ENVIRONMENTAL IMPACT ASSESSMENT OF FOUR VILLAGES LOCATED DOWNSTREAM OF SHIRORO DAM IN NIGER STATE

BY

LIMAN HADIZA MUHAMMAD
M.TECH/SSSE/915/2003/2004

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A thesis submitted to the Postgraduate School, Federal University of Technology, Minna, in partial fulfilment of the requirement for the award of the degree of Master of Technology in Remote Sensing Applications.

Department of Geography

School of Science and Science Education

Federal University of Technology

Minna, Niger State.

Nigeria.

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CERTIFICATION

This is to certify that this dissertation has been read and approved as meeting the requirements of the award of Masters of Technology in Remote Sensing Applications, Department of Geography, Federal University of Technology, Minna.

Prof. D.O. Adefolalu
(Supervisor)

22 Dec. 2005
Date

Dr. M.T. Usman
(HOD Geography)

Date

Dr Malo, Ishaku Ibrahim.
(External Examiner)

Date

Prof. J.A. Abalaka
(Dean P.G. School)

Date

DEDICATION

I dedicated this project to

ALLAH Almighty for His mercies endures forever and to the memory of my late father

Alhaji Salihu Musa

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ABSTRACT

The Shiroro downstream in Niger State has been under environmental pressures caused by man and nature, particularly in villages such as Kami, Layi, Manta and Jiko.

This study attempts to assess the impact of Shiroro dam on these downstream communities using remote sensing, field survey and groundtruthing, questionnaire administration and analysis. The database used include 1967 topographic map of their area, 2001 land sat TM image and 2003 Nigeria sat 1-image data of the area.

The remote sensing images were enhanced and classified using maximum likelihood method against six land use and land cover of the area. They include shrubs and weeds, stream and drainages, bare earth, isolated rocks, water body and crops and farmland.

Other numerical figures on the economic gains and loss of the villages were extracted from the questionnaires. The study shows that Kami, Layi, Manta and Jiko lie in relatively lowland area in the down stream of Shiroro dam reservoir and the area is prone to intermittent flood event. Also over 2 million naira worth of farm products and properties were lost annually by the farmers in the four villages coupled with lots of health hazards such as malaria, cholera, typhoid fever e.t.c which they are disposed to. It is recommended that the farmers be relocated from the Bank of river Kaduna where they are presently residing to avoid future colossal loss, which may affect not only properties and land, but also their lives.

TABLE OF CONTENTS

LIST OF TABLES

Title

LIST OF FIGURES

Title

page

Title **List of plates**

CHAPTER ONE

INTRODUCTION

1.0 Background to the study

The environment is dynamic in nature, because changes are occurring. The impacts of those changes also have to be monitored. There is the need for collection of data that is required for calibration and application to various environmental disciplines (Okhimamhe, 1999).

Nigeria is well endowed with water resources. Both surface and underground water abound in the country. Rivers Niger and Benue and their numerous tributaries as well as other river systems, such as Gongola, Hadejia – Jaamare, Kaduna, Cross River, Sokoto – Rima, Ogun, Imo, Osun and others are good sources of water. The total annual surface water of Nigeria has been estimated to be 193 x 10^9 cubic meters per second. Others have however estimated it to be about 10,000 cubic meters per annum (HYPADEC, 2001).

The existence of these rivers have enabled the construction of several dams in Nigeria, for purposes of irrigation, power generation and flood control, while most of the local communities use the rivers for fishing. However, of the several dams, three are located in Niger State, these are: Kainji, Jebba and Shiroro dams. These dams are sources of hydro – electric power to Nigeria and some other West African countries. These three dams have remained a source of joy and sorrow to millions of Nigerians most especially those of the communities downstream of Shiroro Dam.

In 1808, one time president of United States of America, Theodore Roosevelt, said: "we have become so rich through the lavish use of our natural environment but time has come to inquire very seriously into what will happen when forests are gone, when coal, iron, and gas are exhausted, when the soil has been impoverished and washed into the streams polluting rivers, denuding the fields and obstructing navigation".

Table 1.1: - SOME MAJOR DAMS IN NIGERIA AND THEIR USES

Basin	Location	Purpose
Sokoto – Rima	Bakolori	Irrigation, flood control, power generation
	Goronyo	Flood control, irrigation
	Zobe	Irrigation
	Kafin Zaki	Irrigation, flood control
Hadejia - Jamaare	Chalawa Gorge	Flood control, irrigation
	Tiga	Flood control, irrigation
Niger	Kainji	Power generation, flood control
	Jebba	power generation
	Shiroro	power generation
	Swashi	Irrigation
	Kontagora	Irrigation
Upper Benue	Dep	Irrigation
	Shemanker	Irrigation
	Mada	Irrigation, power generation and flood control

Source: (ECN, 2004)

It has been increasingly recognized by both the people that support and oppose the course of construction of dams that the social impacts of dams are complex and can be far reaching. Social impact can be positive (for example – improved welfare resulting from new access to irrigation water) or negative (i.e. resettlement, decline of a down stream fishery due to flood control). Social impact can be direct (for example the cultural trauma of involuntary resettlement) or where environmental impacts generate economic impacts, and these also cause social impact among which is the impact of changes in river's flooding patterns reducing fish population downstream of a dam. Social impacts can be local to the dam site (the negative impact associated with resettlement) or places that are far from the dam, where water or electricity is consumed. The impact of dams in particular communities dependent on agriculture and fishing in channels, floodplains environments; ecological, economic and social impacts tends to be closely linked (Williams 2000).

The siting of Shiroro Hydro – Electric Power Dam on the River Kaduna is of immense importance to Nigeria and the immediate communities socially and economically. However, the host communities of this electric power station are not enjoying the basic amenities, such as good roads, schools, and electricity supply. Many people have lost their lives and properties worth Thousands of Naira due to flooding, such communities like, Layi, Manta, Gijiwa, Kami, etc

The area of concern is Layi Village. In other to have insight into the impact of Shiroro Dam on Layi Village, conventional physiographic data and ground truth observations are combined with remotely sensed data to assess the impact. Remote Sensing has an important role in environmental evaluation and management strategy. The information obtained from it will provide the basis for decisions that must be made from time to time. It will enable an evaluation of the effectiveness of decision already made. Remote Sensing as an information technology has provided mankind an enhanced opportunity to appraise, monitor and model their natural resources (Adeniyi, 2000).

1.1 Statement of Problem

The Shiroro dam is designed and constructed to meet the electricity demands of Nigeria resulting from the growth of industries and rapid urbanization (HYPPADEC, 2001)

The communities downstream of Shiroro dam are facing annual flooding as a result of release of water from the spill gates of the dam during the peak o the rains. The flood is serious and calls for concerted concerns especially when viewed from the poverty background o the affected communities. As a result of this problem, this research intends to use Remote-sensing techniques to quantify the social – economic effects on the dwellers, through the method of impact assessment

1.2 The Aim and Objectives of the Study

1.2.1 Aim

The study is aimed at assessing the impact of Shiroro dam on the downstream communities, taking Layi, Manta, Jiko and Kami villages as a case study.

1.2.2 **Objectives of the Study**

The specific objectives include:

a. To assess the Landforms and Land use of the study area.
b. To estimate flooded farmlands by field survey and groundtruthing.
c. To determine the spatial and temporal impact of flooding on the study area.
d. To make recommendation for mitigation against repetitive natural disasters, especially flooding.

1.3 Justification of the Study

The construction of Kainji, Jebba and Shiroro hydroelectric dams in Niger State in 1968, and 1990 respectively brought with them serious negative impacts. The flooding situations of 1998 1999 and 2003 were catastrophic and call for concerted concerns.

Before the construction of the Shiroro dam, the people that live along the bank of River Kaduna had a good knowledge of the natural low regular pattern of changes of River Kaduna and could make maximum use of the alluvial soils for agricultural activities. They knew when the water in the river channels over flow their banks transporting with it alluvial soils which is highly fertile unto the floodplains. They are also aware of the type of crops to plant on the alluvial deposits and when to harvest them before the river overflows its banks.

The communities also understood or knew the breeding grounds of fishes and also the type of cast nets to used in a particular place and time of them season.

However, the construction of Shiroro dam had made the riverine communities loss the knowledge and can now only rely on the dictates o the dam operators. At the downstream environment, the excess spill from the dam causes flooding of agricultural lands, residential buildings and even loss of lives. It is as a result of this problem that the research intends to quantify the social – economic impacts on the affected communities.

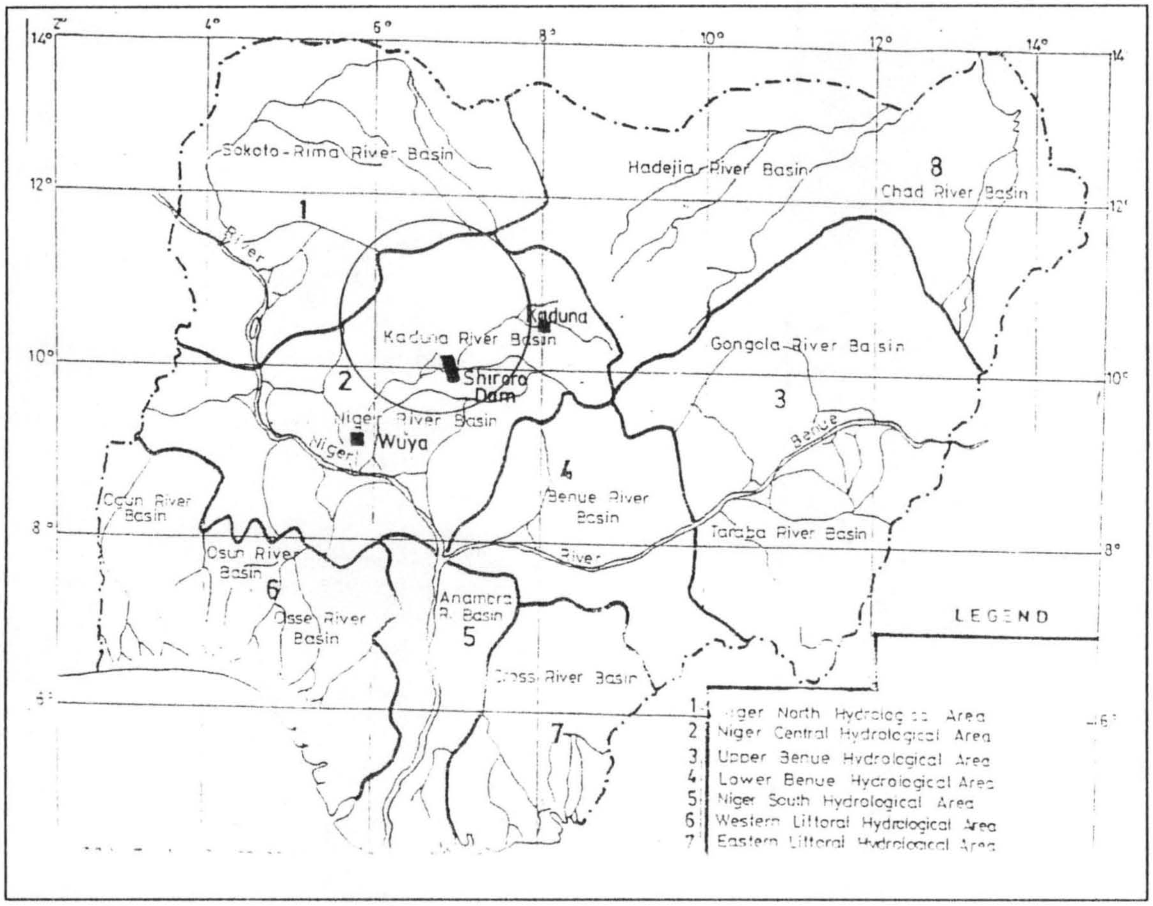
1.4 Scope of the Study

The emphasis of this study is to assess the impact of Shiroro dam (especially flood) on the downstream villages of Layi, Manta, Jiko and Kami.

