the absence of rain adds to the tropical sun to keep the humidity lower.

4.1.8 Area and Population

Akure occupied an urban area of 165 square kilometers with a population of 71,106 people according to 1963 population census. By 1991 population census, Akure had a population of 239,124 and occupied the ultimate urban area of 300 square kilometers. Base on the projection from the 1991 population census at the rate of 2½ percent, the population of Akure 1998 is 282,835 which almost triple that of the 1976 when it was named as Ondo state capital. The increase was as result people movement from rural area seeking employment in government and private offices as well as enjoy urban life.

Table 2: Mean Monthly. Temperature of Akure for 15yrs (83-98)

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp (0C)	32.8	34.4	34.0	32.8	31.2	30.5	28.3	28.0	29.0	30.4	32.1	32.1

Source: FUTA Meteorological Garden.

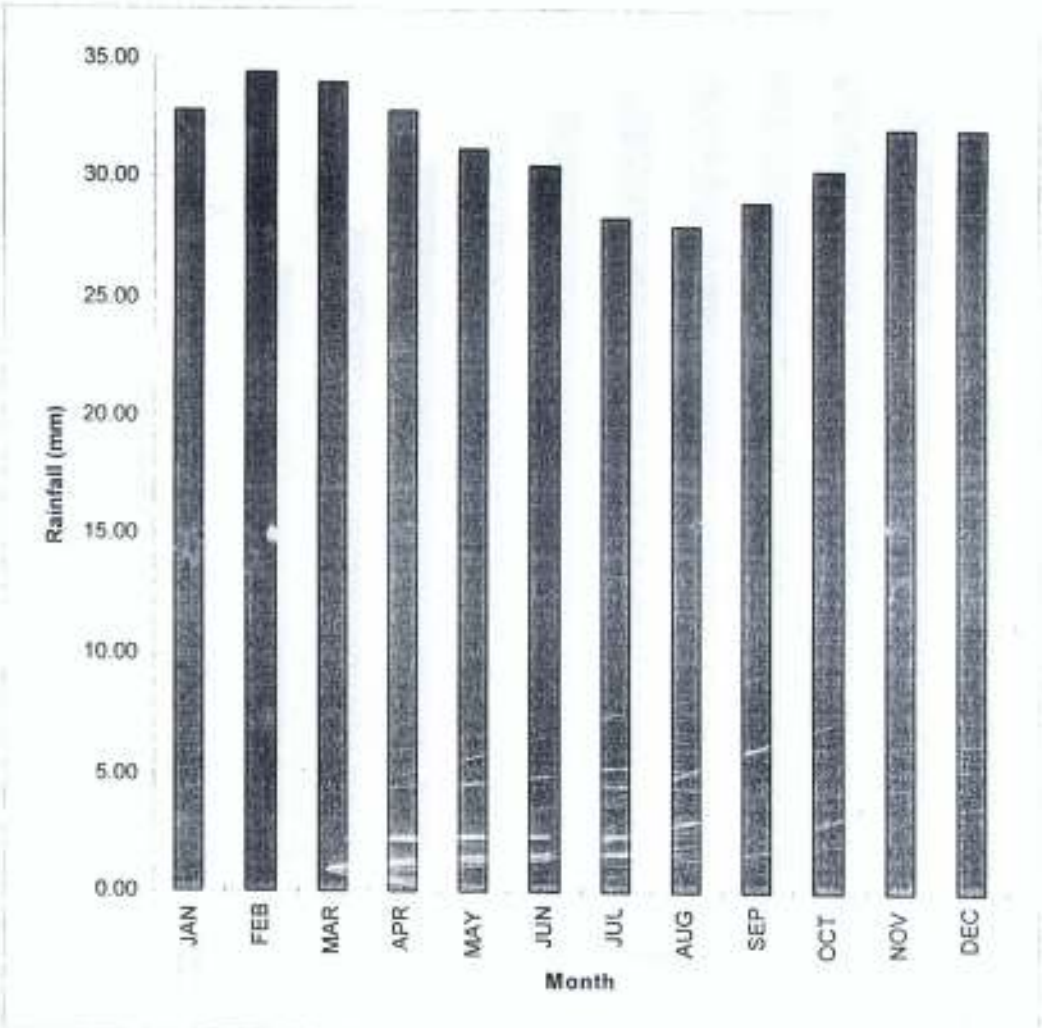


Figure 9: Bar Chart of mean monthly temperature of Akure for 15 years (1983-1998).

Table 3: Mean Monthly Relative Humidity of Akure for 15years (1980-1998).

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Relative Humidity (%)	64.4	68.4	76.1	79.9	81.9	84.2	86.9	87.3	86.4	83.2	76.9	70.7

Source: FUTA Meteoroiogical Garden.

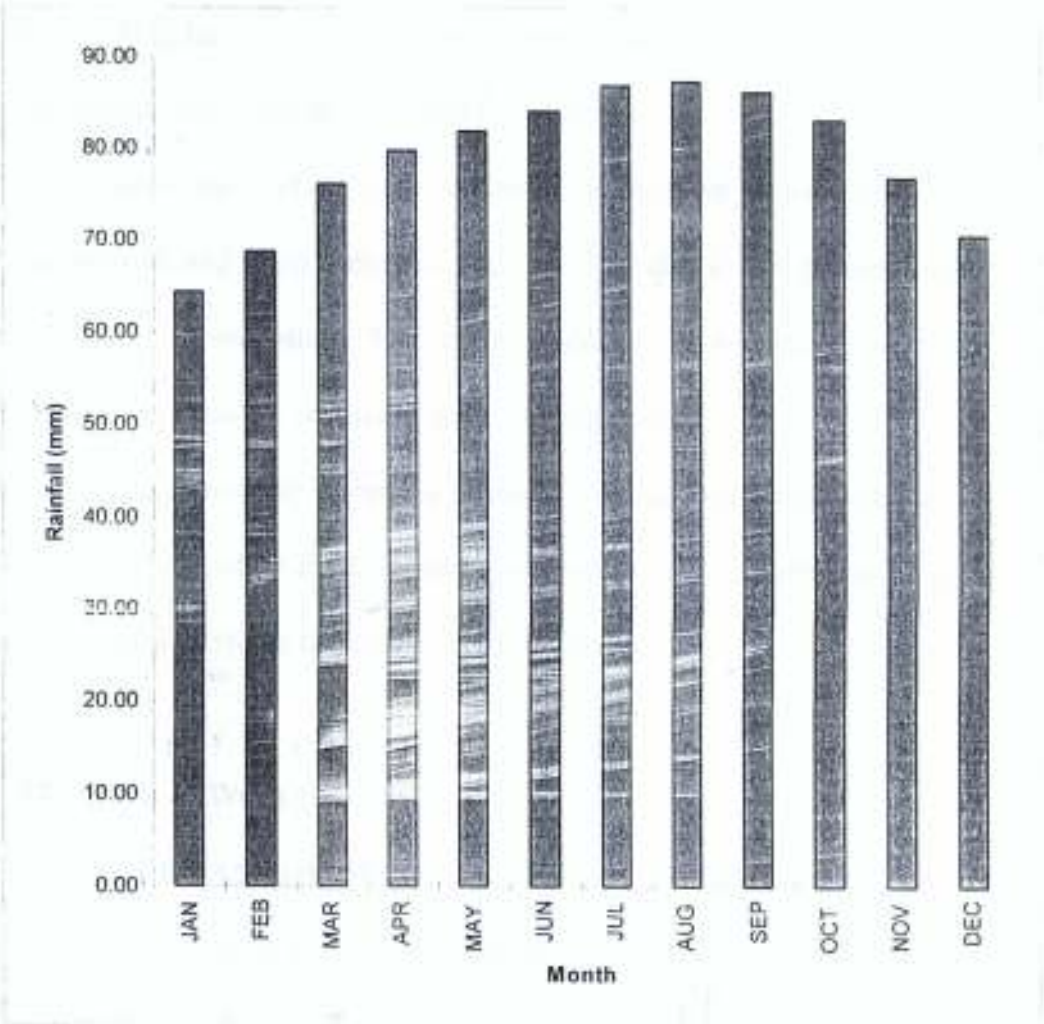


Figure 10: Bar Chart Showing Relative Humidity of Akure for 15 years (1983-1998)

4.2 LAND USE

Residential land use is dominant in Akure. It is more than 70 percent of the built up area of Akure. The intensity of residential land use is very high in the inner core of the town. With the acquisition of the state capital status in 1976, substantial area of land had been acquired and reserved for industrial, commercial, recreational, educational and other development at the outer areas.

