IMPACT OF DAMS/RESERVIOR ON THE ENVIRONMENT

(A CASE STUDY OF JEBBA DAM.)

SUBMITTED

BY

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CERTIFICATION

I certify that this project was carried out by Olademehin Ola I. Of the department of Agricultural Engineering of the Federal University of Technology, Minna, Niger state under the supervision of:

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DEDICATION

This thesis is dedicated to Almighty God for his mercies and to my 'sweetie' Mrs.Odunayo Olademehin for her encouragement and to all those who are striving to offer lasting solution to the problem of degradation

ABSTRACT

The focus of this study is on the Environmental Impact Assessment (EIA) of dams/reservoirs with particular reference to Jebba Dam (Hydro – electric Power) as a case study.

In pursuance of this, questionnaires were administered as well as on the "Spot" assessment of some notable phenomena were carried out in order, to assess the magnitude and significant of the impact of the dam on the environment.

Base on these, the study has examined critically, the impact of the dam/reservoir on the bio – physical, biological, social, economic, cultural and aesthetic environments.

Impacts were classified into primary, or secondary, short – term or long – term, irreversible and irretrievable impacts.

The impact on physical phenomena such as vegetation, soil, water and general land uses were analysed and assessed accordingly. It was discovered that a great modifications and alterations has been done to these physical features at post – dam period compared with what operates during pre – dam period.

Climate parameters such as rainfall, relative humidity, temperature, evaporation and water – discharges were equally assessed. The result of the assessment using both the America and the British standards revealed that there was increase temperature, increased evaporation, water discharges, and increased rainfall at post – dam period due to the impact of the dam in modifying micro – climate.

The result of the study shows a lot of negative impacts ranging from the alteration of water quality down stream; increased water related diseases such as malaria, dysentery, schistosomiasis, dracunaliasis (Guinea worm) and trrypanosomiasis; alteration to aquatic and Biota habitat, increased run – off and incessant occurrence of floods down stream as well as up – stream.

Moreover, it has been discovered that the dam has had in the recent years, great impact on both macro and micro – economic activities of the inhabitants of the study area in terms of power generation, creation of jobs, opening up of avenue for industrial and urban development; creation of recreational activities and research centres. These beneficial impacts has brought about increase per – capital income to the inhabitants of the area.

The incursion of the vegetation, sub – soil exposure due to sheet erosion and flooding, over – grazing and deforestation were prevalent during the post – dam period due to irrigation.

The impacts of possible dam failure has been given prime consideration. By and large, the study has revealed a lot of salient features that has been altered drastically due to the construction and operation of the dam.

In retrospect of all the above discussed, ameliorative measures were profered to mitigate the negative impacts so as to create enabling environment devoid of pollution, flooding and further environmental degradation between now and the next millennium.

To achieve this, recommendations were made as a policy measures toward a sustainable development in a friendly environment.

ACKNOWLEDGEMENTS

The preparation of this work has depended largely on the goodwill active and untiring efforts of a large number of people. To all of them, many of whom I cannot for reasons of time and spaces/economy be singled out, I wish to express my very sincere appreciation.

In particular, I have to register my profound gratitude to my versatile supervisor Mr. O.S. Ayodeji for his untiring effort and guidance to me during the period of writing this dissertation until its completion, his willingness to offer good advice and assistance at these times is greatly appreciated; to all my departmental colleagues who have offered useful suggestions and ideas; to the Authority of Jebba Dam (the AGM Operations, Mr. A. O. Amadi, Engr. Ayeni. And Rasaq) and various government functionaries at the state and federal level who spared time from their busy schedule to discuss with me on various aspects of Environmental Impact Assessment (EIA); to all the staff of the department of Agricultural Engineering Federal University of Technology, Minna for their constructive criticism and advice; the Federal office of Statistics for supplying useful population information; equally worth mentioning is the assistance given by the following group of people, the head of department Agricultural Engineering Dr. M.G. YISA, Dr. E.S.A, Ajisegiri a senior lecturer in the department, Dr.D. Adgidzi a senior lecturer in the department. Mr. Alabadan (Lecturer), Mr Olu Omotayo of the department of Geography FUT Minna, Mr Chukwu (Mrs. Osunde, Mr. P. Idah, Engr. N. Egharevba Lectures FUT), and to all my lecturers who for reason of space could not be mentioned here.

Above all, I am very thankful to Almighty God for his mercies upon my life and my family.

OLADEMEHIN OLA .I.
DECEMBER,1998.

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CHAPTER ONE

1.1 INTRODUCTION

A sustainable use of the natural resources calls for appropriate methods to collect base line information, to assess environmental impacts and to monitor environmental change. The study aims at assessing the environmental impact of water development projects such as Dam construction in Nigeria with particular reference to Jebba dam.