1.5 Description of the Study Area

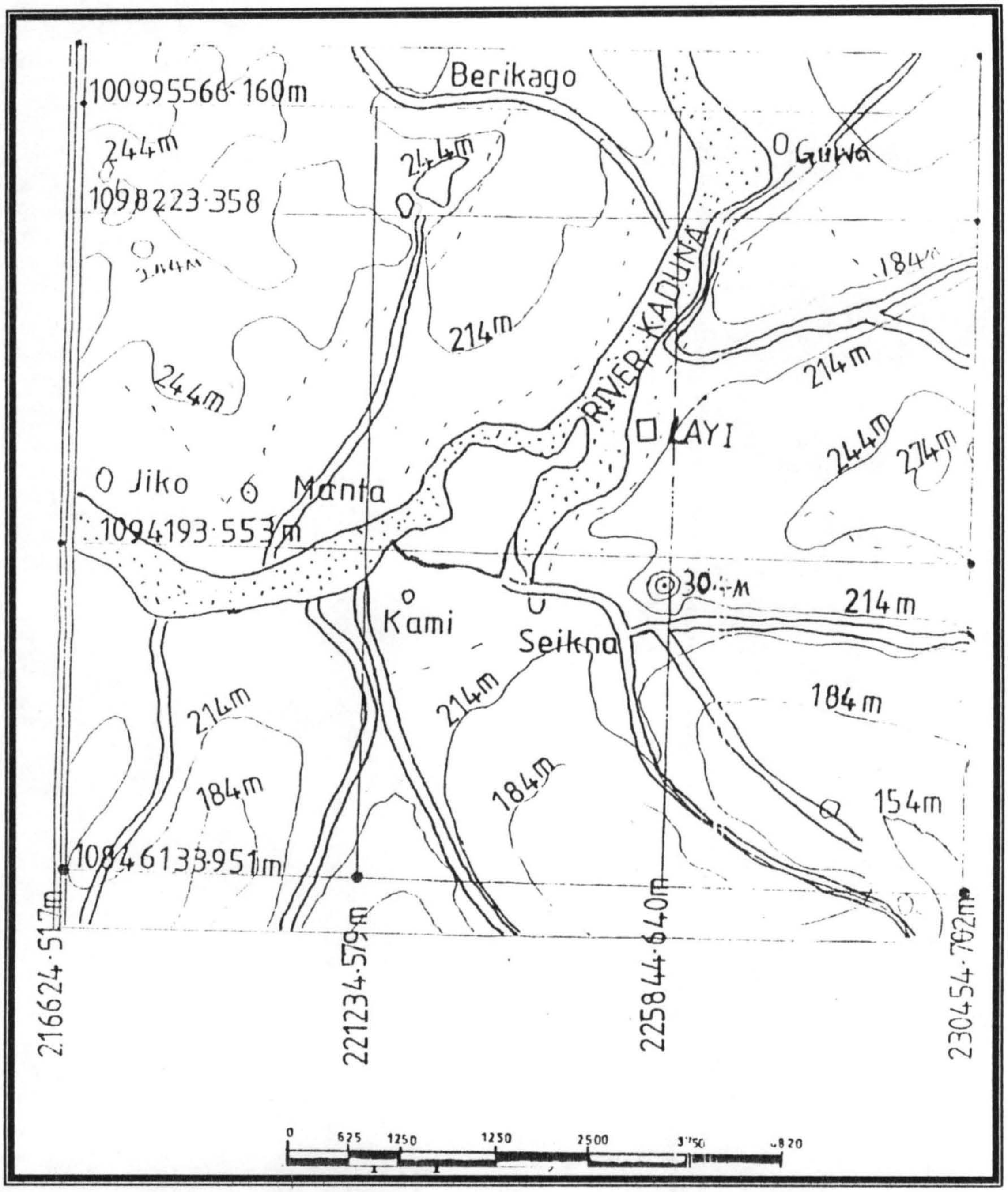
1.5.1 Location

The Shiroro Lake is situated on River Kaduna at the confluence of River Kaduna and River Dinya. The lake s located on latitude 9^{0} 58'N and latitude of 10^{0}51 E, River Kaduna is the major river feeding the lake (Fig. 1.1a, b&c). The river takes its origin around the west and north-west of Jos Plateau. The river flows westward and south-westward from the plateau at an elevation of 1500m through Kaduna town at an elevation of 633m. The major tributaries of the Kaduna River are the river Sarkin pawa and river Dinya. They rise from the hilly areas within the basement complex plains near Kaduna.



Source: FUTMIN Consult. 1992

Fig.1.1: A map showing Catchments of major Hydrological Areas and Shiroro dam

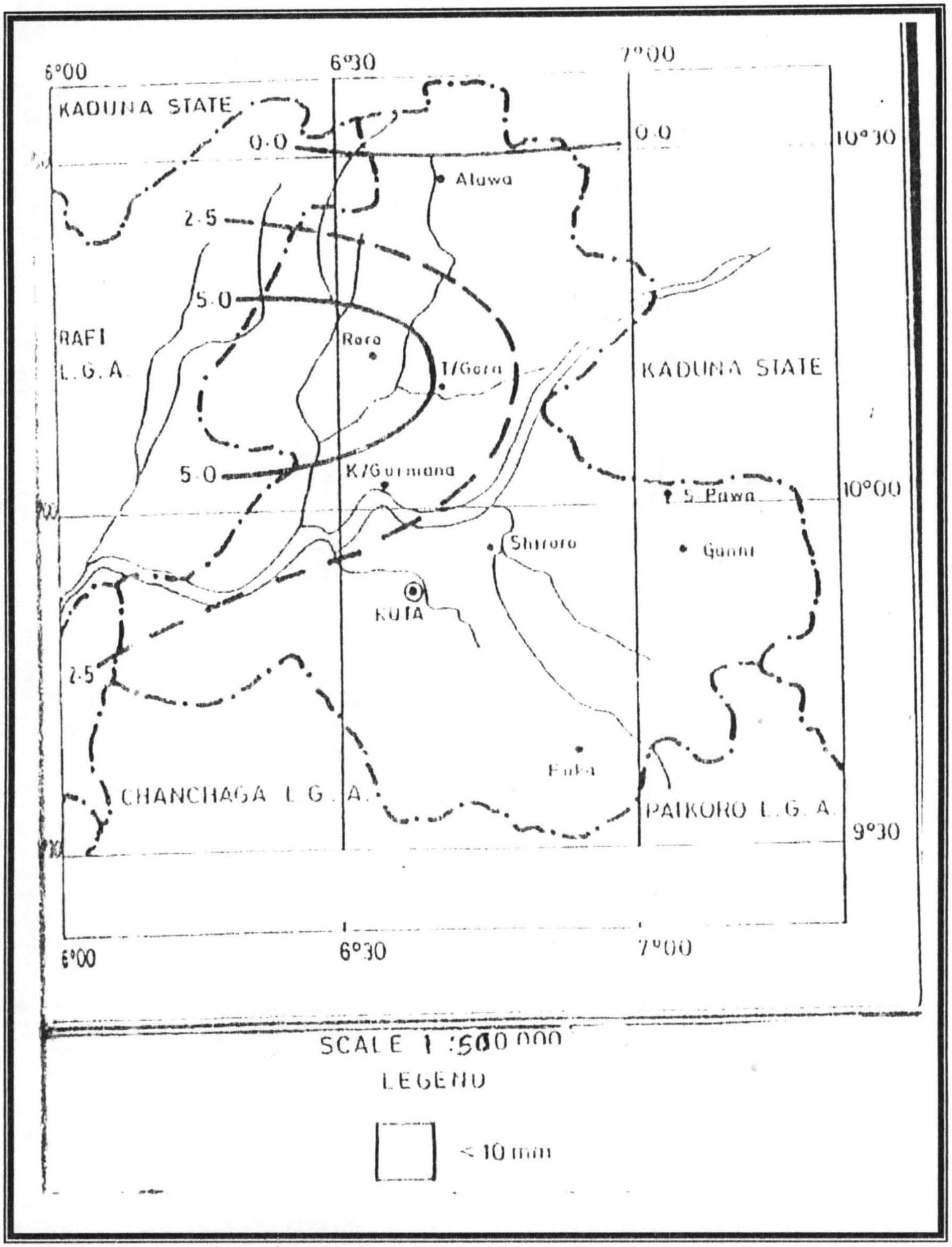


Source: Extracted from Minna Topomap sheet 42, of 1967

Fig.1.2: A map showing Study Areas and Shiroro dam downstream

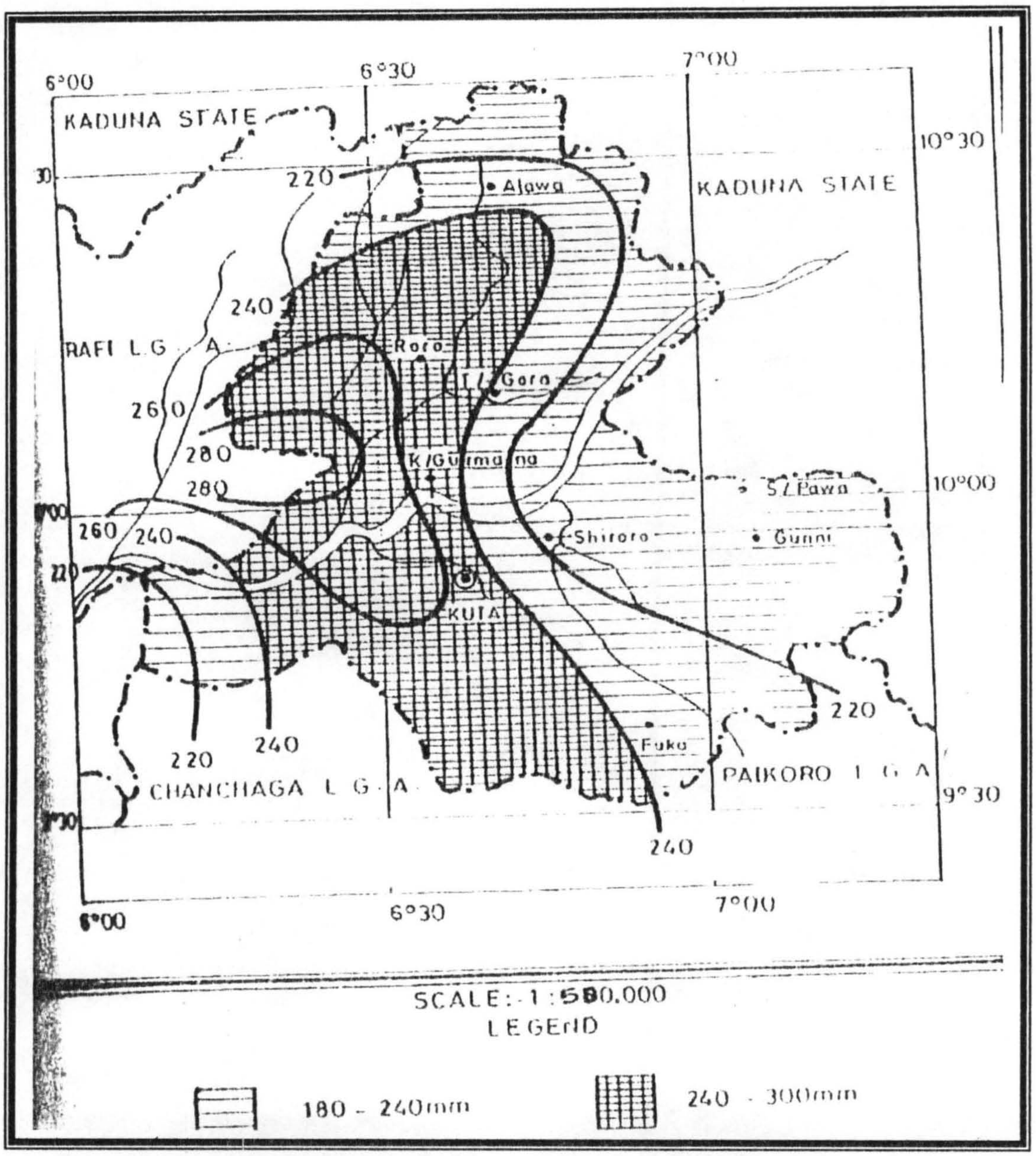
1.5.2 **Annual Rainfall**

Adefolalu (1992) has summarized the rainfall characteristics of the study area from January to December. He said rainfall in January to March (Figures 1.2 a,) is very low from 5mm in January to about 40mm in the extreme southwest in March. By April, rainfall of 70mm or more covers the central parts of the study area while the lowest value is 40mm in the extreme northwest corner. In the catchments basins of River Kaduna, the amount of rainfall to be expected as from April is between 60 and 80mm. Between May and July (Figures 1.2b) the Shiroro Lake watershed receives in excess of 100mm with a peak value of about 280 to 300mm in July .The watershed that receives less than 180-200mm of rainfall in July. August and September (Figures 1.2c) constitute the peak of the rainy season within the Shiroro Lake watershed with amounts in excess of 300mm in the western half of the Shiroro L.G.A. Highest rainfall of over 400mm is expected in September during normal rainy years, this is contrary to the popular belief that maximum rainfall is to be expected in August, a factor which may create recharge problems if proper care is not taken. The above characteristics are severely contrasted with the situation in October (Fig.1.2d) which ought to have similar features with July. However, rainfall drops sharply to a maximum of mere 130-150mm in contrast to the 400mm maximum in September. As may be expected November and December are very similar to January-March when Monthly rainfall is as low as 5-10mm. The onset of the rains is between 20-30th of April and the length of rainy season (L.R.S) is between 161-200 days. In Zungeru area, the onset is between 10th-20th April and the L.R.S between 141to 180 days.