From the land use map; the centre of the town is made up of residential cum commercial and hight industrial uses this includes Deji's palace, Erekesan market, post office, among others. The new low density area are located on the periphery and most of the areas are covered with residential layouts.

Major retail activities are carried out on the major roads such as Adesida Road, Arakale Road while there is inadequate provision and existence of parks and other recreational facilities within the urban landscape.

4.2.1 Place of Work

Of the total population, over 95% work or reside within Akure; only a very negligible few work outside the town, that is 4.79% of the total according to Akure Master plan (1980).

The division of working place and living place is not distinct, rather the two essential land uses are jumbled together. Exception to this is the newly established Federal Secretariat along Igbatoro Road.

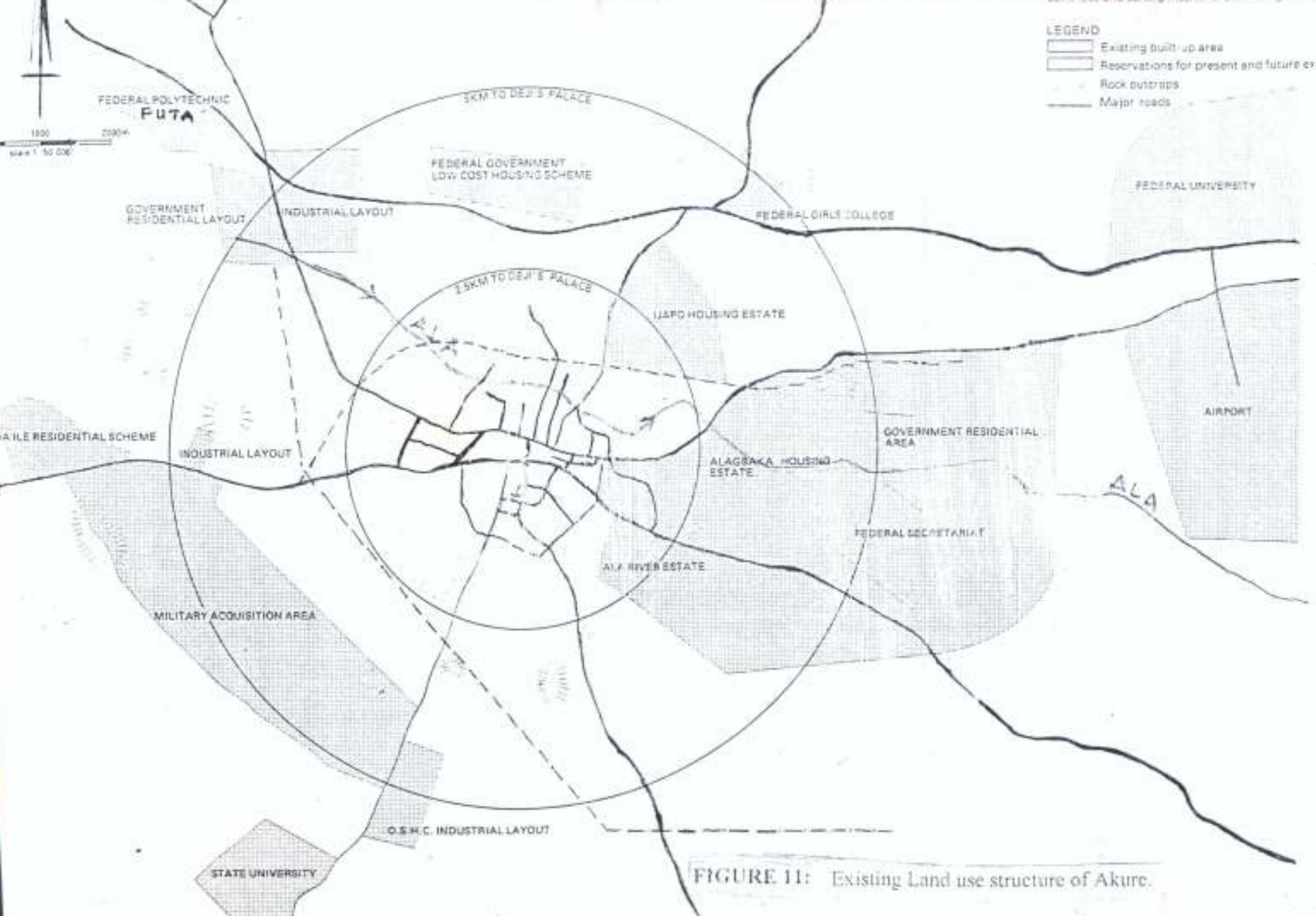


FIGURE 11: Existing Land use structure of Akure.

4.2.2 Educational Institutions

Educational Institutions especially the primary and secondary educational institutions including both private and government owned ones, exist within the residential areas. But other tertiary institutions, like Federal University of Technology, Federal School of Agriculture among others are located at the periphery of the town.

4.2.3 Industrial Land Use

Some areas are allocated to industrial uses. Presently the state government has two main industrial layouts located at Ondo Road and Ilesa express way. Housing corporation has one along Idanre Road. Most of the portion earmarked for industrial layout along Idanre Road by Housing Corporation have been converted to residential layout because of low patronage by the industrialist.

4.2.4 Agricultural Land Use

There has been continuos loss of good agricultural lands to urban development. For instance, most of the Ala river bank as well as Elegbin stream banks that are good for agricultural land use, most especially during dry season, have now being development for the preparation of residential layout at the urban fringe.

4.2.5 Road Network

Most of the existing primary and secondary road network in Akure urban area are inadequate and insufficient. However, they are not maintained. This contributed in no small measure to the problems of the town. It seriously hampered the commuter's mobility. Most of the roads are without drainage channel and those with drains are not take care of.

4.2.6 Recreational Land Use

The location of Akure is unique in respect of abundant land in all directions subject to some physical constraints. Land in Akure is subject to competing demands, like in most urban centres of its type, especially residential, commercial, educational and industrial to the detriment of such unremunerative uses such as recreation. Most of this uses are conflicting as shown in land use map of Akure. The existing stadium is within the residential area. But the newly proposed one is at the periphery, but close to the Federal low housing estate along Ilesa-Owo express way.

4.3 SLUM NETWORK OF AKURE

The growth of Akure as a state capital cum commercial centre resulted in an influx of migrants. Most of urban settled into slums along the Ala river bank located in the heart of the city.

The urban sewarage system which surpose to serve about ten percent of the city population, untreated sewarage and solid waste were discharged directly into the rivers, creating unhygienic conditions.

The slum networking of town, is a community based sanitation and environmental improvement programme that regards urban slums not as resources draining liabilities, but as opportunities to make sustainable changes and improvements to the town as a whole. This programme could be made possible by bringing together communities, governments, Non-governmental organisations (NGOS), and industry for its implementation.