In Nigeria, which is a microcosm of most third world or developing countries, the last 38 years as an independent nation have shown that more problems have been created (perhaps inadvertently) through a myraid of development project because Environmental impact Assessment (EIA) appraisals were not made while poor performance may be associated with in - adequate data input which could have been given to (EIA) Environmental impact assessment report if it had been available for forward planning at the time of independent in 1960.

Environmental Impact Assessment (EIA) is a process based on current scientific knowledge, used to predict the environmental consequences of a proposed action, project or programme and to provide decision makers with systematic information presented in such a way that the impacts, as well as mitigating needs can be assessed in temporal and spatial perspective (CF. UNEP, 1988; Stromquist and Tatham, 1992; Glasson etal, 1994).

The history of (EIA) in developing countries dates back to the late 1970s, when the first EIAs were carried out within projects funded by development banks or donors. These EIAs mostly followed the criteria and procedures practised in the donor country (Kakonge, 1994), which might have hampered the development of EIA in the individual countries by not taking into consideration the "local" environment and associated environmental problems.

If it had been adopted to the local environment and its problems, EIA would more rapidly have become a useful tool for environmental management and planning.

One of such problems is the imminent threat of flooding, desertification, over cultivation and grazing and water quality down stream etc.

These study therefore shows what Environmental Impact Assessment report of any project either proposed or already established such as Jebba Dam (A Hydro Power Project) can contribute to National development in general and assist in curbing further environmental degradation. It is pertinent to note however, that problems associated with implementing EIA are often identical in most developing countries.

The most important problems, have been identified and highlighted by different authors such as Kennedy (1988), Kakonge and Imeubore (1993), Kakonge (1994) and Russo and Narins (1994).

They are:-

- Lack of monitoring equipment and baseline data, often insufficient monitoring of environmental parameters.
- Lack of simple EIA procedures. To achieve higher reliability of predictions, appropriate techniques which use local competence should be taken into consideration.
- Inadequacies in the role and place given EIA in project design. Many projects start before the environmental studies (not only a problem in developing countries). Jebba dam project is a good example of such projects. This forms a good basis for the justification of this project/study.
- Lack of a legal requirement for EIAs for certain projects. EIA has to be a necessary requirement in order to be an effective tool for environmental protection.

Like most economic and technical feasibility studies, an EIA is a management tool for the authority who must take important decisions about major development projects.

Projects have been abandoned because of public pressure, unforeseen environmental costs or even as a result of disastrous accidents and negative impacts. As these experiences show, it is very risky to approve a project design before taking into account the future environmental consequences (UNEP, 1988).

In recent years, the World Bank and other International Financing Institutes have required an approved EIA before financing the implementation of a project.

The case study is a hydro power project located at Jebba Dam where the main focus is to identify the loss of habitats, especially grazing land, riparian species/resources, loss of family cohension due to displacement and loss of economic activities.

The beneficial impacts of the project will also be assessed for further enhancement for a sustainable development between now and this next millennium.

1.2 JUSTIFICATION

If the trend of environmental degradation, loss of natural habitats and riparian resources continues the impact of such a declining ecological balance on man may be disastrous hence there is the need to carry out environmental impact assessment of the hydro power project of this magnitude, so as to be able to profer lasting solution towards its negative impacts and improve on its positive postures.

Despite the wealth of information available, one faces a dilemma in choosing the formulas and the techniques of analysis which would be most applicable as aids to judgement and experience in dealing during design with specific problems such as erosion below dam. This is the reason why in most situations in the developed world, post impoundment studies are always undertaking especially in the long run after the closure of the dam to relate assumption made during design with real – life performance afterwards. A good

example is the conflict between the need for a stable pool versus down stream needs for discharge may have taken a different dimension in the recent years because of the general drought which has some what changed the discharge levels of the rivers in the area.

It should be noted that Jebba hydro power project had experienced several decades of hydrologic years associated with drought which could have influenced the discharge and re – charge rates.

This therefore, calls for assessment in order to profer solution to emerging problems and as a guide for future projects.

1.3 OBJECTIVES:-

1. The objective of this study is to examine the socio – economic, cultural and probable health implications of the dam on the people within the environment with particular reference to human activities such as agriculture (fishing, crop production and livestock).
2. To assess the environmental impact of the dam (Jebba) on the environment as well as the hydro geology of the river before and after impoundment.
3. To profer solution(s) to the problem that might have been caused by the presence of the dam in the locality with special emphasis on human activities, hydro geology and ecology.