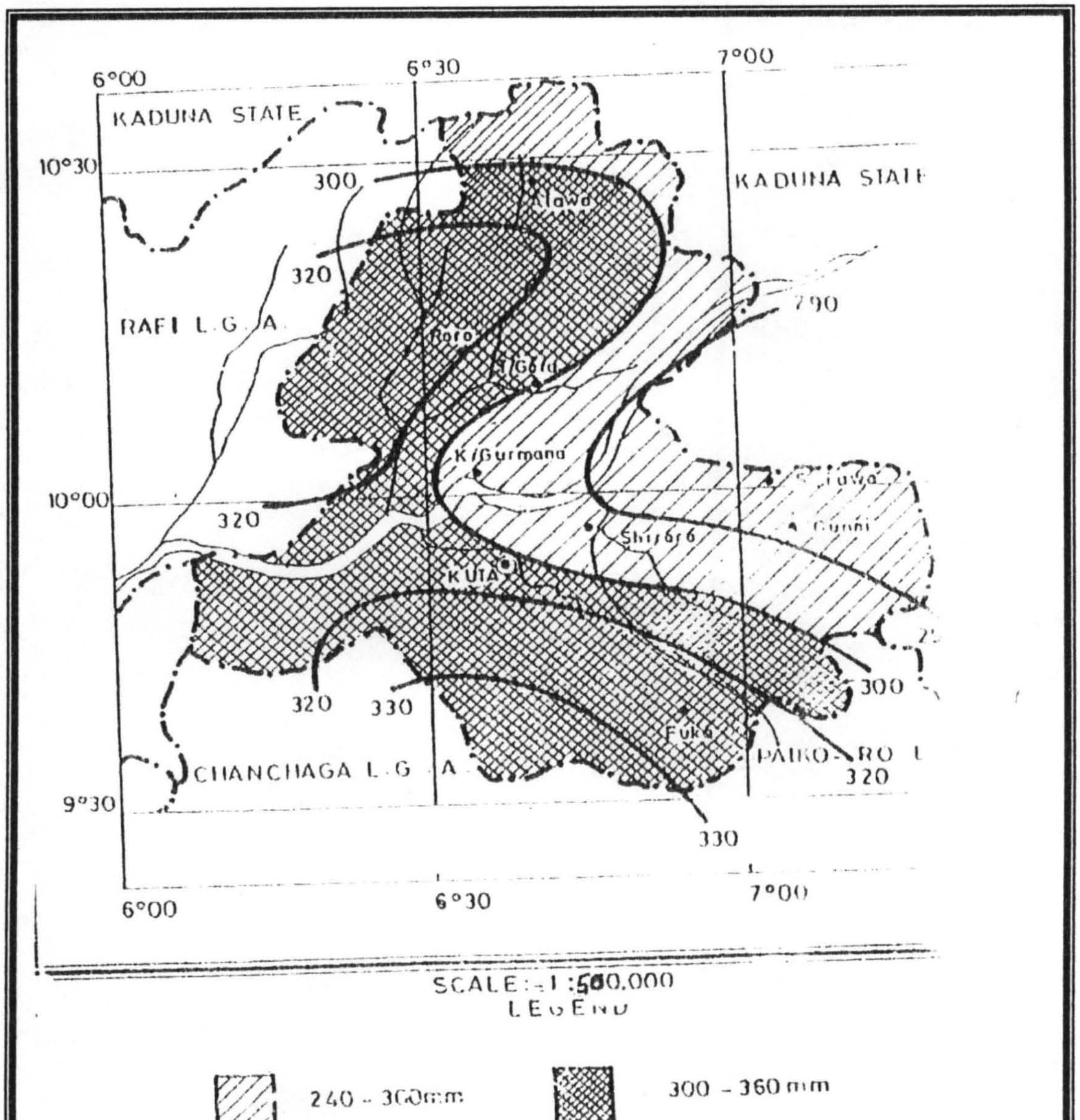
Source: Adapted from Adefolalu 1992

Fig.1.4: Mean Monthly Rainfall Amount for March



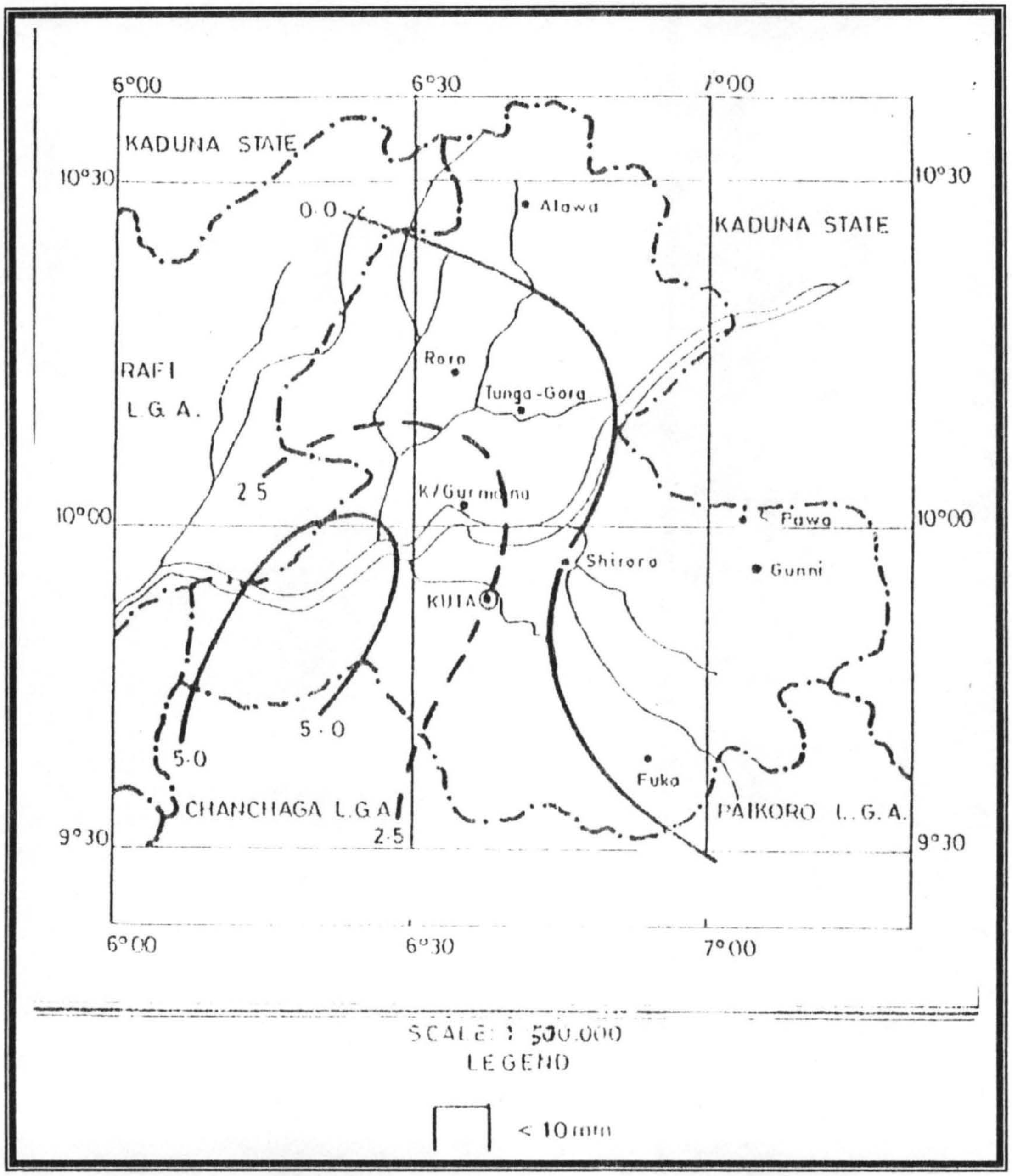
Source: Adapted from Adefolalu, 1992

Fig.1.5: Mean Monthly Rainfall Amount for July



Source: Adapted from Adefolalu, 1992

Fig.1.6: Mean Monthly Rainfall Amount for August

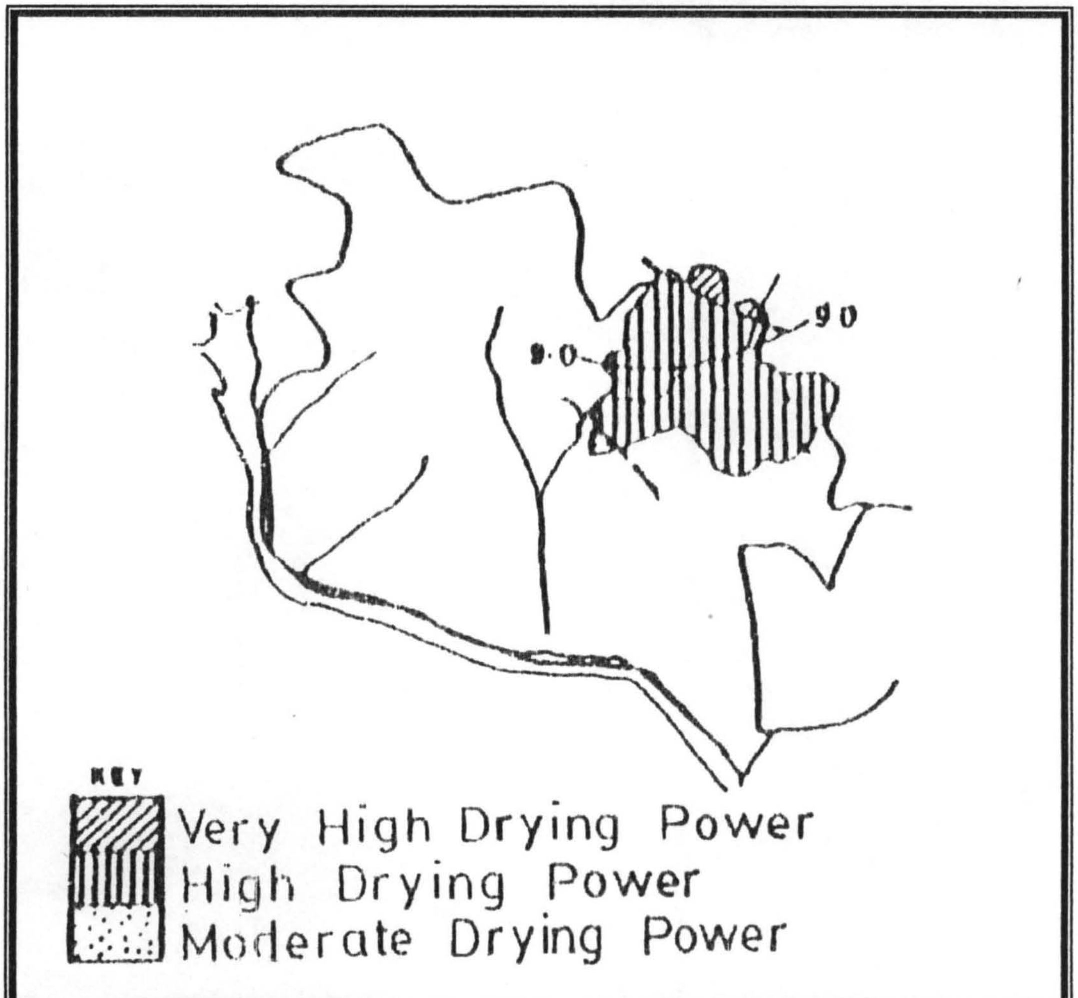


Source: Adapted from Adefolalu, 1992

Fig.1.7: Mean Monthly Rainfall Amount for December

1.5.3 **Sunshine Hours and Radiation**

Long hours of sunshine (Fig.1.3) combine with high irradiative power across the study area resulting in 'high drying power' across the entire area. The planning implications of these features relate to water storage (deficits) during the period discharge exceeds recharge (i.e. October through May).