Petroleum Trust Find (PTF) took the advantage of the location of Erekesan-market area slums, home to over 5,000 people, to introduce an efficient infrastructure path for sewarage , storm drainage, and fresh water services, that followed the natura

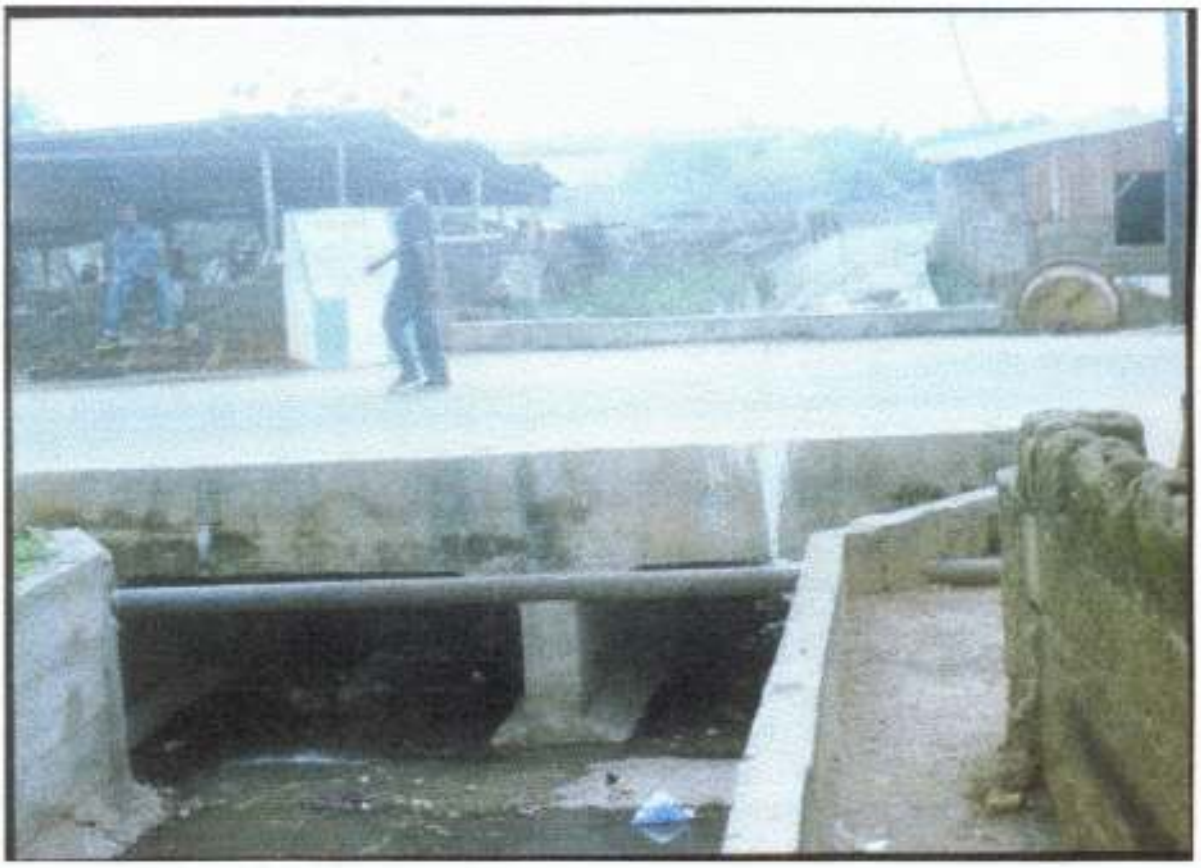


Plate 1: PTF Constructed Drainage and Culvert

erosion courses. These improvements were realised through innovative and low-cost engineering solutions, and implemented in two levels, at the city level, a main sewage artery was constructed along the erosion channel, at the street level, where there sewage channels cross road, box-culvert were constructed. Both sides of the culvert were covered by wire mesh to prevent and disallow throwing of garbage into the river by the people passing bye the river.

4.4 INCIDENCE OF FLOOD

Documentary of flood affected areas nation wide is mainly to appraise critically, derive experience, and inspiration so as to proffer solutions to proposed project from such past existing project. This is achieved by studying the cause, effect on the people and solution provided to prevent future occurrence. Though, these are the aim of the researcher while collecting data, but unfortunately, —

all might not be possibly achieved due to one reason or the other of which flood is natural and cannot be predicted easily. Flood is an environmental hazards that occur nearly every year in different parts of the country and are repeatedly in the headlines of local and national news most especially during the rainy season. The examples include the following:

(i) In Yobe, flood turns residents to refugees. In Damaturu, after a down pour of rainfall, 150 houses located along the Yobe River bank in Gashua were turned to refugees. (Source: The Guardian 'August 25, 1999. pp. 13 & 14).

(ii) Groans as flood sacks 60Villages in Kwara. Houses in Petigi were submerged due to flood. (Source; The Guardian October 19,1998 pp. 13)

(iii) Seven Local Government area of Kogi State were flooded and destroy over 100 hectares of farm land. The local government includes Ida, Ajaokuta, Idif.,

Basa, Kogi and Igala Mela. And Kogi State Governor-Col.Augustine gave them ₦5million and some relief materials. (Source: Network News October 28,1998).

(iv) In Ekiti State, Osun River at Ikere overflow its bank and destroy property worth ₦2million. (Source: NTA News October 21,1998).

(v) Flood clained two persons life and four others seriously injured by collapsed building in Mongo Park Street in Lagos. (Source: Guardian October 23,1998 pp.1).

(vi) Driving in the rain, heavy downpour compound motorists headache. (Source: Tell No 25. June 21,1999 pp38).

(vii) 200 Houses destroyed by Erosion in Delta State. Gully erosion at Owa in Ika North Eat local government area of Delta has destroyed over 200 house. (Source: Nigerian Tribune Sept. 1, 1999 pp. 1.)

(viii) Flood : Council boss seeks government assistance. No fewer than 300 people are now homeless in the Monguno local government area of Barno state as a result of a recent flood disafter which also destroyed property worth about ₦23million. About 2,670 farmlands were destroyed by the flood. Governor Alhaji Mala Kachalla had donated some relief materials to the affected victims. (Source: The punch Sept. 14, 1999 pp. 9).

(ix) Victoria Island : A city waiting to collapse. It has happened before, the most recent was in 1996, when the entire victoria Island, Lagos, the home of the Nigerian and in fact African rich was threatened. The Atlantic Ocean over flooded its bank with water at waist-level in most instances. The threat this time is worse (Source : Sunday Vanguard. July 18, 1999 pp. 9,10 & 16).

(x) It rains from 3pm to 6pm that is 3hours on Tuesday at Ibadan. This resulted to flood that claimed 10 lives and destruction of property with millions of Naira. The dreaded months are here once more June, July and August. The roads are water logged, the drainage over flooded and the sky moody. (Source: Network News, July 8,1999).

(xi) Erosion buries Igboland. Imo State is fast becoming an ecological water land, as the rainy season of successive years devastate homelands, leaving the soil ever more vulnerable to erosion. (Source : Tell Aug. 2, 1999 No.31 pp. 42-45).