1.4 SCOPE:-

Environmental impact assessment (EIA) is a wide scope of study and as a result of this we shall limit the areas of assessment on this study to social economic and ecological impact of the dam on the people and the environment. The impact on vegetation, rainfall and other natural habitat. This study will look into those areas such as the type of agriculture practised in the area whether subsistence or commercial and the viability. It will also look at the effect on the down stream, it may go further to find the impact of irrigation scheme around the

dam such as modification of atmosphere branch of the cycle, modification of surface run off. The impact of the dam on public health will also be considered and finally the possible foreseeable impact of the dam failure on the environment will be looked.

1.5 CONSTRAINTS AND LIMITATION OF THE STUDY:

As identified and highlighted by different researcher and authors such as Kennedy (1988), Kakonge and Imeubore (1993) that lack of monitoring equipment and baseline data and often insufficient monitoring of environmental parameters; lack of simple EIA procedures to achieve higher reliability of prediction; appropriate techniques which use local competence are among the various limitation that potential researchers normally faced.

- This fact remains as one cannot developed or generate all data requirements for a study of this nature.
- Among the most costly items required for the study is chemical reagents to test some vital substances such as Water, Soil, rocks and air composition of the study area so as to ascertain the level of changes or alteration caused by the existence of the dam. This has actually constituted a great constraints and limitation due to its financial and capital out lay.
- The degree of reliability and extent of being current of some data that are collected or may be collected or those reached;
- Poor response from some respondents and most importantly, was the problems posed by the terrain of the dam area that made it virtually impossible to get access to some salient features within the dam area.

These constraints not withstanding, the information obtained from both primary and secondary sources during the course of this study would normally form a good bedrock on which future research works could be based as far as Environmental Impact Assessment (EIA) of hydro – power project is concerned with the required updating of the facts and figures given in this present work.

By and large, the seemingly insurmountable problems were surmounted at the end.

1.6 HISTORICAL BACKGROUND OF JEBBA DAM (HYDRO ELECTRIC POWER)

In order to harness the potentials of River Niger fully, for a sustainable Development in Nigeria, the Electricity corporation of Nigeria (ECN) in 1951 took the bull by the horns by embarking on an in – depth tour and investigation of feasible sites for the development of hydroelectric power.

In 1958, Balfour Beatly and company limited and a consortium of Engineering consultants from the Netherlands intensified their operational study of the Dam sites.

The overwhelming acceptance of their recommendations based on intensive study and investigation alike later formed the basis for the construction of the Jebba Hydroelectric power station.

Monaco of Canada, a consulting engineering firm was fully responsible for the over all design and supervision of the power station.

Marubeni of Japan, Fougeroile Nigeria Limited and Escher Wyss of Switzerland also played important and notable roles throughout the construction of the power station.

GENERATING CAPACITY:

The Jebba hydro – electric station is made up of six turbines of 90mega Watts each. At full firing, the station can produce 578MW of electricity.

COST:

The power station was built at the cost of over N600million.

In April, 1985 the project was commissioned by Major General Muhammadu Buhari (Rtd).

1.6.1 DESCRIPTION AND LOCATION OF THE STUDY AREA

The study area is situated within the Niger drainage basin and located on river Niger between latitude 9°00's and 9o15'N and longitude 4°54'E and 5° 00'E. see figure 1(a). Jebba Dam (Hydro power) project is located in Jebba north (Borogu local government area of Niger state).

In relation to the political boundaries, the state is bounded on the east by the Federal Capital Territory (Abuja) and Kaduna state, on the West by the Republic of Benin, on the north by Kebbi and Zamfara states and on the south by Kwara and Kogi states. See figure 1(b).

The study area is accessible directly from Ilorin the capital of Kwara state, from Minna via Bida, Mokwa Jebba by well tarred major highway roads. The study area is also bounded by Kainji hydro electric power dam and Borogu game reserve from the north and Jebba town from the south. See figure 2.

1.6.2 THE DAM

The dam is situated on an alluvium sand which is densified with in – situ concrete. It covers a total area of about 24.5Km square. It is made up of concrete, rocks, and earth filled embarkments.

The height of the dam is about 108metres while the length is 100Km with an approximate width of 2.3Km.

Figure 1(c) depicts the cross – section of the dam and plate 1 shows the physical outlook of the embarkment.

The dam is having in built pressure relief drains.

THE SPILLWAY (UNDERFLOW GATED)

The type of spillway used in discharging water is "fleep bucket lip" which is controlled by six radial gauge. The radial gauge is operated by a means of hydraulic system. The overall length of the main spillway is 57.5metres. While the width is 108metres.