Source: Adapted from Adefolalu, 1992

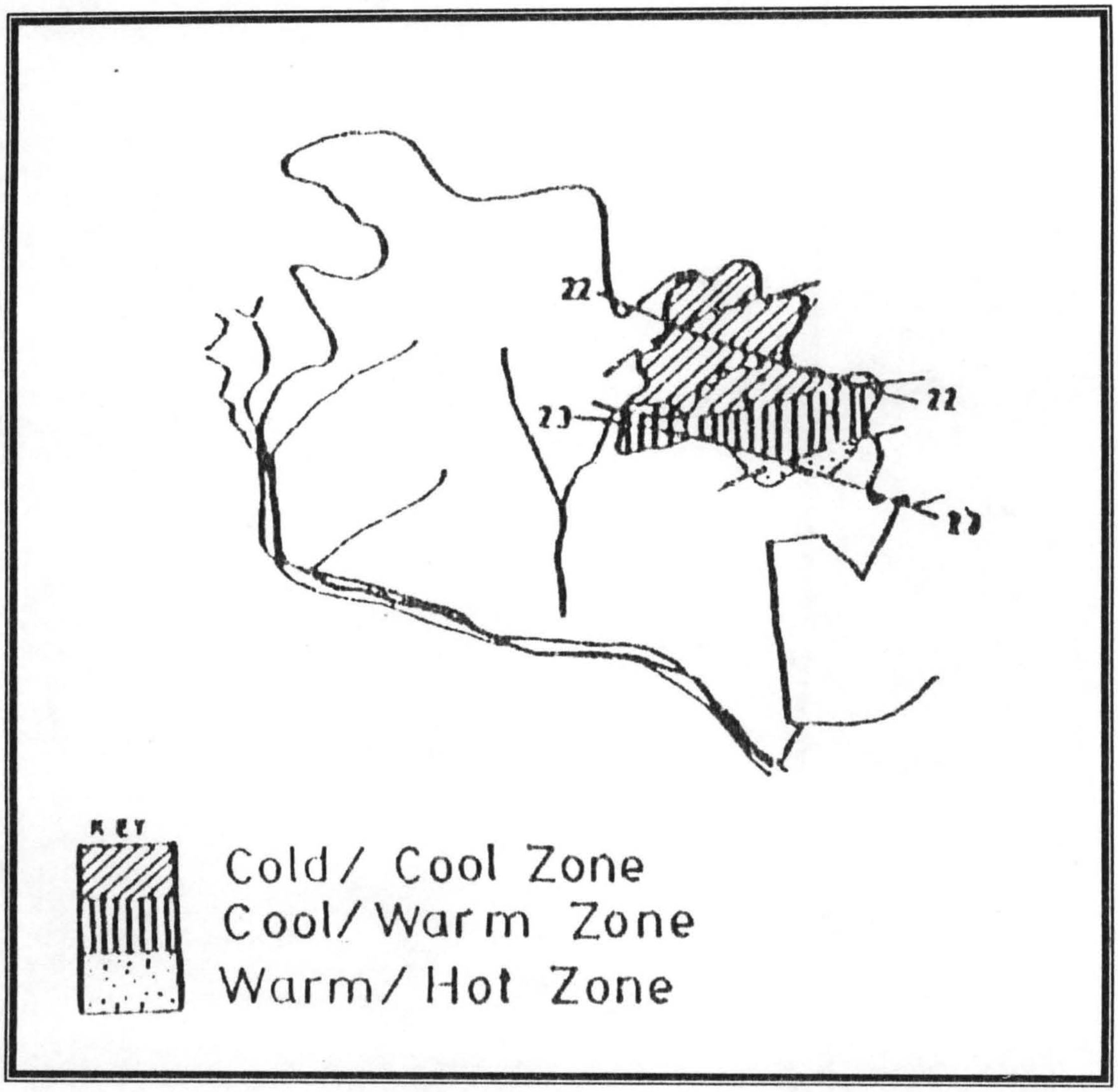
Fig.1.8: Sunshine Hours and Radiation

1.5.4 **Effective Temperature Factor**

The study area is in the cold/cool to cool/warm zone (Fig.1.4) with the colder sector in the northern half of the study area. The above characteristic feature suggests that effective heating rate is low in the Shiroro lake watershed. This may have a compensating effect on the sunshine/radiation factor. If these two factors of evaporative power cancel each other out, the controlling factor of maximum water loss due to evaporation will be the chill factor. In view of the high cold air advection (especially at night), water loss due to evaporation is experience in the Shiroro lake watershed.

1.5.5 **Relative Humidity**

Relative humidity for the watershed ranges between 32% to 78% for pre-dam condition, to value being higher between Julys to August (Adefolalu 1992). The values range between 40% to 88% for post dam condition. The highest values occur between July and August while the lowest values occur between December and February.



Source: Adapted from Adefolalu, 1992

Fig.1.9: Effective Temperature Factor

1.5.6 **Hydro geological Features**

River Kaduna is a major tributary of the Niger which flows in a North South direction. It takes its source from the Western slopes of the Jos plateau and has a total area of about 65,530 square kilometers from its head waters to the gauging station at Wuya Bridge. Unlike most rivers in northern Nigeria the Kaduna River is a perennial river although it is subject to great seasonal fluctuations in level. River Kaduna cuts its channel through crystalline rocks up to Wushishi where it enters the sedimentary formation of the Bida basin, (Adefolalu, 1992). The river flows in a fairly straight course in the upper and middle stages with some meanders at the lower course, its long profile consists of a number of steep gradients. Erosion is confined to the steep parts of the profile. The lower course of the river is characterized by islands and multiple channels which cause the spreading of the river in numerous places to as much as 1.5 kilometers wide. (Adefolalu, 1992). Its course is interrupted where it crosses hard rocks. Deep gorges have been cut across the areas of more pronounced steps in the valley. These include the 5.0 kilometre ravine in the granite at Shiroro and the 9.5 kilometre gorge through schist at Guria. Flood water from Kaduna river valley often extends far inland during the rains converting large areas into swamps while several villages (e. g. Agwi, Kwasa Erena, Blanda, Kogo, Jiko etc) become isolated and can only be reached by canoes.

There are about 15 tributaries of Kaduna River within the Shiroro Lake watershed, the major among them being river Dinya, Sarkin pawa, Guni, Erena and Muyi. The tributaries flow in the north south direction and few western tributaries flow in the North West to south east direction.

The surface hydrology has the problem of low base flow of rivers. The storage does not sustain river flow during extending dry season. This explains the seasonality characteristic of these rivers, since they depend on rainfall. It is obvious therefore that the volume of the river varies with the quantity of the supply of rainwater. Thus in the wet season the rivers swell in volume with ranging torrent while in the dry season they dwindle to dry up.

1.5.7 **Terrain Features and Geology**

The topography is highly undulating and varied in heights. Isolated hills of over 600m above sea level are common, while the valleys in between can get as low as 400m above sea level. Kaduna hills in Kaduna State form part of the ranges that extend across River Kaduna. These ranges continue southward close to Sarkin pawa village up to the Lake site and terminates at Kolafe and Kabula hills before Doka forest reserve. The forest is close to Katari village along Suleja/Kaduna road.

The study area is underlain by the rocks of the Precambrian Nigeria basement complex with outcrops prominent all around. The complex is mainly of granite (oldest rocks), meta-sediments, biotite, granite and grandiosity. The biotitic granites and granodiorite are introduced into older rocks. These rock types are therefore found interwoven (Adefolalu 2001).

The gorge on which the dam is located is a result of Kaduna river eroding a NW-SE fault zone which crosses a prominent NNE-SSW ridge of granite hills up to 600m above sea level. The range of granite hills almost 3km wide from the western edge of most of the Lake. Deep lateritic soils are limited in the dam and gneiss are dominant rocks in the lower terrain. Gneiss and schist which are Precambrian metamorphosed sediment underlie most of the reservoir area, and West of the granite ridge. The massive biotitic rocks later intruded the schist and gneiss. This intrusion was accompanied by regional folding with major NNE-SSW trends. Tear faulting in the direction N-S and NW-SE also resulted from this crustal movement. Prolonged weathering resulted in the characteristic topography of peneplain of inselberg and domes of resistant rock giving varied topographic heights.

1.5.8 **Vegetation**

The vegetation type of the watershed is Guinea Savannah. There are marked differences which occur at close intervals both in floristic composition and the open character of the vegetation which is often caused by variations in soil type's topography, ground water situation and human interference.

The vegetation is composed of montane forest of mainly trees with little shrubs and grasses. The grasses are between 1.5 to 3.5m high. The trees are short bold broad leaf trees of up to 16.5m in height. Riparian and gallery forest predominate along the river valleys. Most of the plants in other areas are shrubs with scattered trees most especially *Butyrospernum paradoxum, parkia clappertoniana* and occasionally *Afzellia Africana*. Other dominant species include *piliostigma thonningii, combretum molle. Corcorus spp, isoberlini doka, Monotes Kerstingii, Terminalia avicenniodes,* Bush fallow and mixed slow growing leguminous wooded savanna are prominent. Examples include the *isoberlina-Uapaca* woodland found around Kurmin Giwa. The *Terminalia* woodlands, *Detarin* woodland and *Daniellia Vittelaria* woodland which is the most widespread type. Where the mixed leguminous wooded savannah has been farmed repeatedly, as it is common in the watershed only. The large and economic trees, the so called farm trees (scattered farm trees system of Agroforestry) like *Vittelaria spp, parkia sp, Daniellia spp, isoberlinia sp,* *Terminalia sp* and few mango trees (*mangifera indica)* are preserved, the rest of the woody vegetation having virtually disappeared.

The vegetation produces countryside (with a park like appearance) in which only the tall trees and grassy lower layer survive. The major effect on the vegetation is excessive grazing due the increase in cattle population. This, coupled with the effect of the drought years which compelled the Fulani herdsmen to move southwards has led to much greater pressure being put on the woodland. The vegetation type is a by-product of centuries of tree devastation by man and fire and a continuous attempt by the plants to adapt to the climatic environment. Thus the trees grow long tap roots and develop thick barks which enable them to survive the long dry season and resist bush fires. Some of them have unique shapes and a few small leaves. Most of them have umbrella-shaped canopies which not only shade the ground and limit loss of soil moisture, but also present a thin edge to the wind. They shed their leaves in the dry season in order to minimize loss of water by transpiration. The grasses have durable roots which remain underground after the tops have been burnt away after a dry season fire. They sprout again with the onset of the first rains the following year.

During the dry season the landscape looks dry while in the wet season, it is green with fresh leaves and tall grasses. The gallery forests are found along river banks where the ground is moist. They are usually greener than the surrounding vegetation and grow dense enough to cover the rivers.

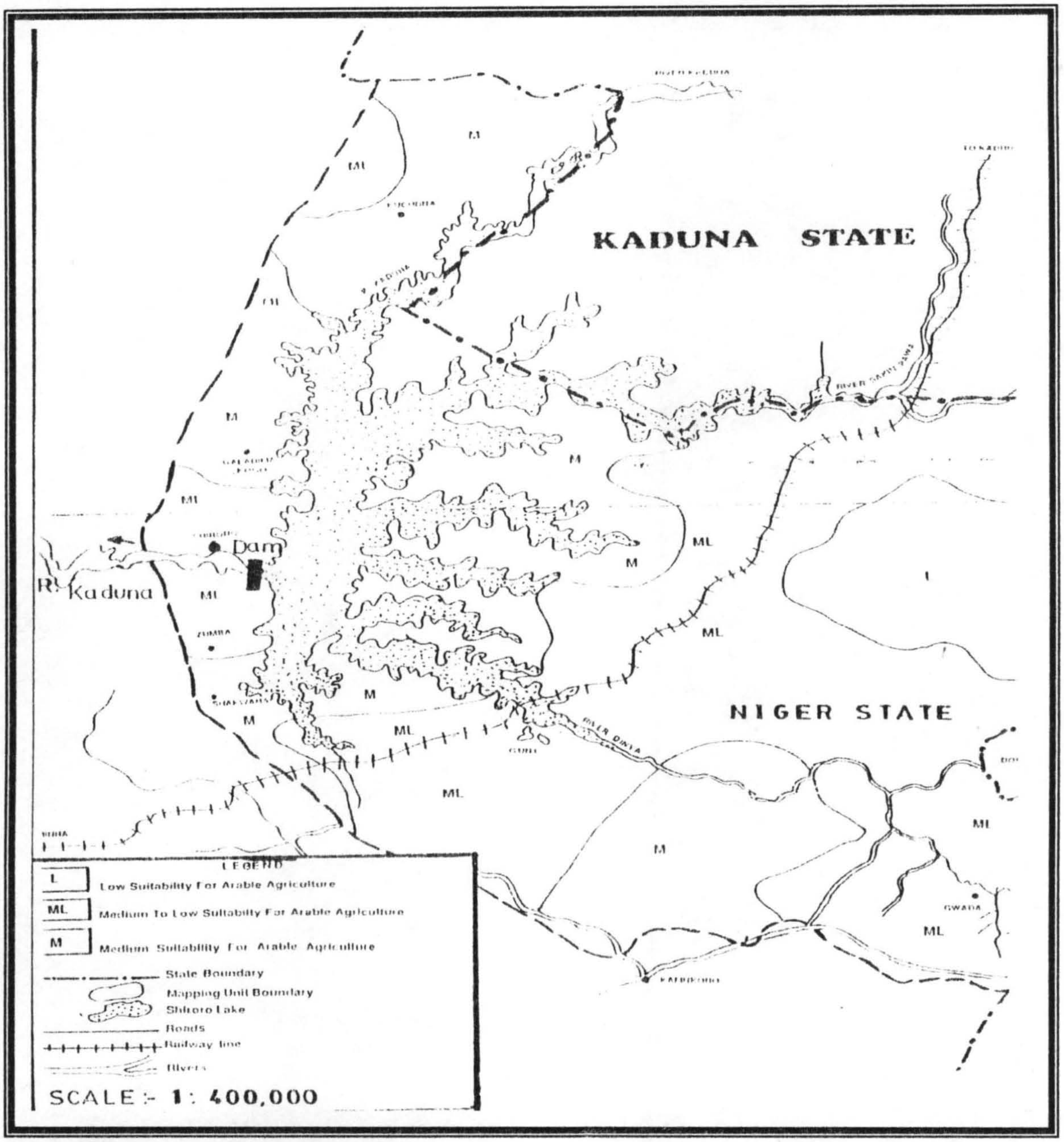
1.5.9 **Soils**

The soil type is primarily the result of the interaction between climate (mostly rainfall and temperature) flora and fauna (biotic), parent materials and geomorphic factors over varying periods of time. The soils of the Shiroro catchments area are developed from the Precambrian Basement Complex rocks comprising granites, schist, gneiss and amphiboles.

1.6 **A Brief History of the Shiroro Dam Reservoir**

The Shiroro electricity project was initiated by the defunct Northern Nigeria Government and the former electricity co-operation of Nigeria in 1957 (Shiroro Annual report 1996). It was originally conceived to meet the electricity requirements o the Kaduna, Zaria and Kano areas. Work on the project commenced in 1978 and it was commissioned in 1990 (HYPADEC 2001).

The dam is situated at Shiroro gorge on the river Kaduna downstream of its confluence at the Dinya River. It has a vast catchments area covering about 20,300 square Kilometers in Niger state alone and drains about 27% off the total landmass of the state. It rises from the Western slopes of the Jos Plateau and has a total area of about 65,580 square Kilometers from its headwaters to the gauging station at Wuya Bridge in Niger State, Annex 2. The dam itself has a surface area of 306 square Kilometers, an elevation of 382m and a tremendous storage capacity of 605 billion cube meters. Shiroro dam has four (4) numbers of turbines, each turbine generating 150 Kilowatts of electricity, the four (4) turbines generates 600 Kilowatts of electricity altogether.