CHAPTER FIVE

5.0 ANALYSIS OF THE STUDY

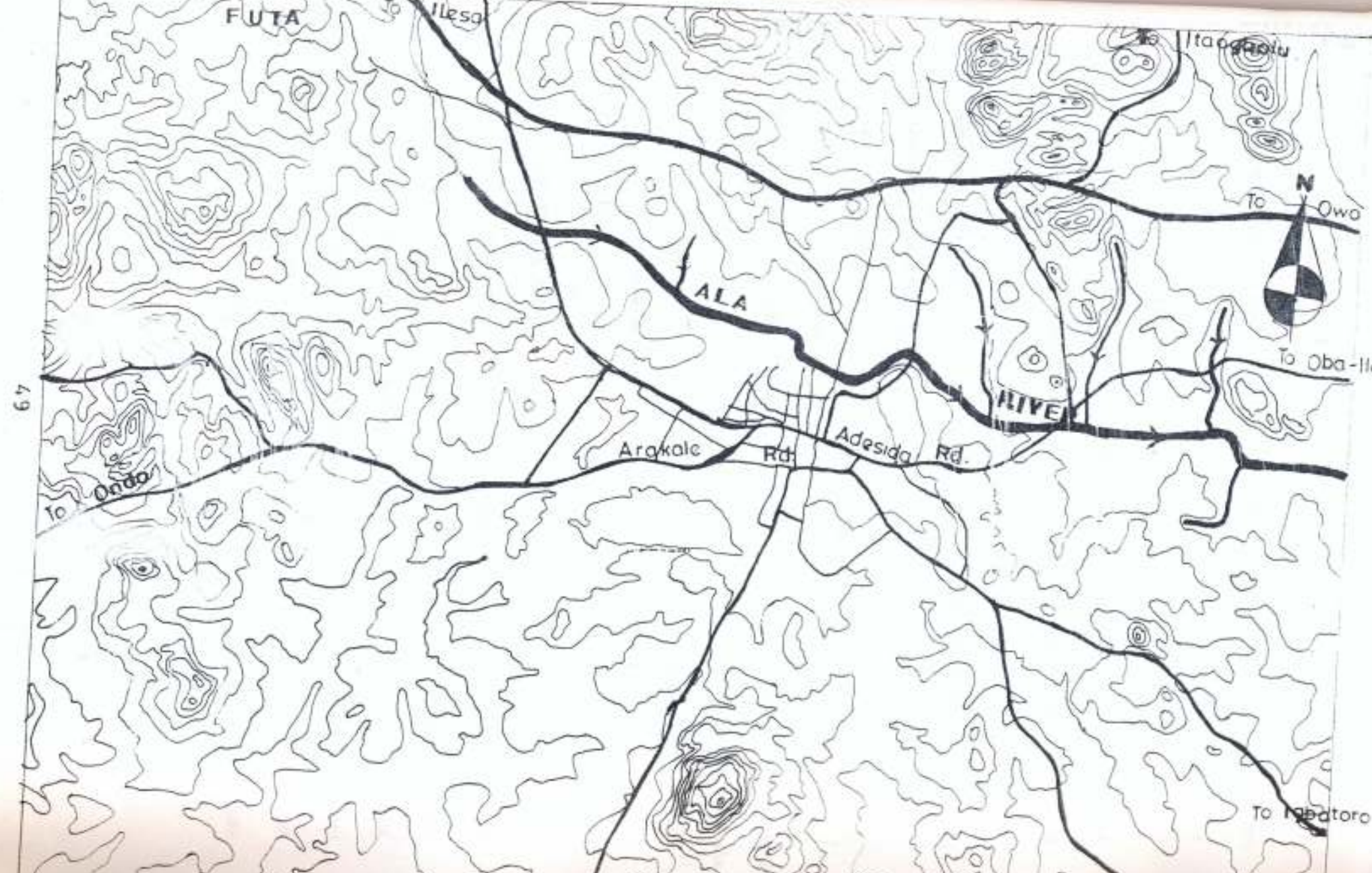
5.1 ALA RIVER

Ala River takes its source from (around Ipinsa) Ilesa motor park to the North-West of Akure. It receive a lot of tributaries (Elegbin stream, Ijala stream, Ilore stream) all along until it assumes a composite large stream towards the Ala forest reserves. Over three-quarter of the built-up area of Akure form part of the extensive catchment area of Ala river. Its length within the town is about 30,000metres.

Ala River is the most important out of the numerous streams that bisected Akure terrain. It carries heavy floods during every rainy season. The Ala with its numerous tributes drains the northern section of Akure.

The presence of this remarkable river dictated the name of Ala housing estates and Ala forest reserve. Ala River which flows from West to East through the developing urban area to the North of the town centre, is heavily built upon by public and private developers. The development on the flood plains has resulted into disastrous flooding of July 1978. The flooding problem on the conflict in compatible land uses.

The other tributary of Ala river that is noticeable is that which passes between St. Peter's Unity Secondary Schools and the Ministry of Works yard, crossing Oba - Adesida Road through St. Louis Grammar School, crossing Ondo Road near Isinkan market until it emerges again crossing Arakale street to Baptist church and across Oba - Adesida road agian into Obanla and Ijomu Quarters


FUTA
Ilesa
To Itapaloju
N
To Owo
ALA
To Oba-Ile
ILIVE
Arokale Rd.
Adesida Rd.
To Ondo
To Ibadan

(Elegbin stream) to join the river Ala to the North at Isolo (confluence point for Ala and Elegbin). Such tributaries also constitute a hindrance to housing or physical development.

The river flood plain does not attract physical development to its flood plains. About 90 hectares of undeveloped land exist on the Ala flood plains. Ala River and its numerous tributaries flows from North-West to South-East direction.

Ala songs of praise:

'Akure has two main stream,
the two were called Ala,
One at home and the other one at farm,
Ala been referred to has now changed
to an object of worship,
Akure can't but not have Ala,
Mine is kept inside my mother save.'

Oriki Ala (Yoruba Version)

"Akure lomi meji,
won pe mejiji ni Ala,
Ala ti ile tabi toko,
Ala ti won peri, Ala tidi omi ebo
Aye kii se Akure ki ona ni Ala,
Ala temi nbe ninu oke iyami.'

5.2 THE STUDY AREA

The study was carried out in flood-prone area of Ala River especially at the low-lying area of Akure. The catchment area is Isolo Quarters cum Oke-Ijebu Quarters. This area is where the river annually causes havoc to the urban inhabitant of the area. At Isolo cum Oke-Ijebu Quarters, both at the northern part of the town, the southern edge of it is steeply tilted toward the river that drains the southern portion of the city. while the Northern edge slopes gently towards the river that drains the northern portion of the city.