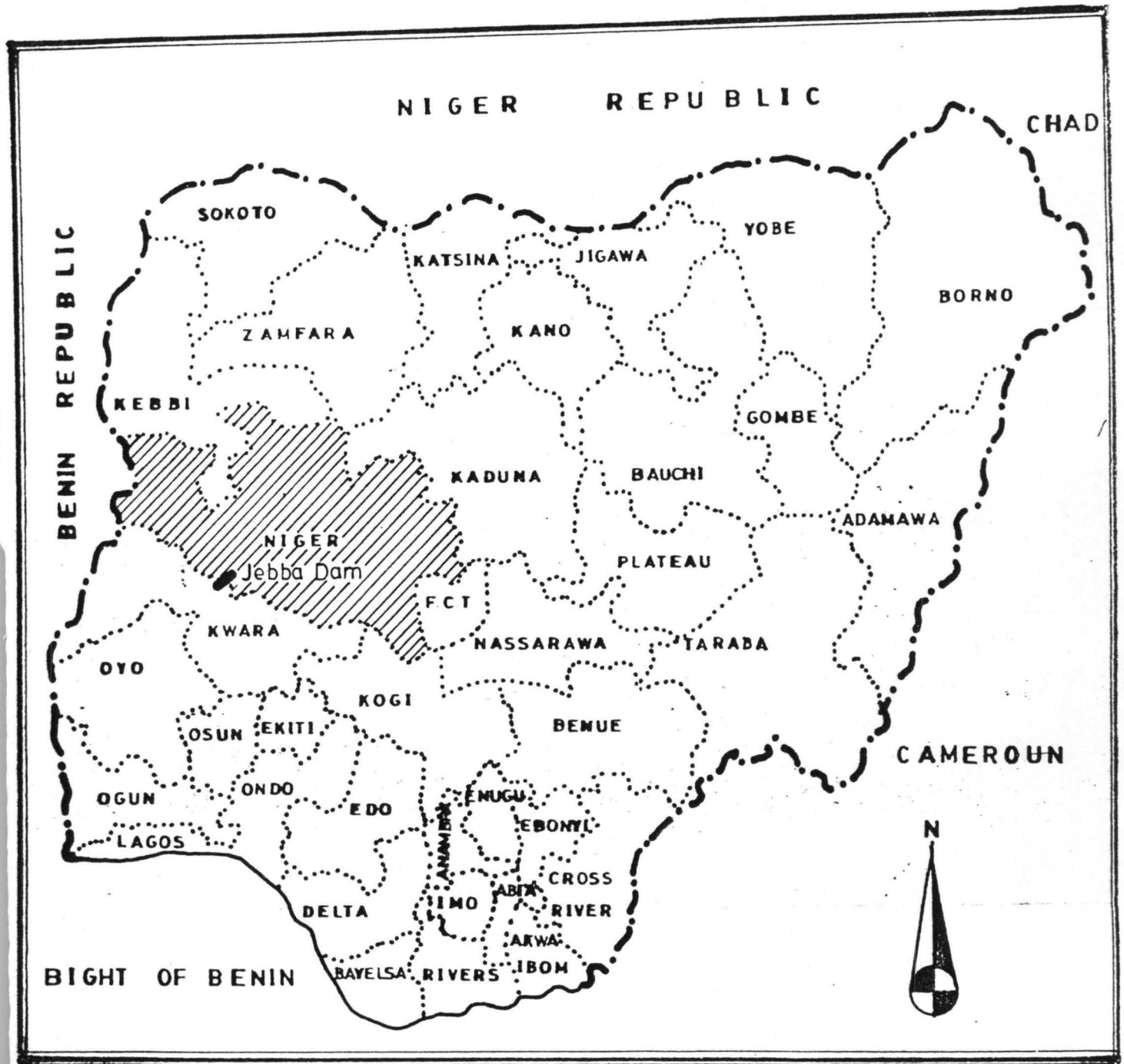