Source: Adapted from FUTMIN Consult, 1992

Fig.1.5: Hydrology of Shiroro Watershed

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

"It is said that the essence or focus of any science is a set of problems and a method of solving them. This statement further elicits the question "What are the sets of problems"? According to Baba (1999), a scientific problem is any unanswered question about our experience.

The first attempt at dam construction in Nigeria started with building of small concrete dams in the south-western part in the 1950s. By the 1960s more than 30 towns and villages in that part of the country were getting their water supplies from these dams.

Nigeria has about 108 dams with a total capacity of 26,291x 106m3 and most of these are found in the middle-belt and Northern parts of the country. There are about four major types of dams, in Nigeria.

The first type is the small-scale earth dams built essentially for small-scale irrigation, lives stock veterinary and is usually constructed by large agricultural agencies, private individuals and some government parastatals and agencies.

The second types are the municipal dams for water supply to towns, cities and rural municipalities. These types of dams are found in large numbers in the western states, particularly in Oyo and Osun States. Examples of municipal dams are Erinle, and Eleyele in Oyo State, Kubanni and Galma in Kaduna State, Kogin Gira, Lamiyo and shen all in Jos municipality in Plateau State. Asejore in Osun State, Era in Ondo State, Ojirama in Edo state and Oyam in Ogun State (ECN 2004).

The types of dams found in Nigeria are the multipurpose dams, constructed essentially to serve two major objectives. Irrigation and water supply. These types of dams are found in Kano, Kaduna, Bauchi, Sokoto and Borno state. Kano state has about 20 of this type of dam with the Tiga dam being the largest with 198 km^3 at full capacity. Other dams in this category include Kiri dam in Adamawa State, Kafin Zaki, Misai, Dindima and kifi in Bauchi State. Kangimi and Materi in Kaduna State, Dutsima and Jibiya in Katsina State, Zoba In Nassarawa State, Bakolori and Garonyo in Sokoto State.

The forth types type of dam is the large multipurpose dam designed essentially for electricity generation. Dam in this category includes Jebba and Kainji dams on River Niger and Shiroro dam on River Kaduna, which are the focus of this study.

Globally, there has been a drastic increase in the number of dams over the last 20 years. The utility of the dams are immense and include irrigation, hydro electricity, power generation, industrial uses, flood control, water supply and creating artificial lake for recreation as exemplified by the Kainji Lake

2.2 The Down Stream Impact of Dams.

Dams are major forms of human intervention within the environment, bringing about some changes which are often unintended and unplanned for. Many such changes are disadvantageous, even dangerous to the local people. The impact of dams on social life and the physical environment have, up to this point in time, been largely ignored or given only little attention by the decision makers.

The social impacts of dams down stream environments tend to result from complex interaction between environmental impacts and economic impacts. The downstream impact of a dam on people depends on a rather complex set of impacts on the amount and timing of water flowing in the river and on the hydrological links between river and flood plain. Where the dependence of downstream communities on economic activities (such as farming, fishing e.t.c) is on river flows, social impacts reflect, ecological impacts closely.

As it is the case in the study areas, these communities live at the bank of river Kaduna. They embrace a number of distinct practices, including farming on the rising flood or on the falling flood (involving the use of residual soil moisture left by retreating floods). Flood plain soils often contain clay and hold water well. Farmers become adept at judging the likely duration of water and soil moisture in these areas, and plant suitable crops as the water make this possible. Flood cultivation is a high- risk activity that offers the chance of high returns. Flood plain wetlands are highly productive in ecological terms compared to the dry land around them, partly because floodwaters allow plant growth for a longer period. Flood plain wetland, are also relatively fertile.

Annual inundation involves the deposition of silt and other solid material carried by rivers, which with the dissolved load of the floodwater can support continuous cropping in such wetland environments, which is so widely necessary in dry lands.

2.3 **Environmental Impact Assessment**

Environment impact assessment (EIA) is the process of identifying, assessing and evaluating negative and positives consequences of human actions on the environment with the view of mitigating any of the negative consequence. EIA is a major component of environmental management. By assessing the potential impacts if dams, information can be obtained and made available on the condition trends of change in the environment. This interaction provides the basis for decision that must be made from time to time as well as enable an evaluation of the effectiveness of decisions already made.

In certain situations Environmental impact assessment is required even before a project is approved for construction. This assessment requires that all potential benefits and costs (both tangible and intangible) be weigh in terms of monetary value. A project is approved for construction if the potential benefits outweigh the potential cost. Fortunately, EIA is fast becoming a standard tool for decision making especially for developmental planning in both the developed and developing countries.

Ola (1997) defines environmental impact assessment (EIA) as a process of evaluating several aspects of main's interaction with nature, man with man and nature with nature, with the view of strengthening and enhancing the positive consequences of these types of interaction on man and nature.

The environmental impact assessment of dams, according to Olofin (1980) can range from interruptions and changes in natural drainage conditions causing poundings, fluctuations of the ground water table, alterations in stream flow characteristics, soil salutation, water borne hazard, changes in water turbidity suspended load and temperature increase, chemical pollutants such as heavy metals and insecticides to changes in vegetation caused by clearing site and alteration of site conditions, changes in wildlife populations species and distributions caused by opening up new habitats and destroying existing ones.

Abubakar (1997) has enumerated the negative effects of dams on the environment and the people in Nigeria to include: reservoir flooding of large areas, population displacement, creation of aquatic environment favourable for the multiplication of harmful organism, elimination of sediment supply to flood-plains, decreased fishing in downstream areas, salinity and water-logging problems, weed problems, dam failure with loss of lives and property, sedimentation and local micro climate change at the dam site.

In addition to the above problems, there is also a lot of environmental effects that need urgent attention. Some of these are ecological changes and human diseases. Ponds and irrigation canals create condition, which are favourable for the spread of diseases such as Bilharzias, which is particularly prevalent in the tropics and sub-tropics.

These adverse effects of dams may not always be localized. In some cases, large areas interconnected by the hydrological cycle may be affected extending beyond national boundaries. The atmospheric branch of the hydrological cycle and the surface run-off may be modified. Higher erosion potential and greater sediment transport result from increase in the amount and intensity of catchments run-off.

The aquatic ecosystem is also affected by the creation of dams. They become perennial water bodies that serve as media for aquatic life. Dense algae growth and aquatic weeds choke and invade channels and distribution systems that are rich in organic matter. Natural vegetation, flora and fauna are disturbed. Some of these changes could be highly devastating. Precautions can be taken to minimize or prevent these adverse consequences.

2.4 Remote Sensing as viable tool for Environmental Impact Assessment

Remote sensing is defined as the acquisition of data and derivative information about objects or materials (targets located on the earth's surface or in its atmosphere) by using sensors, which detect and record electromagnetic energy at a distance from the targets.

"Remote sensing is particularly a powerful tool for Environmental Impact Assessment". (Erickson, 1994) Remote sensing offers enormous opportunity for examining the environment, monitoring its health, and making predictions about future conditions. As the cost of technology decreases and its utility increases, more and more scientists, managers and resource users will become proficient in remote sensing.

The use of remote sensing tools has contributed positively to our knowledge of the environment.

Remote sensing applications provide a means for maintaining changes in the distribution of activities, which in turn are related to social and economic changes. Remote sensing data from aerial photographs, radar, and satellite imagery can be used either singly or in combination, to study changes in the physical aspect of the negative impacts of dam construction. Soil moisture content, which is an indication of water content, water logging, pounding and fluctuation of the ground water, can be delineated using remote sensing data.

This is because of the change in absorption or reflectance spectrum in the visible region that occurs in the soil when it absorbs water. Imageries acquired prior to the development of water projects will persist in identification of areas where soils have been disturbed, where organic matter had been dislodged and transported into water ways, and where natural vegetation and soil humus which normally retard rapid run-off have been removed, thus increasing the material load being carried by the water.

Satellite-based remote sensing has a synoptic coverage. The data collected are permanent, consistent and have spatial integrity that is they are more amenable to spatial analysis. Remote sensing has a broader view and more selective ability to detect changes and variations in the environment. Satellite data provides the perspective for viewing regional environmental problems. Permanent, spatial and temporal records are readily available for dependent information about the area. This permits rapid in-house assessment of resources and the environment in general within limited fieldwork. This is bound to lead to consistent and reliable results. Changes occurring within any environment either in land use or land-cover can be monitored by comparing segmental coverage.

In a study of the impact of dam construction on fadama cultivation in downstream parts of Jakara Dam in Kano State, Nicholas (1989), reported in Abdulkadir, (1993) applied the use of SPOT and aerial photographs to assess changes in the soil moisture status at pre-dam and post-dam periods. The study concluded that there is a serious fall in the soil moisture during the post-dam period resulting to a change in land use (from fadama to pre-dominantly rain fed).

Adeniyi and Omojola (1999) in a study carried out in the Sokoto-Rima Basin of North-western Nigeria, attempted mapping and evaluating the land use and land-cover changes within the study area. Aerial photographs taken in 1962, were used in conjunction with SPOT (P and XS) of 1977 and land sat MSS of 1986. The GIS was applied for the generation of land use and land cover statistics for each time period for change assessment. Results indicated that between 1962 and 1977, only settlements and water bodies had positive changes in the study area. Agricultural land and bare surfaces increased in the Goronyo area while natural/semi natural vegetation had slight increase in the Sokoto area. All other land use/land cover (LU/LC) categories had negative.

Adefolalu (1986b) used a combination of SLAR (Side Looking Airborne Radar) land sat and ground truth observations to study the West African and Nigerian land use (vegetation) situation. He recognized five major vegetal covers-woodland grassland, scrublands, farmland and forest. He showed that the two states in the Sahel Savannah, Borno and Sokoto States as of 1986 were experiencing harsh effects been reduced to 19.29% and 41.89% respectively. While grassland and shrubs were 59.97% and 38.35% respectively, human activities made the situation in Kano and Kaduna States to rise to 68% and 82% of the total land under intensive agriculture. He had forecast that at the early part of 1991 – 2000 arable lands in the two states would be turned into shrub land vegetation and the Sahel proper.

Abdulkadir (2003) used remote sensing technique to investigate the factors influencing sedimentation of Bosso dam, using SPOT (HRV) multi-spectral date of Minna acquired in 1994 and topographic map of Minna prepared in 1969, five classes of land use were identified. A Digital Elevation model (DEM) was developed and used to determine potential erosion yield. NDVI technique was also used to examine the vegetation cover of study area. The result show that the rates of soil erosion, intensive land use and vegetation degradation of the study area have contributed to sedimentation in the Bosso reservoir, hence its shrinkage. Remote sensing technique is a viable tool for environment assessment.

Ahmed (2002) uses reconnaissance survey to assess the impact of some hydro-meteorological variables of Shiroro dam on its immediate environment. His results show that there are tremendous changes that have taken place between pre-dam and post- dam period. He further said that there is high evaporation rate due to the flat floor of the Shiroro dam, and that of the environment, because of the high humidity which favours the growth of disease carrying germs, which would have adverse effect on the communities.

Kanyanya (2002) integrated remote and GIS to assess land use, land cover changes and the environments of land use with bank dam area of middle-burg mpumalanga in South Africa. Land sat images of 1994 and 2001 over the area were analyzed using Iliwis 2.1 for windows to assess possible environmental impacts of land use and land covers during the seven year period. His results showed that there have been significant changes in the land use and land cover during the period of study. He added, its evident from the result that there has been an extension in the dam area coverage and resulted in extinction of other land use in the area.

Halilu (1999) used remote sensing and GIS techniques in studying sediment potential of part of Lower Usuma River Basin. Surgical indices of sediment yields of the catchments tributaries of lower Usuma dam were used in mapping the potential catchments areas. The mapping was to determine the likely life span of the dam, erosion problems and management of the reservoir, classification of the potential rate of erosion and sedimentation.

Toro (1994) identified the negative effects of the Cameroonian Lagdo dam on the environment downstream to include siltation of riverbed and water intakes, in the Benue River lose of fadama cultivation and navigation constraint. He also identified the positive effect of the Lagdo dam on downstream river Benue to include flood control and land reclamation and increase dry flaws.

Rima (1998) used GIS to examine physical, ecological and socio-economic impacts of potential human interactions on aquatic ecosystems across spatial scales. He integrated geo-spatial information analysis and landscape features to identify the relationships among the environmental elements. Judging from his study, GIS is a tool that is impressive and reliable.

Abubakar (1994) observed a serious modification of local micro climatic changes at the three hydropower dams (Kainji, Shiroro and Jebba) sites and their immediate surroundings. Evaporation rates in all the three-hydropower dams have been found to increase by as much as 85% as a result of large surface area of the reservoir. While both minimum and maximum temperature have been observed to be lowered by as much as 10% during the post dam period. Also, humidity has been found to increase by as much as 185% in all three hydropower dams.

Olu and Yusuf (1998) observed that many ecological problems accompanied Bakolori irrigation scheme especially at upstream location. Some of which are disease. River blindness, malaria and schistosomiasis. Others are Otitis media, diarrhoea, dysentery and skin diseases. Rising water table and water logging and local microclimate change at the upstream location, increased salinity, and pollution of reservoir's water and creation of aquatic environment favourable for the multiplication of harmful organisms are other negative effects of the dam.