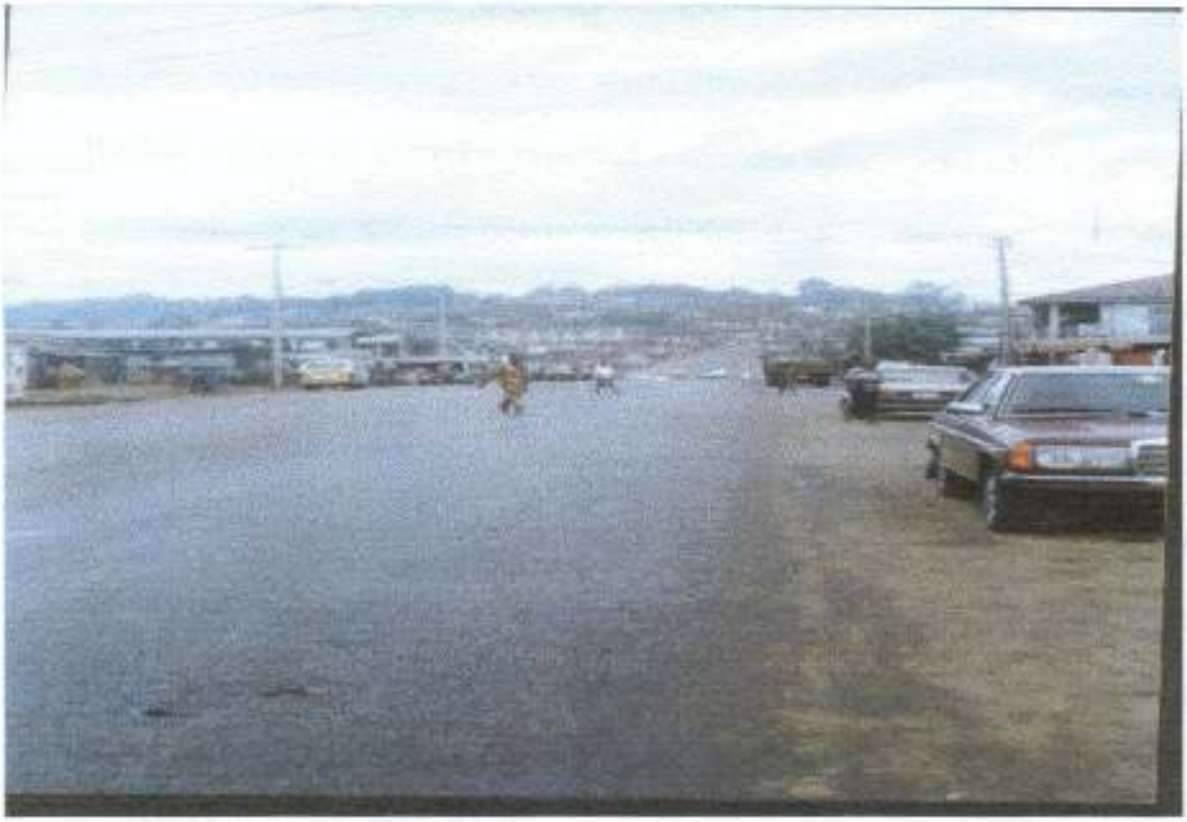


Plate 2: The Relief of Oke-Ijebu

Plate 3: Open gutter not properly inter connected to be functional

During the last 23years, Akure has witnessed a tremendous growth in population and area coverage according to Akure Master Plan review (1998). It is also noted that the built up area of Akure has expanded within this same period-in an attempt by individuals, groups, and government to meet the increasing demands for residential houses, roads, markets, parks, recreational, industrial, and institutional facilities. The development of these urban facilities usually involves the replacement of the natural vegetal cover with impervious urban land use surfaces which increase surface runoff through infiltration inhibition of rainwater. Although some of the major streets are provided with open gutters to convey the generated surface runoff. They are not adequate in design capacity, and number not properly interconnected to be functional. This has meant that flood water disposal is still poorly managed.

Flood water now flows freely on road surface until it discharges either into nearby low-iying areas to form depression or to Ala river to swell the river. With the presence of river flood, depression and their associated sediment pollution problems. Isolo/ Oke - Ijebu is a suitable study area for the examination of flood problems in Akure.

5.3 BASIC DATA

For the purpose of data collection and analysis, the study involves field checks. During rainstorms, the researcher drove along the nearest roads (that is plaza road, Isolo road, Araromi road and Oke-Ijebu road) to the catchment area to ensure that it corresponded with the water parting live for the adjoining sub-gutter.

In relatively flat areas, it was found that gutter carried run off form one area to the other. The area were checked to follow the gutter up to the point of change in the direction of flow. The intensity of flood was observed by earmarking the area with depression flood, area that experienced one hour or more floods duration during the

rainstorm, area with accumulation of sediments on streets, and area with gully erosion. Each of these flood-hazard of the catchment areas were summed up.

The area with drains were determined in the field and actual length measured on maps to determines its proportion to total length of roads in the study area. 50-Questionnaire were administered on the field. The respondents residing close to flood-prone areas were randomly sampled to obtain information about their perceptual assessment of the causes and damage from floods in their neighbourhood.

The number of flooded area between 1978 and 1998 stood at eight, that is, 60% increase. The phenomenal rise in the number of flooded areas over twenty years is attributed to the rapid expansion of urban structures from the core areas to Akure fringes without a corresponding provision of adequate modern drainage facilities.

A closer look at the intra-urban distribution of flooded areas within Akure between 1978 and 1998 reveals a progressive shift of flooded area from the core areas to the urban fringes. For instance, out of the flooded areas reported in 1978, three were located within the fundamental core area. By 1998, only three of the eight flooded areas were reported in the core areas, while the area surrounding the core area recorded three and the urban fringe five. That of the core area included Adesida road, Arakale road and Isinkan road while that of urban fringe includes Oshinle, Oja-Oshodi, Araromi, Isolo and Oke-Ijebu Quarters.

Table 4: No of flood-prone area in Akure.

Year	Zone	No of flood-prone area.
1978	(1) Core area (Adesida Road Arakale road and Ishikan Road. (2) Fringe (Non).	3
1998	(1) Core (Adesida Road, Arakale Road and Ishikan) (2) Fringe (Oshinle, Oshodi, Isolo, Araromi & Oke - Ijebu).	8

The urban fringe also witnesses a rapid rate of development and construction work without much thought given to the provision of drainage facilities. As such, the flood area is expected to grow progressively with time from its pre-urban stage to its initial urbanization stage. Depression, surface runoff pondages and river floods area the common flood types. River floods is common because of inadequate functional conveyance facilities.

5.4 IDENTIFIED CAUSES OF FLOODS

Six causes of flood were identified by residents of flood-hazard zones. They include excess rainfall, anger of God, building along water flow path, inadequate storm drains, dumping of refuse in drainage path and impervious urban surfaces.

Twenty-four percent of the time respondents mentioned inadequate storm drains as an important cause of flood. This is closely followed by dumping of refuse in drains and drainage paths with twenty-two percent.

To some of the respondent, flood is seen as the act of God which could be remedied by making sacrifices to appeal the angered God. Eight percent of the respondent mentioned this factor as the sixth variable.

The role of road surfaces in causing flood is not appreciated by the respondent. Excess rainfall with twenty percent is ranked as the third important variables. So also building along water flow path is one of the causes as well as the impervious urban surface (over site concrete) which prevent infiltration.

Table 5: Identified causes of flood.

Identified causes of flood.	No of times	% of total times	Rank.
Rainfall	10	20	3
Anger of God	4	8	6
Building along water flow path	5	10	5
Impervious urban surface	8	16	4
Inadequate storm drains	12	24	1
Dumping of refuse in drains.	11	22	2
Total	50	100	

Source: Field work 1999.

5.5 FLOOD-PRONE AREA INHABITANT PROBLEMS

When the inhabitants of flood-prone area were asked to list the major flood or flood related problems facing them. The residents in flood-prone neighbourhoods identified seven problems. These includes damage to landed property, damage to house hold property, business showdown, traffic congestion's clogging of drains turbid water unsuitable for municipal use and despoiling of valued lands.

Clogging of drains was identified as the most important with thirty percent. Ten percent reported that they have suffered huge loss of money resulting from damage to household and landed property. The last two problem are despoiling of valued lands and turbid water unsuitable for municipal use, eight percent and four percent respectively.

Table 6: Flood-prone area inhabitant problems.

Problems	No of times	% of Total	Ranks.
Damage to landed property	8	16	3
Damage to household property	14	28	2
Business slowdown	2	4	6
Traffic congestion	5	10	4
Clogging of drains	15	30	1
Turbid water unsuitable for municipal use	2	4	6
Despoiling of valued lands	4	8	5
Total	50	100	

Source: Field work 1999.

5.6 FLOODING AND VEHICULAR TRAFFIC

Accelerated population growth and the increased tempo of urbanization are becoming common Phenomena in Nigeria. Recently, Akure has been experiencing traffic congestion, that is a problem associated with the dynamics of urbanization. Also, environmental hazards or erosion threat such as floods have given rise to a lopsided concentration of vehicular traffic on a few of the urban roads in Akure, Thus making the roads a locus of great conflict between man and the natural environment.

The increase in the area of Akure jurisdiction presently, has an enormous implications on intra-city movement. Surprisingly, traffic congestions on a few of Akure roads become a common features of the transport system. It is observed that much of the Akure traffic problems during the rainy season are closely associated with street flooding problems.

It is observed that tilted plain of Oke-Ijebu road which slopes in northern and southern direction towards the low-level narrow existing bridge that clogged with waste on Ala river forming valley at this spot bordered on the traffic flow of this road.

The relatively flat terrain of Adesida Road (between Baptist Church and Toyin Bookshop) and Oyemekun Road (The Nigeria Airways Office), makes surface runoff very slow, with floods resulting. Field investigation shows that the covered drainage channel provided here is blocked.