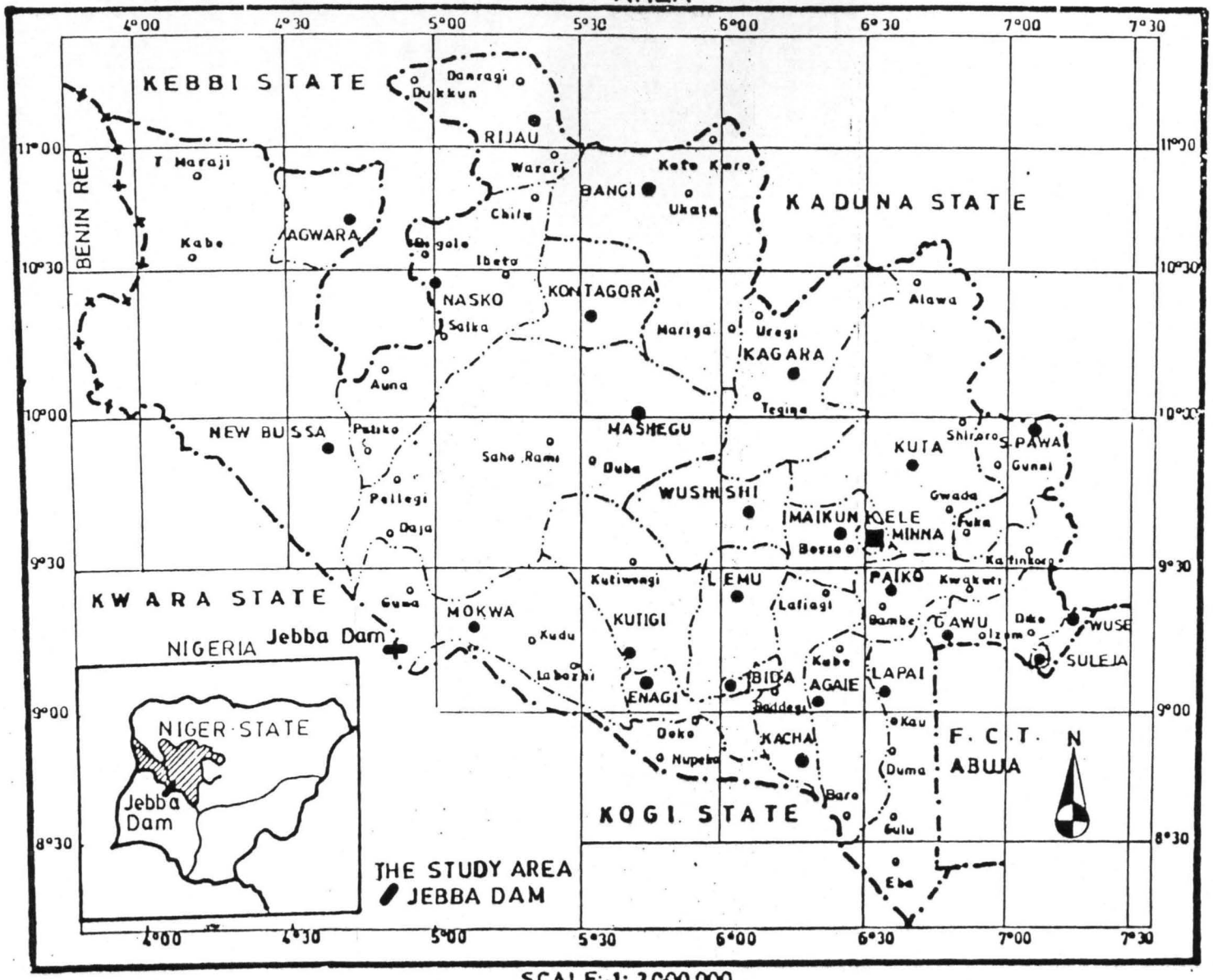