CHAPTER THREE

RESEARCH METHODLOGY

3.0 Introduction

The materials used in conducting this research work are discussed in this chapter as well as the description of the materials and the methods used in carrying out the work.

3.1 Data Description

3.1.1 Remote Sensing Data

Multi-temporal images of Land sat-TM of 2001 and Nigeria sat 1 of October 2003 were used. The Land sat TM, 2001 with spatial resolution of 30m was acquired from the department of geography, Federal University of Technology Minna. And the Nigeria sat- 1 2003 with spatial resolution of 32m was acquired from National Space Research Development Agency (NASRDA) Abuja.

3.1.2 Topographic Map

A topographic map of Minna, first edition, sheet 42, of 1967, at a scale of 1:250, 000 acquired from Niger State Ministry of land and Survey Minna was used for this research.

3.2 Extraction of the Study Area from the Topographic Map

From the topographic map with a scale of 1:250, 000, the study area was mapped out and was enlarged four times to a scale of 1:83, 000.The enlarged map was traced out, scanned, and saved in J-peg file format (JPG). The map was then imported into Idrisi-32 GIS software. The coordinates of the map were converted from geographic to Universal Transverse Mercator (UTM) grid coordinates for use.

3.3 Field Work And Ground Truthing

Field survey and ground truthing of the study area was conducted in order to obtain first hand information required for this research. Preliminary information was obtained. Photographs of features and degraded areas were taken. Reconnaissance survey was carried out on-board a canoe around the water body.

3.4 Instrumentation

3.4.1 Global Positioning System (GPS)

The global positioning system is an extra terrestrial positioning system with the capacity of recording coordinates of a point simultaneously in θ, λ, and h or X, y, z, coordinates. Hand-held GPS (GARMIN 76) was used to acquire four (4) sets of 3-dimensional coordinate of the study area and co-registration of the topographic map.

3.4.2 **Idrisi-32:** Image processing software was used to process the digital data (NigeraiSat-1 and Land Sat images).

3.5 Questionnaire Administration

Questionnaires on socio-economic attributes of the study area were distributed to the communities (See Appendix A). Two hundred (200) questionnaires were distributed and collected in the study areas (Kami, Layi, Manta and Jiko villages). Fifty (50) questionnaires were distributed in each of the villages. From the questionnaire, five (5) items were picked: major occupation of the people, general assessment on the impact of Shiroro dam, cost estimate of damage to farmland and crops at the time of flood and health hazards resulting from the indirect effect of the water body.

3.6 **Image Processing**

3.6.1 **Image Enhancement**

Two image data (Land sat-TM of 2001 And Nigeria sat-1 of 2003) used in this study were relatively enhanced for better classification process and outputs. The methods of image enhancement used include image auto scaling and colour-bit reduction, image band compositing and image geo-referencing.

3.5.1.1 **Image Autoscaling and Colour-Bit Reduction**

This is the automatic division of a range of an image data values (DN) into new range of values for display in either 8-bit or 24-colour bit or any other colour palette. The Autoscaling process performed a linear stretch of the image data values (DN) and assigned the lowest data value to the lowest palette and the higher value to the highest palette thereby causing the image to look sharper in the regions of the dominant DN values.

3.6.1.2 **Image Composite**

One of the continuous image processing methods used is the production of colour composites as a means of manipulating and displaying several multi-band images of a scare as one colour image. Composite produces a colour composite image from three bands of byte binary imagery a 24 and 8-bit composites may be produced from this procedure. In this study a 24-bit image was obtained for the initial purpose of display and visual classification analysis.

One the Land sat-TM data, Bands 1-7 were acquired, but for the purpose of Land use and Land cover recognition and subsequent classifications, three principal bands (Bands 3, 4 and 5) were selected and used to produce a composite. The Nigeria sat-1 data has 3 bands, the Blue, Green and the Red representing Bands 1, 2 and 3, which were separated prior georeferencing and later merged as one image for classification.

During the process of producing the composite, the selected contrast stretch type was the linear with saturation points in order to create a 24-bit composite with original values and stretched saturation points.

3.6.1.3 **Georeferencing**

This is space as defined by known coordinate referencing system. This exercise was performed only on the Nigeria sat-1 data as the Land sat-TM data was already a georeferenced digital copy before acquisition from the source.

The procedure involved the registration of the minimum and maximum X and Y ground coordinates of the corresponding minimum and maximum rows and column of the image corner points using IDRISI 32 software. The UTM rectangular coordinates system in zone 32 was used as the reference surface and system for the study of the three Bands (Blue, Green and Red) which were georeferenced separately with the same documentation coordinate data. A georeferenced 24-colour bit of these bands were created as single image for the classification process. The original 3 bands images were stored in Tagged Image Format (TIF), which were imported into Idrisi format 'band-by-band' during the georeferencing exercise. Example of the georeferencing corner coordinates is as shown in Fig. 3.1.

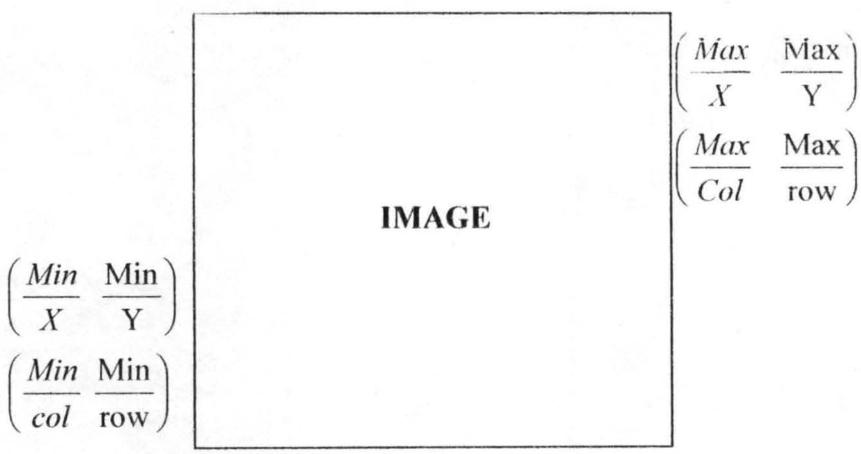


Fig. 3.1 Georeferencing Bounding Corners

The purpose of this exercise is to establish the real world coordinates of the study area analogous to that of the Land sat TM data of 2001, which bears direct resemblance with the ground points in the study area.

CHAPTER FOUR

ANALYSIS AND DISCUSSION OF RESULT

4.0 **Introduction**

In this chapter, the results of data collection are described and the findings from the image processed are presented. Firstly all the analysis from the satellite data are presented and described. This is followed by the results of the questionnaires analysis and statistics inferences.

4.1 **Classified Land Use of the Study Area.**

The result of the 2003 data (Fig 4.3) shows that the largest portion of the study area lies in the flood plain or marshy land as shown by the drainage land cover types.

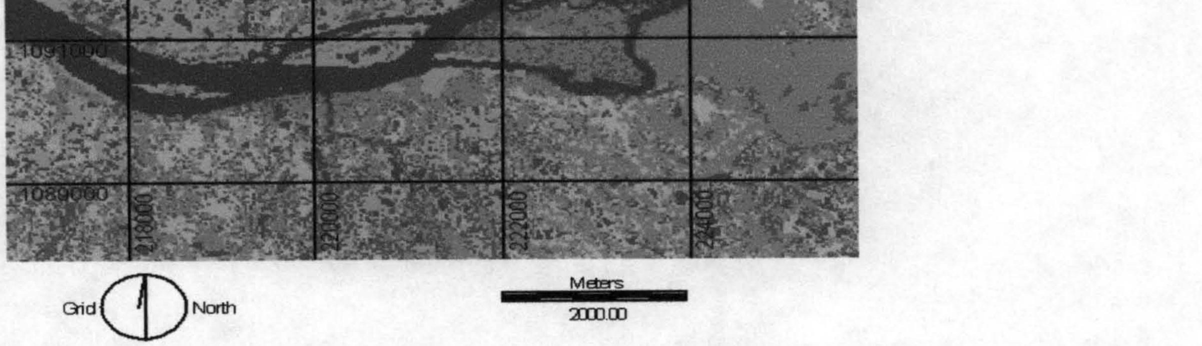


Fig.4.2: Land Use/Land Cover Classification of Shiroro Downstream, Land sat TM Data of 2001 (Maximum Likelihood Classifier)

The land use change position of the study area was classified in to six categories; streams and drainages, Bare earth, rock, Water body, crop and farm and shrubs and weeds (Table 4.1).

The result analysis of the land cover changes of Shiroro down stream using multi-temporal images (land sat-TM, 2001 and Nigeria sat, 2003) has shown that, there is tremendous change in the pattern of land use. It is observed that shrubs and weeds in the study area between 2001 and 2003 have reduced drastically. The trend shows reduction of 61.91% (about 1007.11 hectares covered with shrubs and weeds in 2001, which was reduced to 4272.17 hectares in 2003). This reduction may be due to increase in the volume of sand deposited (Plates 1and 2) as a result of the yearly flood.

Table 4.1: **Landuse\landcover types and changes**

S\NO	LANDUSE \LANDCOVER TYPE	AREA(Ha) LANDSAT TM 2001	AREA(Ha) NIGERIASAT-1 2003	DIFFERENCE	PERCENT
1	Shrubs and weeds	10007.11	4272.17	-5734.84	61..91%
2	Drainages	897.62	136.34	-761.28	8.21%
3	Bare ground(soil)	1545.31	303.38	-1241.93	13.41%
4	Isolated rocks	461.44	592.81	131.37	1.42%
5	Water body	695.77	670.39	25.43	0.28%
6	Crops and farm land	2155.47	787.66	1367.81	14.77%

Source: Compiled by the Author's, 2005

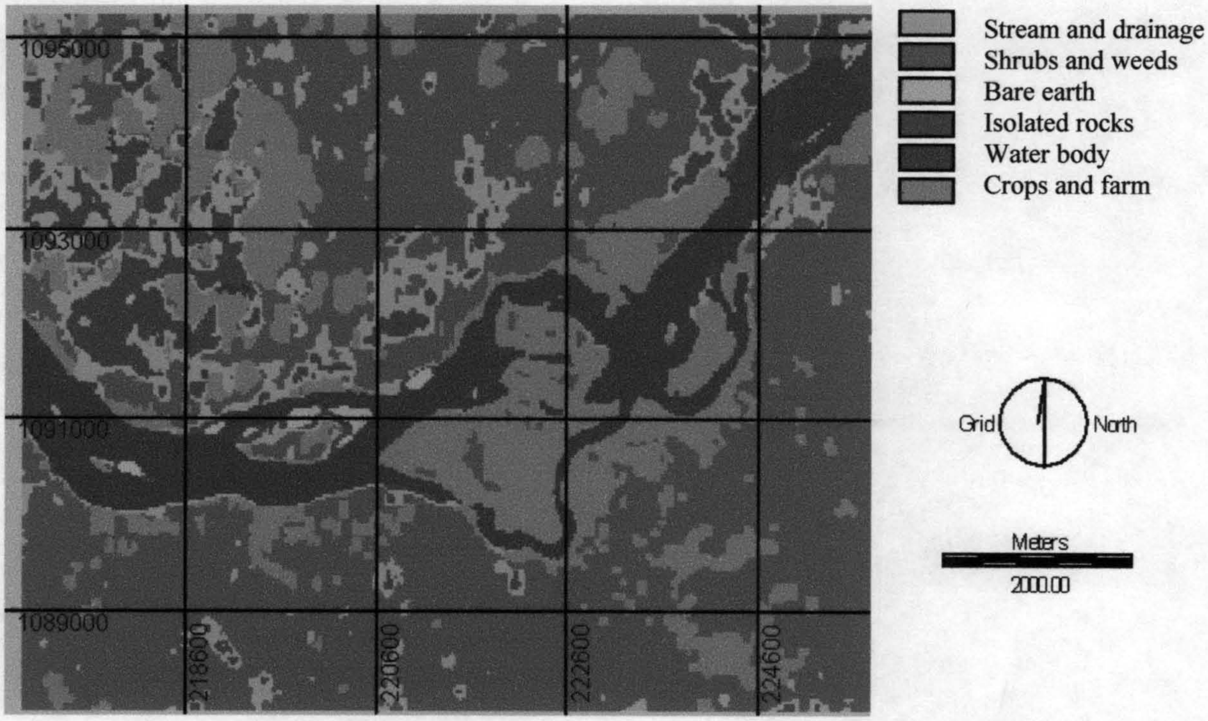


Fig.4.3: Land Use/Land Cover Classification from 2003 NigeriaSat-1 Data of Shiroro Downstream

Considering the pattern of change in drainage, the result has shown decrease in number of streams and drainage. In2001, the result shows that the streams and drainages in the study area cover about, 897.6.2 hectares which decreases to about 136.34 hectare of land coverage in 2003. This decrease in streams might be as a result of decrease in vegetation.

Plate 1: Sand Deposited at the Bank of the River

Plate 2: Part of the island in Layi Village where the villagers cultivate their crops, washed away. October 2004.