Traffic were formed to have been stranded in the flooded areas during the period of carrying out the field investigation. Traffic as used here by the researcher refers to all vehicular and all non-vehicular movements. The traffic bottleneck created by a single bridge on Ala river along Oke-Ijebu road stands out in bold relief and clogging of the drains by refuse. In the case of Araromi road and Isolo road, which is an important inter-city road that floods whenever there is an heavy down pour, have been made possible by the ineffectiveness of the drainage systems provided for these roads.

Plate 4: Oke-Ijebu (Road) Bridge on Ala River Clogged with Refuse

Plate 5: Flooding of Oyemekun Road that Obstruct Traffic Flow

5.7 SANITATION

Cleanliness is next to Godliness. In essence, you must be clean in order to keep a healthy environment. In traditional times, environmental clearing and sanitation were highly encouraged and organised. Public clearing was supervised by the chiefs and elders. Defaulter were severely punished or fined. In colonial times, environmental clearing and sanitation were given high a priority and government attention. Refuse is initially dumped in an open space or open drains with perpetual flies and small. Sanitation inspectors saw to it that neighbourhoods (and even personnel hygiene) were well kept.

Unfortunately, since independence, traditional ethics, ties and sanctions have not only broken down, but have disappeared fast with rapid urbanization. Consequently, heaps of refuse now abound in various parts of the city. But for some time, War Against Indiscipline (WAI) took good care of some aspects of refuse disposal. This WAI has been scraped by the present civilian government and replaced by Environmental Management Ministry.

Field study revealed that household dumped refuse indiscriminately into the existing drains whenever it rains; blocked drainage channels, causes delay in the surface runoff with floods resulting.

Plate 6: Indiscriminate Dumping of Refuse on the Existing Drains

5.8 THE DESIGN PROPOSAL

Design in urban planning is directed at the distribution, over a whole detriment, of buildings activities, and open spaces rather than at single objects or with systems of public facilities. Akure as an urban centre, is the centre of population growth and mobility, and makes possible most of the education and technology that are remarking our country Nigeria.

The major features of the Akure plan were a natural street systems of the (herringbone system), a system of rare-open spaces, and non-uniform spacing and set backs for the buildings.

An urban centre should be planned ahead in terms of meeting future needs, mounting urban growth problems, among which flood is important, because flood can create crises and rob urban living of its many qualities.

Flooding results when a mass of water cannot be contained in its normal path, for example, when Ala river over flows its bank, the areas around such Ala river (flood-prone areas). Isolo cum Oke-Ijebu area, are flooded. Factors responsible for flooding of these area includes, dumping of refuse in the river, building on the river valley among others. After the investigation and analysis of the problems on Ala flood plain, the planning and design implication of the existing flood plain development, the existing erosion channels and refuse collection of the study area; the following design proposals were made for an effective solution to control perennial flood disaster along Ala river bank.

5.8.1 Channelisation of Ala River

In Akure, further development such as erecting more building roofs, deforestation and construction of more roads thereby resulting in greater run-off into

the Ala river valley and increasing flooding intensity. Flooding would then become an annual ritual with dreadful consequence for the people. To prevent this, the river course should be improved three dimensionally. This can be done by living the edges and floor with concrete. Also, deposits along the course of the river may be dredged.

5.8.2 Building Level

Finished flood level of building should be raised above natural ground level and above the *road right level of alignment by 300mm / 450mm / 600mm*. To prevent flooding. Otherwise, if the few existing drainage were filled up with rubbish when rain falls, the drains overflow into the roads and into houses with low damp proof level.

5.8.3 Drainage Channel

Individual household should convey their internally generated water or surface runoff to the street gutter which would finally discharge the street runoff to the main sewers. This drains should be about 300mm / 450mm wide and 450/600mm deep around the building perimeters to prevent the drains from overflow.

5.8.4 Landscape Planning

Tree planting must be encouraged, trees beautify our environment, apart from the pleasant aesthetics ; it protects the soil erosion and providing suiting shades during the dry and hot season. By the road sides delonix regia or cassia can be planted. For car park, cassia or oil palm can be planted.

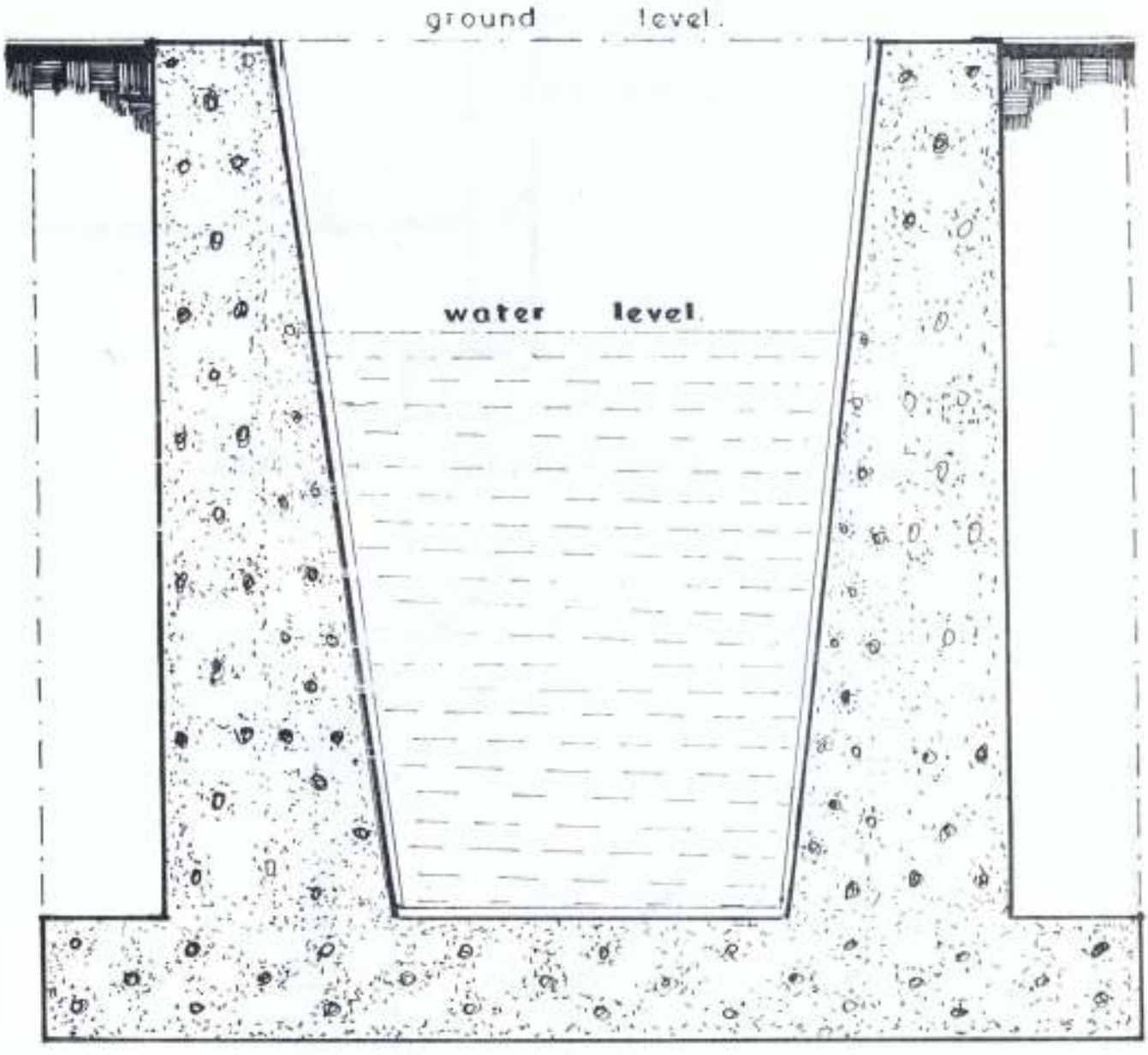


Figure 15: CONCRETE CHANNEL.
(OPEN DRAINS)