Fig. 1(a): MAP OF NIGERIA SHOWING THE STUDY AREA

Source:- Geography Department Federal University of Tech. Minna
Cartography Section (1998)

Fig. 1(b) MAP OF NIGER STATE SHOWING THE LOCATION OF THE STUDY AREA



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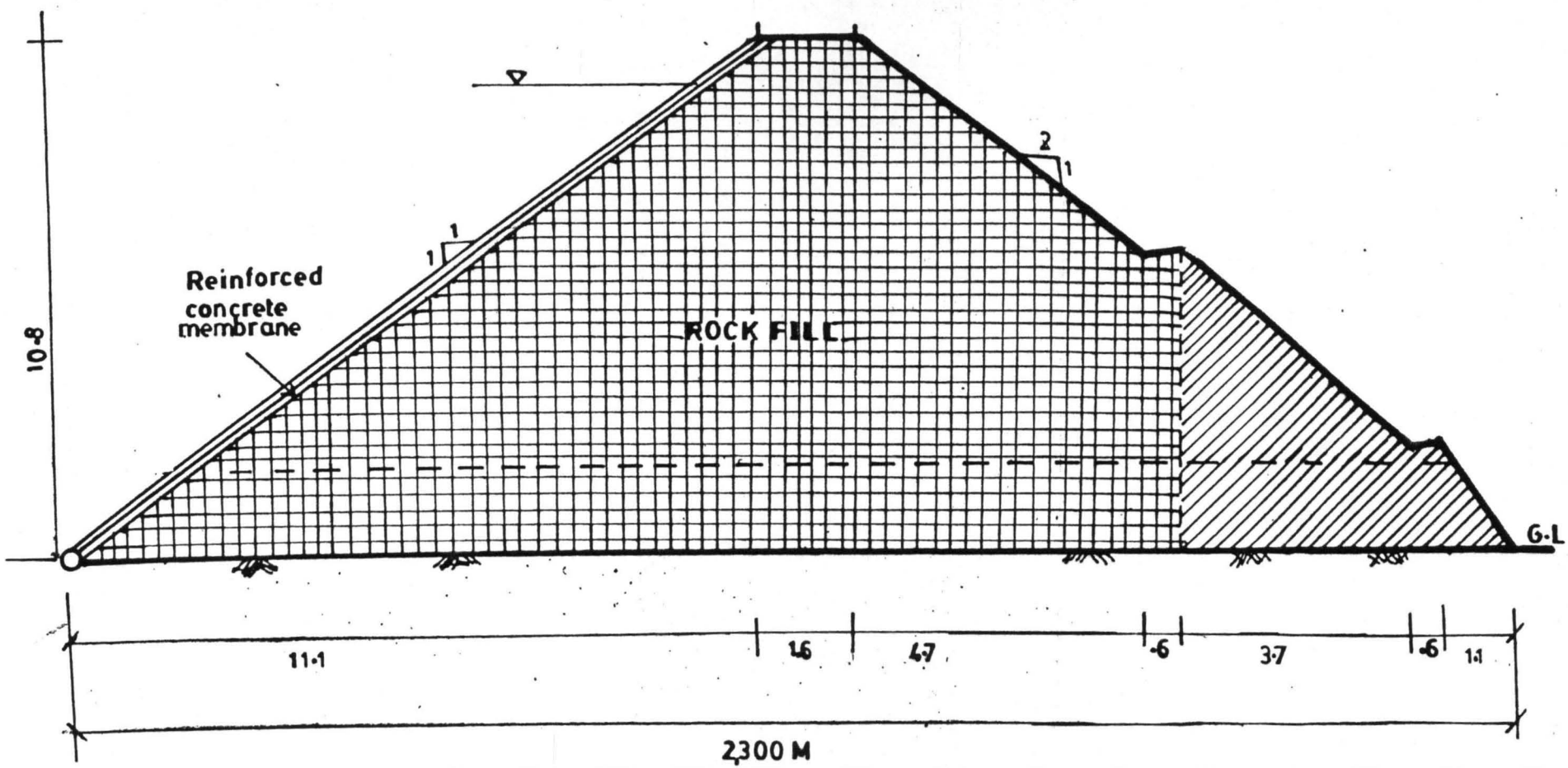

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Fig.1(c): A TYPICAL SECTION OF THE DAM