In assessing the pattern of change of degraded area /soil between these years, the result shows decrease in the total land cover by bare soil 13.41%.It is confirmed that some of the islands (Plate 3) at the middle of the water have been washed away by the effect of flood. Hence reduced by replacement the total number of area that was formally degraded

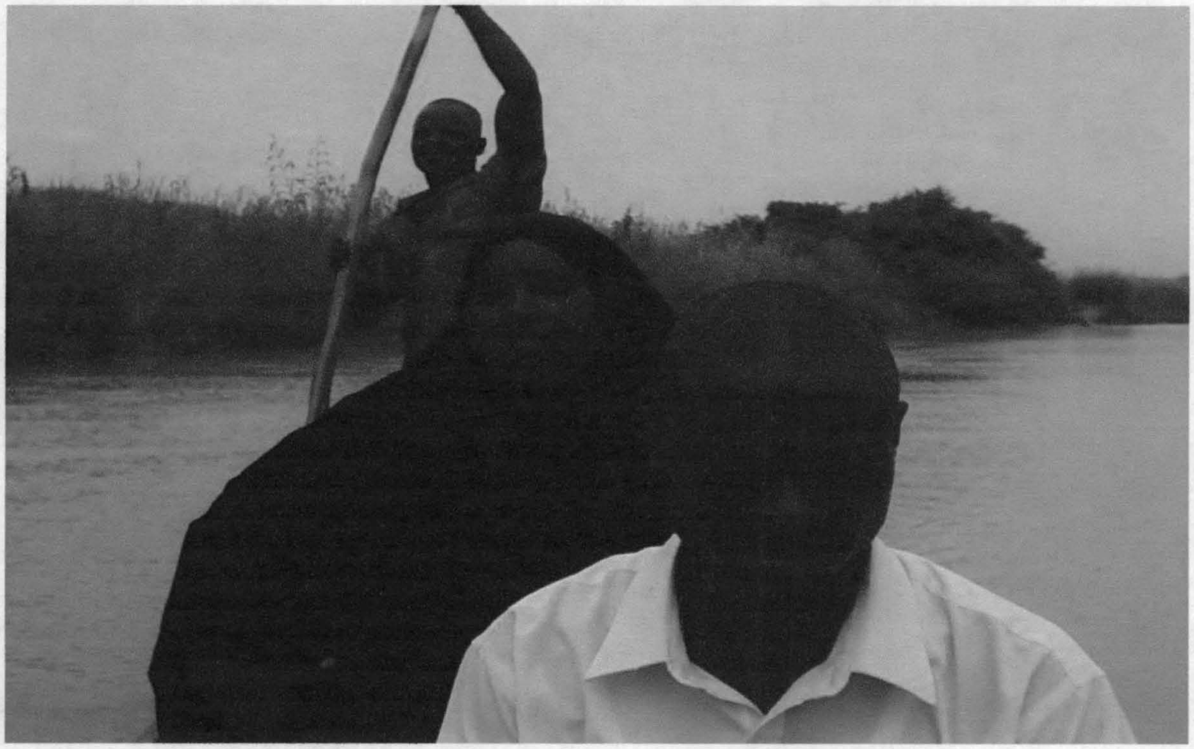


Plate 3: The Author and others on board a canoe on the River Kaduna.See the island at the background in October 2004

With the adverse effect of the rain and flood, some of the rocks (basement rocks are exposed hence the increasing number of rock outcrop found in this area. The trend in the pattern of erosion is shown in Plates 4, 5 and 6.

Plate 4: Previous farmland washed away by flood. Surveyed in October 2004

Plate 5: Partially exposed rock after the sand was washed, October 2004

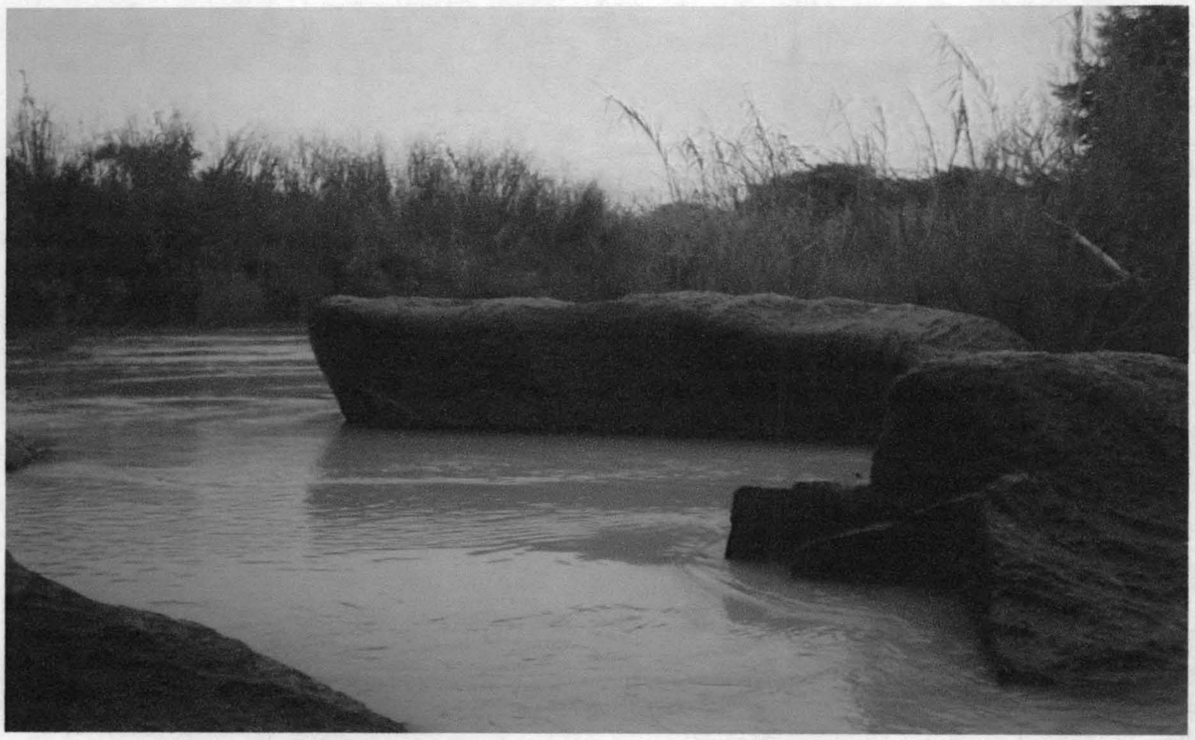


Plate 6: Once a farmland but the rock now exposed as a result of erosion, October 2004.

Assessing the activities (Fig.4.4) of the people (basically farming) the result shows a reduction in farm land. The result of analysis reveals that in 2001, there were about 2155.47 hectares of farm land. This has reduced to about 787.66 hectares of farm land in 2003. This is because more fertile land available for cultivation was washed away by flood effect (see Plate 7, 8 and 9) and more rocks exposed (see Plate 4, 5 and 6 above) as a resultant of erosion effect from flood. Hence, the total land area available for effective cultivation is therefore reduced by this effect since most of the farming is done at the bank of the river. Beside, the entire study area is characterised with isolated rocks which made the land unfit for cultivation.

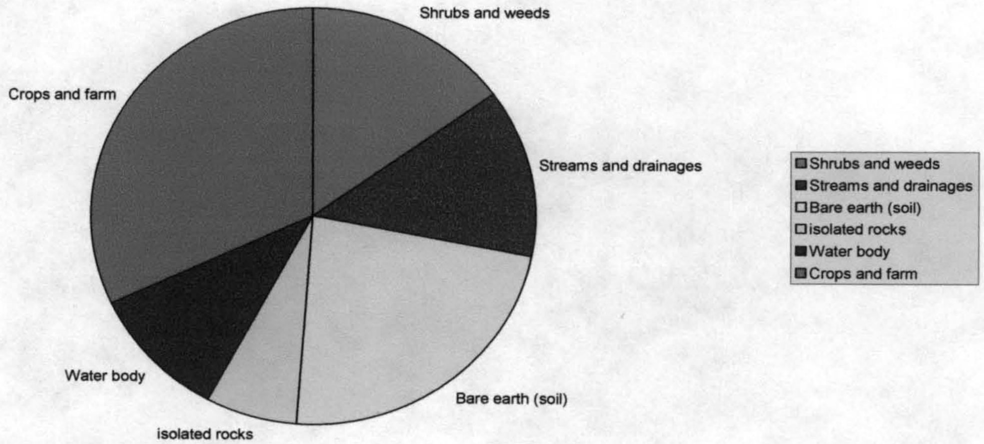


Fig.4.4: Summary of the changes in land use

Plate 7: Farmland about 150m from the river, but over flow went up to the Baoba tree in the picture.

Plate 8: Farmland about to be washed away. October 2004

Plate 9: Farmland of the settlers about 300m from the river. October 2004

4.2 Digital Terrain Model

Digital terrain model (DTM) is a numerical representation of terrain features in terms of elevation and plan metric measurements obtained by sampling a topographic surface. In order words, it is a numerical representation of both plan metric details and height information that provides a continuous description of the terrain surface. The DTM (Fig.4.5) of the study area reveal that the landforms of the area are made up of a lowland (usually between 197-235 metres above sea level) with few hills ranging between 235m – 259m above sea level, and the valley that harbours the river(water body) which occupies a range between 183m – 197m above sea level(Fig.4.6).Hence the terrain is deduced to be a typical flood plain with dotted high lands.

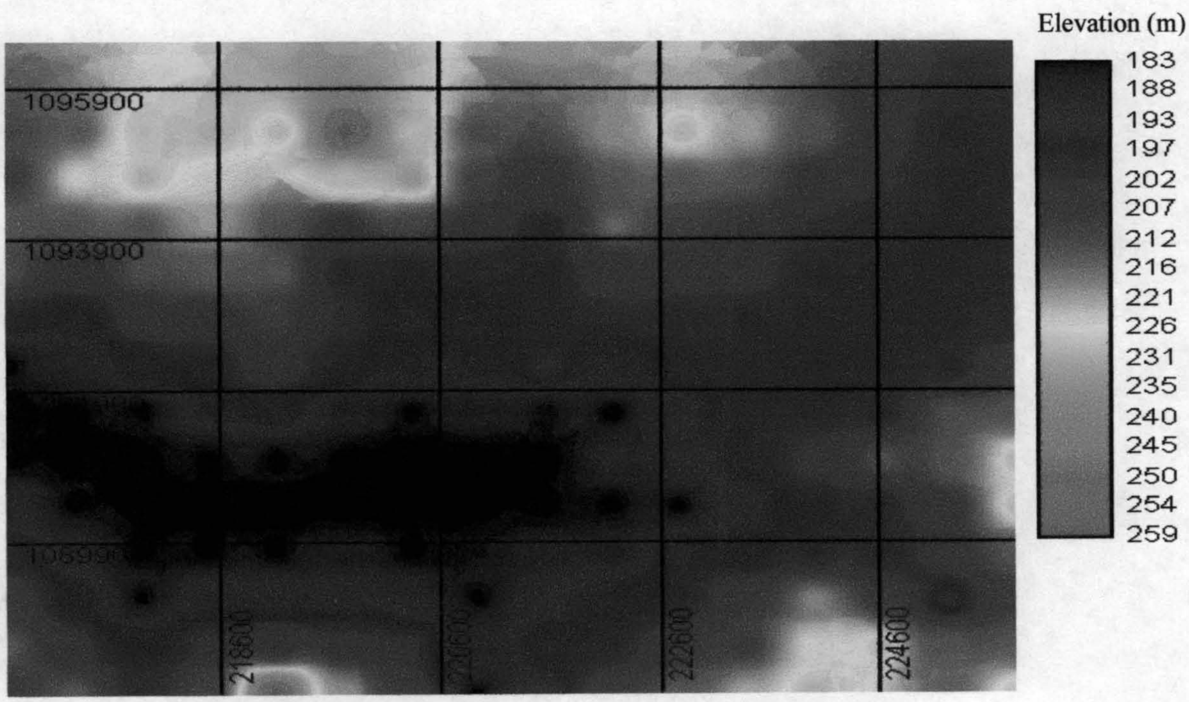
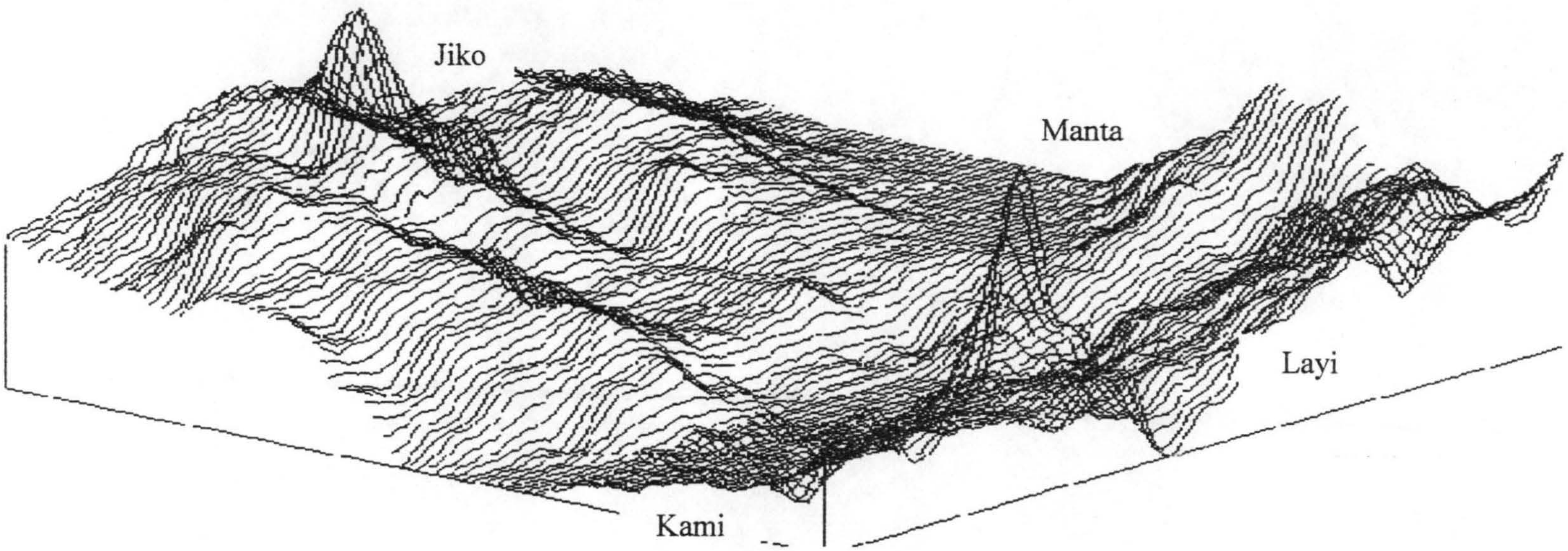


Figure 4.5: Raster DTM of Shiroro Downstream, (Idrisi256-colr palette)



Source: Author's fieldwork

Fig. 4.5: DTM Orthomap or Block Diagram of the Study Area

4.3 **Occupations of the People in the Study Area**

The research analysis had revealed that 51.5% of the dwellers in this area are predominantly farmers, 27% engage in both farming and fishing as their occupation, 6.2% are traders while 15% of them engaged in fishing activities. From the table below, over 51.5% of the populace are engaged in farming activities.