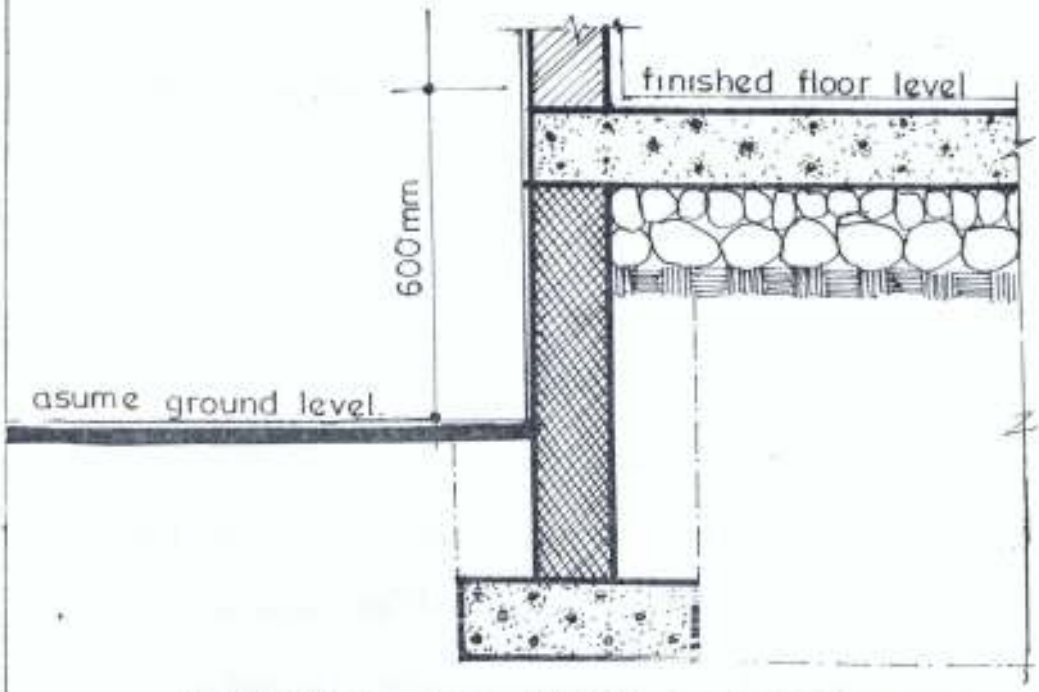


FIGURE 16 : BUILDING FINISHED FLOOR LEVEL

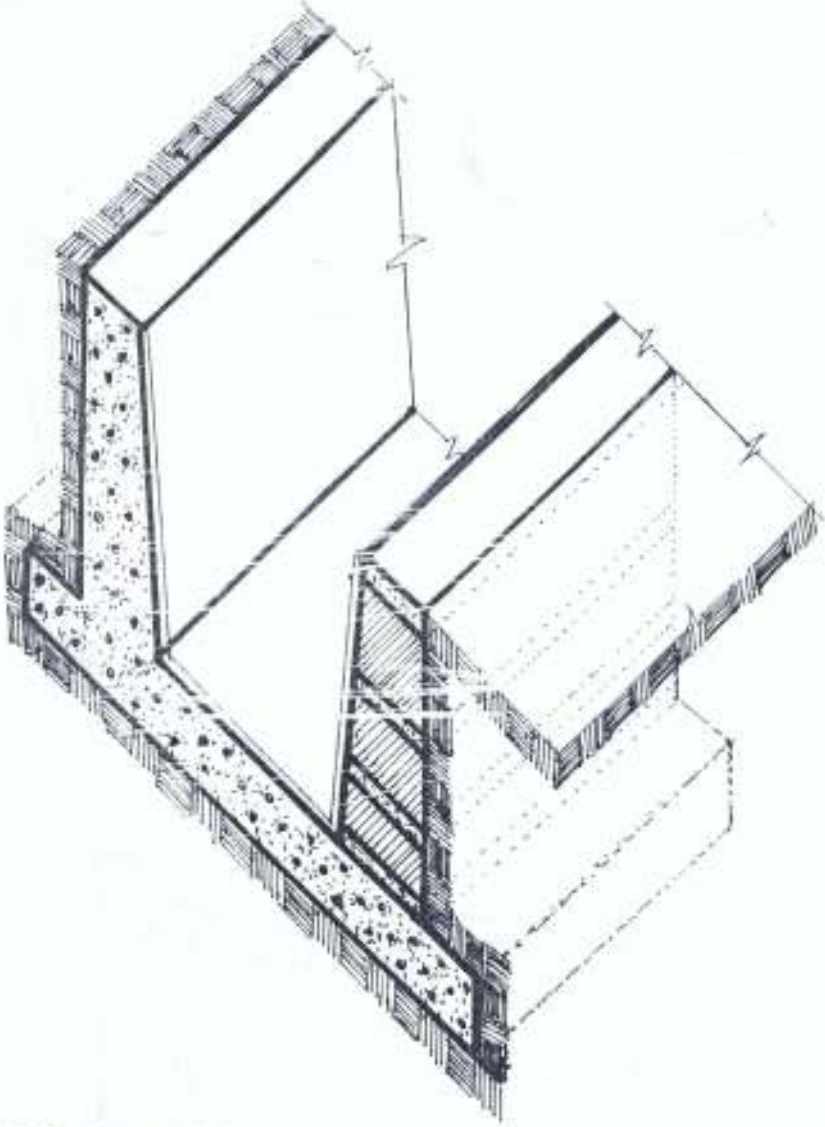


FIGURE 17 : DRAINAGE CHANNEL

5.8.5 Sewage Disposal

In urban area, sewage disposal is the likely problem faced by the in habitants. Individual should have waste disposal bin in-front of its house. Refuse has to be removed from house by paying a token fee to Waste Management Authority or else people run the risk of being infected with diseases. Two main kind of refuse generated are those which are mainly dry and can be put directly into the dust bins, and those in liquid form that may be drained away through the gutter.

Incinerator, this is a satisfactory and much used method of refuse disposal. It involves burning the refuse to ashes. Disposal of faces and urine is by using either pit latrine and water closet.