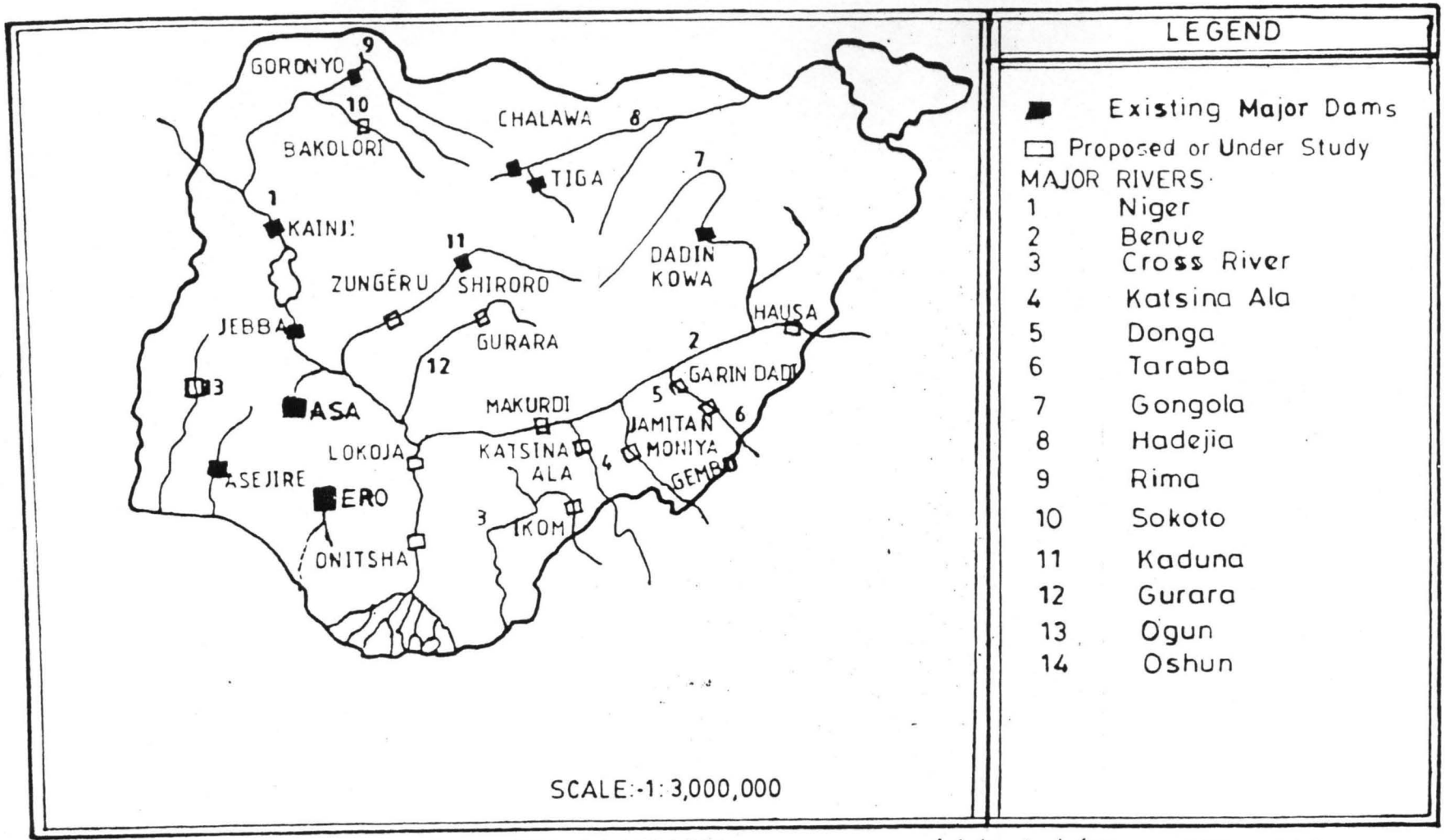


Fig. 2: SOME MAJOR DAMS AND RIVERS IN NIGERIA (Adapted from NEST 1991)

The maximum height is 42metres. The fleep bucket lip elevation is 70metres. This is being operated at an angle of 31 degrees with a radius of 35metres.

This can only be operated when the elevation is 103metres to control the flow of water. The design flood is 13300 (m^3/sec.).

EMERGENCY SPILLWAY (BROAD CRESTED WEIR)

This is located at the extreme end of the embarkment in the southern part of the dam. The length of the emergency spillway is about 220metres with a width of about 6metres. It is used to discharge abnormal flood due to unprecedented rain or to allow for repairs.

1.6.3 GEO – PHYSIOGRAPHIC & HYDROLOGY

1.6.3.1 RELIEF AND CLIMATE:

Generally, the land rises from the south with the associated highlands towards the western corridor. The Niger river originates from Futajalon Highlands in Sierra Leone and flows southwards down to meet river Benue at Lokoja.

Five major land units have been identified in the area, hill slopes, colluvial foot slopes, groundwater woodland, riparian zone and Niger river, each land unit has its own geological and ecological characteristics.

Steep hill –slopes represent steep bedrock, often covered by thin infertile soils. Colluvial foot – slopes (including pediments and small hills), border to the steep hill –slopes having potential visual impacts. Accumulation of materials from the upper hill – slopes has created coarse texture colluvial deposits.

Ground water bush land/woodland surrounds the seasoned tributaries to the river Niger. The seasoned streams flow in direct response to precipitation. The climate condition of the project site/study area is mild and of the tropical type with sudan savanah type vegetation.

1.6.3.2 **RAINFALL:**

The rainy season span between April and October. Mean annual rainfall is within the range of 1,100mm to 1,200mm. See figure (3). Most of this is received during the rainy season when about 220 to 260mm is recorded in the month of September as illustrated in figure (4).