Table 4.2: **Major occupation of people in the study area**

Study Area	Farmer	Traders	Fishermen	Farming & Fishing	Total
Kami	20	5	10	15	50
Layi	25	3	5	17	50
Manta	30	2	8	10	50
Jiko	28	3	7	12	50
Relative %	51.5	6.2	15.0	27.0	200

Source: Author's fieldwork

4.5 **General Assessment on the Impact of Shiroro Dam to the Study Area**

In assessing the impact of the dam to the study area, it is deduced that 87% of the dwellers have a negative perception to the impact of the dam on their living. About 11% that claimed to have experienced a positive effect while 2% are neither positive nor negative about the effect of the dam. The study has shown that the negative impact of the dam on the dwellers in the study area outweighed the positive effect (Table 4.3).

Table 4.3: **General impact of Shiroro dam to the study area**

Villages	Negative	Positive	None
Kami	49	0	1
Layi	48	1	1
Manta	38	10	2
Jiko	39	11	0
Relative %	**87**	**11**	**2**

Source: Author's fieldwork

4.6 Cost Estimate of Damaged Farmlands and Crops at the Time of Flood (In Naira)

In quantifying the cost of damage to farmland, and crops at the time of flood in the study area, it is observed that the effect of the flood was suffered more in Kami and Layi villages than the two other villages (Manta and Jiko). This may be due to the proximity of Layi and Kami villages to the bank of River Kaduna (the main place where Shiroro dam is sited dammed). A total of over N500, 000 was estimated to have been lost to flood yearly in each of these villages (amounting to 2million naira).

4.7 Health Hazards (Common Disease Epidemic)

In assessing the health conditions of the dwellers in the environment they live, the result of analysis shows that the common disease epidemic in the study area are cholera

(45%malaria (23%)and typhoid 19%.While other related diseases found in the area include guinea worm (3.5%), Bilharzias and river blindness see (Table 4.4 for details). Although these are indirect effects resulting due to flood occurrences.

Table 4.5: **Common diseases in the study area**

Common disease	**Kami**	**Layi**	**Manta**	**Jiko**	**Relative %**
Cholera	20	22	25	23	**45**
Typhoid	10	10	8	10	**19**
Malaria	14	8	9	15	**23**
Guinea worm	1	3	2	1	**3.5**
River blindness/Bilharzias	5	7	6	1	**9.5**

Source: Author's fieldwork

4.5.1 **Damage to the Area**

In quantifying the damage done from the effect of the river (flood) to the study area, four key items were considered: farm produce, livestock, property, and health condition. About 81% of the populace said that, their farm produce are mostly damaged by the effect of the flood experienced yearly from the river. While 4% of the livestock were lost, 5% property,(mostly canoes, fishing net used in transporting people and their goods from one village to another or to their farms,) and 10% health condition(outbreak of waterborne disease).see table 4.6 below.

Table 4.6: **Damage to lives and properties in the study area**

Landuse	Kami	Layi	Manta	Jiko	Relative %
Farm produce	42	39	36	45	**81**
Livestocks	1	2	4	1	**4**
Property	2	3	3	2	**5**
Healthy condition (lives)	5	6	7	2	**10**

Source: Author's fieldwork

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMEDATIONS

5.1 SUMMARY OF FINDINGS

The results of this study can be summarised as follows:

- Larger portion of the study area lies in a floodplain and marshy landscape as shown by the DTM land form. Results of the study show that these areas are subject to flooding at heavy down pour of rain. The elevation ranged between 197-235m above mean sea level.
- There was tremendous change in the land use pattern between 1967 through 2003 as analysed from the multi-temporal images and map data. The trend shows a reduction of 12.42% in shrubs and weeds due to the yearly deposition of sediments conveyed in flood water.
- That there was an increase in the area covered by the drainage system due to decrease in vegetation, hence resulting in the rejuvenation of streams and inefficiency of old streams.
- The degraded area (bare earth) decreased by 17.7% between 2001 and 2003 and some of the isolated land areas (islands) in the middle of water and river have been largely washed away due to the effects of flooding. This led to the exposure of sizeable amount of isolated rock outcrops in the study area.
- It was found out that the settlers are basically peasant farmers and that their farmlands have been reduced due to deregulation caused by flooding in the study

area. The analysis revealed that over the years, particularly between 2001 and 2003, over 1367.81 hectares of farmlands were lost as more outcrops areas that are not tillable emerged.

- Results of the study further show that about 51.5% of the dwellers are predominantly farmers, 27% engaged both farming and fishing while 6.2% are traders and 15% engaged themselves solely on fishing activities.
- The effect of the flood estimated for Kami and Layi villages were high and above those of Manta and Jiko because the former are closer to the river than the latter. A total of over N500, 000 (five hundred thousand naira) was estimated as lost to each of the four villages due to flooding during the study period.
- Due to the nature of the environment, the villagers are pre-disposed to disease epidemic such as cholera, malaria, typhoid fever, guinea worm infestation etc. The health hazard assessment between 2001 and 2003 include cholera 45%, malaria 23%, typhoid 19% and guinea worm 3.5%, while river blindness/Bilharzias accounted for about 1.5%.

5.2 CONCLUSION

Before the construction of Shiroro Dm reservoir, the people that live a long the bank of River Kaduna had a relatively good knowledge of the natural flow pattern and seasonal discharges of River Kaduna and could make maximum use of the alluvial soils for their agricultural activities. However, the frequent over flow from the reservoir has over the years placed the downstream settlers, in an unpredictable drainage flow impacts.

This study has shown from the landform DTM and the image analysis and the quantitative deduction from the questionnaire interviews that the areas are liable to flood at any slightest storm event from the upstream, and at such event, properties worth millions of naira are often lost. This is economic drain in an era when poverty alleviation is being propagated by the government. This study serves as bedrock upon which further research on land use planning purposes, with the view to assisting the villagers can be carried out.

5.3 RECOMMENDATIONS

The recommendations for this study are as follows:

i. The people in the study area should be relocated from bank of River Kaduna

ii. Social amenities such as good roads, electricity, schools, clinics or dispensaries should be provided to the villagers to improve their standard of living.

iii. The study could be extracted for further understudy for land use planning and management purposes with the view of assisting the villagers.

REFERENCES

Abdulkadir A. (1993) Remote sensing and land degradation in NISORS (Edit) Nigerian Journal of Remote sensing Nig.Soc of remote sensing. 10 - 12

Abdulkadir A. (2003) Assessing the suitability of Bosso water supply dam site. Unpublished master's thesis Federal University of Technology Minna. 7-9

Abubakar A.S. (1997) Environmental impact assessment of Shiroro dam on some hydro Meteorological variables in the Kaduna River Basin. Unpublished PHD thesis, Federal University of Technology Minna .21-30

Adefolalu D.O (1986b) Regional studies with satellite data in Africa an Desertification of the sudan – sahel belt in Nigeria. In proc. ISLSCP conf. Rome – Italy (Eroife. Ed) 429-439.

Adefolalu et al (1992) Ecological and land use mapping of Niger state phase 111 Report, Federal University of Technology, Minna.

Adeniyi P.O and Omojola A (1999) Land use / Land cover change evaluation in Sokoto – Rima Basin in North – Western Nigerian based on Archival remote Sensing and GIS techniques in Adeniyi P.O (Edit) Geoinformation Technology Application for Resource and Environmental management in Africa. African Association of remote sensing of the Environment (AARSE). 102-105.

Ahmed. M. A (2002) Some hydro metrological impact of the Shiroro dam on its immediate environment unpublished master thesis. Federal University of Technology Minna. 3-6

Baba J.M (1999) Lecture notes on contemporary philosophy and methods in geography. Federal University of Technology Minna.

ECN (2004) Problems and prospect of small scale Dams in Nigeria workshop Proc.Tafawa Belewa University Bauchi Nigeria, 6

Erickson P.A (199) A practical guide to Environmental impact Assessment. New England Research Inc.Worcester, Massachusetts, U.S.A. 1-5

Halilu A.S (1999) Sediment potential mapping of parts of Usuma River Basin integrated Remote sensing and GIS Technique Unpublished PHD thesis Department of Geography Federal University of Technology

HYPPADEC (2001) Executive summary (seminar paper presented to the National Assembly committee on Ecological disaster on relief) HYPPADEC publication .5-8

INTERNET http//www.dam.org./kbase/sunmission/showsub.phd?rec=soc 100

Lillesand and kiefer (1994) Remote sensing and image interpretation (3rd edition) John Wiley and sons Inc. 205-208

Nicholas J.E. (1987) Monitoring the Effect of Dam construction in Fatima cultivation using SPOT Satellite Imagery and Sequential Aerial Photography, Proc .of National Conf. of Nig. Soc. of Remote sensing Kano.

Okhimamhe A. A (1999) Introductory lecture notes on remote sensing application, Geography department. Federal University of Technology, Minna. 1-2

Ola O.E.A (1997) Environmental impact Assessment of water supply projects. Lectures paper for Granonee workshop on current trends in watershed management. Kwara water co-operation Illorin Nigeria .pp 46-50

Olofin, E.A (1980) Some Effects of the Tiga Dam on Environmental downstream in the Kano River Basin, Unpublished Phd. thesis A.B.U Zaria.

Onyebuchi C.C (1993) Trends and prospects for the development of remote sensing in Nigeria. Nigerian Journal of Remote sensing Vol. 1, No. 1, Journal of the Nigerian society of remote sensing .8-12

Rima A. (1998) A decision support GIS for the clean water Act permit Review Analysis. Paper presented at department of Geosciences, University of Missouri Kansas city. 20-24

Toro, S. M (1994) Post construction effect of the cameroun Lagdo Dam on the Benue River system with a case study of the Upper Benue River Basin in Nigeria

Appendix: Sampled Questionnaire

Fill In or Tick as Appropriate

1. Name of village/settlement: ....

2. State the members of your family 1-5 [ ], 6-10 [ ], 11-15 [ ] more than 15 [ ]

3. State your major occupation [ ] farming, [ ] fishing, [ ] public service, [ ] trading, [ ] others (specify), [ ] fishing & farming.

4. (a) Does the Shiroro Dam have any effect on your occupation? [ ] Yes, [ ] No

   (b) If yes, in what form? [ ] Positive, [ ] Negative (precisely flooding)

   (c) If negative, give estimate of your losses in cash per year. N50, 000-N100, 000 [ ], N100, 000 – N150, 000 [ ], N150, 000 – 200,000 and above [ ].

   (d) Common damage to property (homes, farm, furniture e.t.c)

5. Were you compensated for lost property (ies)? [ ] Yes, [ ] No.

6. If yes, how much? N50, 000 – N100, 000 [ ], N100, 000 – N150, 000 [ ], N150, 000 – N200, 000 [ ], N200, 000 and above [ ].

7. Do you use the water from the Dam? [ ] Yes, [ ] No.

8. If yes, what for? [ ] domestic, [ ] farming, [ ] fishing, [ ] livestock, [ ] fishing and domestic purpose, [ ] others.

9. What type of human disease do you think is new in this area or is too common which can be associated with the dam project? Guinea worm [ ], Typhoid [ ], River blindness [ ], Cholera [ ], other (specify) [ ]

10. Which of these has/have affected members of your household? Guinea worm [ ], Typhoid [ ], River blindness [ ], Cholera [ ], Malaria [ ], Typhoid and Malaria [ ]