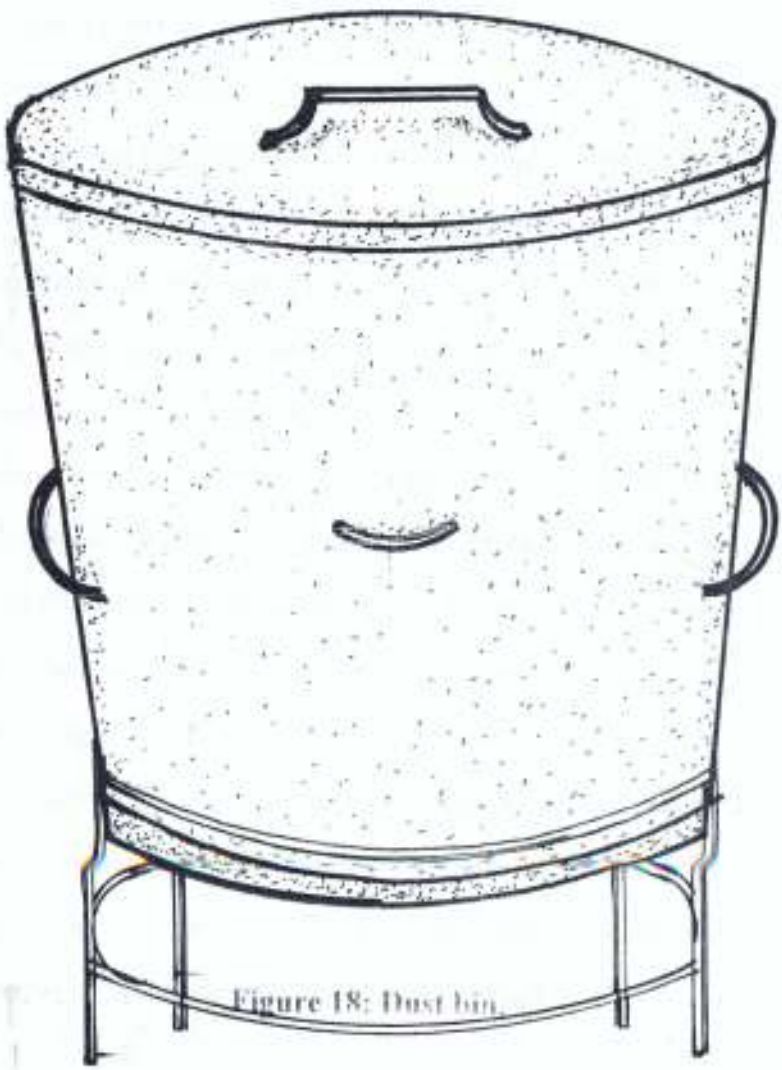


Figure 18: Dust bin

FIGURE 18 : DUST BIN

5.8.6 Building Setback

Due to land price and lack of effective planning control, some buildings were erected on the flood plains and tributaries. This idea should be discouraged. The building adoptive bye-laws should be reviewed in such a way that improvement are brought about the use of land in terms of setback along rivers and streams, building off-set from the centre of the roads, high tension lines among others.

5.8.7 Building Material of light house

Building to be built in flood-prone area has been developed by using special techniques. And the building has to be floating buildings, float buildings should be easily recognized as water born structure. It must have all the feature of land-based structure, but builder must use materials that make possible much more sophisticated arrangements and groupings.

The design of this building must provide for forces such as stability, buoyancy, strength, stiffness , correct distribution of weight, adequate mooring and bilge pumps, as well as the influences of winds, wave and tidal motion.

The building must be justified by lower cost, better aesthetics and practical consideration. The building must be built systematically starting with the hull. A hull may be made of concrete, steel or plastic.

A hull section is an open topped box, split into compartment by bulk heads equipped with flanges for fixing to the timber or steel superstructure. The bulk heads favored for this building were made of boxes board. This is a light weight foam cover material with cross-linking glass fibre webs for stiffening.

The interesting aspect of this building is the ability to take out a damaged section while the whole structure remain a float. Materials possibly used includes tubular steel frames, glass reinforced plastic mouldings or stressed skin play wood panels are used as they are strong and light weight. Even so while putting the whole thing together it is desirable to avoid uneven distribution of weight.

Plate 7: Building Built without enough set back to the River Ala

CHAPTER SIX

6.0 SUMMARY OF FINDNGS

The research work started with a study of flood threat to Akure urban spine with particular reference to Ala River as a case study. Flood threat identified as a result of high concentration of people on limited urban space is urban flood.

The identified causes of urban flood includes:

(i) inadequate storm drains or lack of it and non-channelisation of the Ala River to take account of excess rain water,

(ii) dumping of refuse in drains and drainage path.

(iii) heavy rainfall down pour.

(iv) impervious urban surface.

(v) building along water flow path out of ignorance and for economic reasons (cheap acquisition of land), and

(vi) anger of God according to the inhabitant of the flooded area.

Other identified causes includes:

i. building finished floor level lower than the road level,

ii. building on flood plain without enough set back and

iii. use of inappropriate building materials on the flood-prone area.

Moreover, the effects of flood on the flood-prone area inhabitants and on the total environment where also investigated. It posed a great danger to man, house and other valuable materials that can be washed away. Others include:

(i) clogged drains,

(ii) damage to household property,

(iii) damage to landed property,

(iv) traffic congestion,

(v) despoiling of valued land,

(vi) contamination of water and business slow down.

The effects also include:

(1) abandonment of buildings,

(2) some road were also abandon and

(3) rapid spreading of water born disease.

Finally, the problems were critically analyzed and solutions to them as they affect urban dwellers especially those at the urban fringe were put forward.

6.1 RECOMMENDATIONS AND SUGGESTIONS

On the basis of the findings in this thesis, the following recommendations and suggestions are made concerning a study of flood threat to Akure urban spine focusing, on Ala River as a case study.

(1) There is an urgent need for resettlement of population present within the non-buildable set back of the river.

(2) There should be no further construction or removal of sand within a specified set back to the river.

(3) In order to meet the challenges of further urbanization, the land use zonal map must be strictly followed, that is area earmarked for residential must not be converted to other uses.

(4) There is an urgent need to channelise Ala river to natural course of the river.

(5) There is the need to provide or improve on the existing infrastructural facilities like drains construction along our primary and secondary roads within the town, so as to enhance smooth run-off flow within the drainage channels.

(6) The drain design plan and specifications must be approved by planner and engineers before construction to enhance stable structure of drainage channels.

(7) The planner must be ready to move out of office to align the existing land use map with the newly approved plan, so as to comply with the laid down rules in relation to set back along river back, off-set to the centre of road among others.

(8) The planner must be willing and be encouraged by the state government to review the base map of Akure within a short period of five years.

(9) Drainage plan must be one of the criteria for building plans approval by the state government.

(10) Use of modern building materials has to be adhered to an flood-prone area to achieve excellent in design with reflection of functions, good technology and aesthetics.

(11) Building finished floor level must be at least be 300mm higher than the road right level of alignment to prevent flooding.

(12) State government should make it compulsory for landlord to provide a dustbin within their compound to prevent indiscriminate dumping of refuse into drainage path.

(13) State government should also make it mandatory for landlords, to provide at least a pit latrine if they cannot afford water closet and build public toilet very close to market and other public functions to avoid indiscriminate littering of streets drains with excrement.

(14) Sub-urban areas ripe for development must first be provided with infrastructural facilities, especially sewage and drainage facilities basic urban foundations well ahead of development by the state government

(15) Government policy should aim at reducing the percentage of paved area which reduce infiltration capacity of land that compounded run-off problems.

(16) The urban management frame work policy formanaging urban flood must have both a short-term programme to handle the immediate urban flood problems and a long-term programme to reduce urban flood problem.

(17) The existing bridges on Ala River especially along Oke-Ijebu road should be demolished and reconstructed to prevent flooding and traffic obstruction.

(18) Government should formulate a policy mandating individual to clean drainage channel within its jurisdiction.

(19) There should be a comprehensive and long-range national programme for flood management and control in Nigeria. This should involve a country wide inventory and mapping of flood-prone areas, measures for prevention and monitoring flood trends.

(20) Flood on urban streets and river overbank floow is a serious problem in Akure and other Nigerian urban cities. The intensity of the problem is closely related to the rapid rate of urban expansion, especially, where the simultaneous provision for an adequate urban runoff disposal system is lacking.

(21) Then the spread of urban structures, especially road network, and property development into developed parts of Akure must be accompanied by a simultaneous development of storm sewers.

(22) The sub urban areas ripe for development must first be provided with infrastructure facilities, especially sewage and drainage facilities as basic urban foundations well ahead of development.

6.2 CONCLUSION

- Urban floods have become serious issues of national concern that should not be tackled with levity. This is because of the large-scape effects of environmental degradation and ecological hazards resulting from flood. Lastly, the problems of flooding in Akure can be eliminated by preventing development on the flood plain of Ala river and by channelisation of Ala river.

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APPENDIX II

FLOODED BUILDINGS AND ABANDONED BUILDINGS ON THE FLOOD PLAIN

Appendix II: 1

Appendix II: 2

Appendix II: 3

Appendix II: 4

Appendix II: 5

Appendix II: 6

Appendix II:7

Appendix II: 8