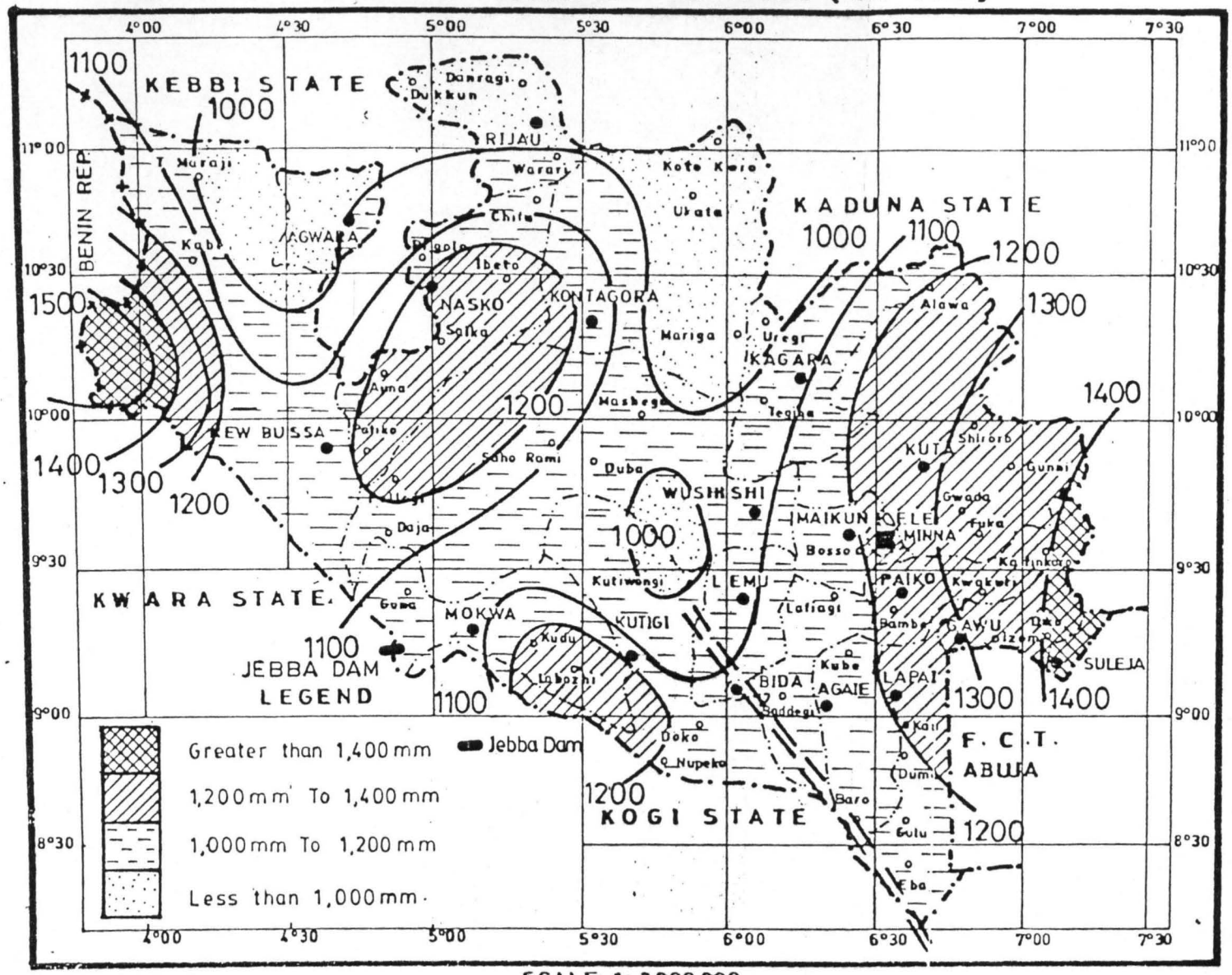
Phenologically, it is not the amount of rainfall that matters, it is how much of it that is available to dissolve soil nutrients, (minerals which yield protein, sugar, fat and carbohydrates as end – products) that plants require from the soil. A soil which is very rich in nutrients can only release them to plants if they are in solution, But when plants have no access to these nutrients, there is bound to be failure.

Such a situation may arise when precipitation distribution (in time and space) is abnormal. For example, late onset, (ie the beginning) of the rains may result in problems even when the total rainfall received during the entire season is normal or above average, Due to this abnormal situation, irrigation scheme was integrated into Jebba dam project as an alternative means to rain fed agriculture along Niger basin.

Similarly, premature cessation (ie. The rains stop before the normal period) constitutes a major problem. To this end, the "Precipitation effectiveness" is very important. The mean onset dates of the rains in the study area is between April 20 – April 30. While the mean cessation dates of the rains is between October 27 – November 16. See figure 5(a) & 5(b) on mean onset, cessation dates of the rains (and implied length of rainy season, LRS) respectively, suggest that (i) Rainfed agriculture cannot be embarked upon before April 20 – April 30 (ii) Plants that cannot normally mature on or before October 27 – November 16 should not be introduced without adequate tests and in-depth studies. (iii) Discharge and re – charge of impoundment cannot take place before April 20th. (iv) Flooding/Erosion should be expected in the month of maximum rainfall (September). The south – westerly winds blow mostly

NIGER STATE

FIGURE 3: MEAN ANNUAL RAINFALL (IN MM)



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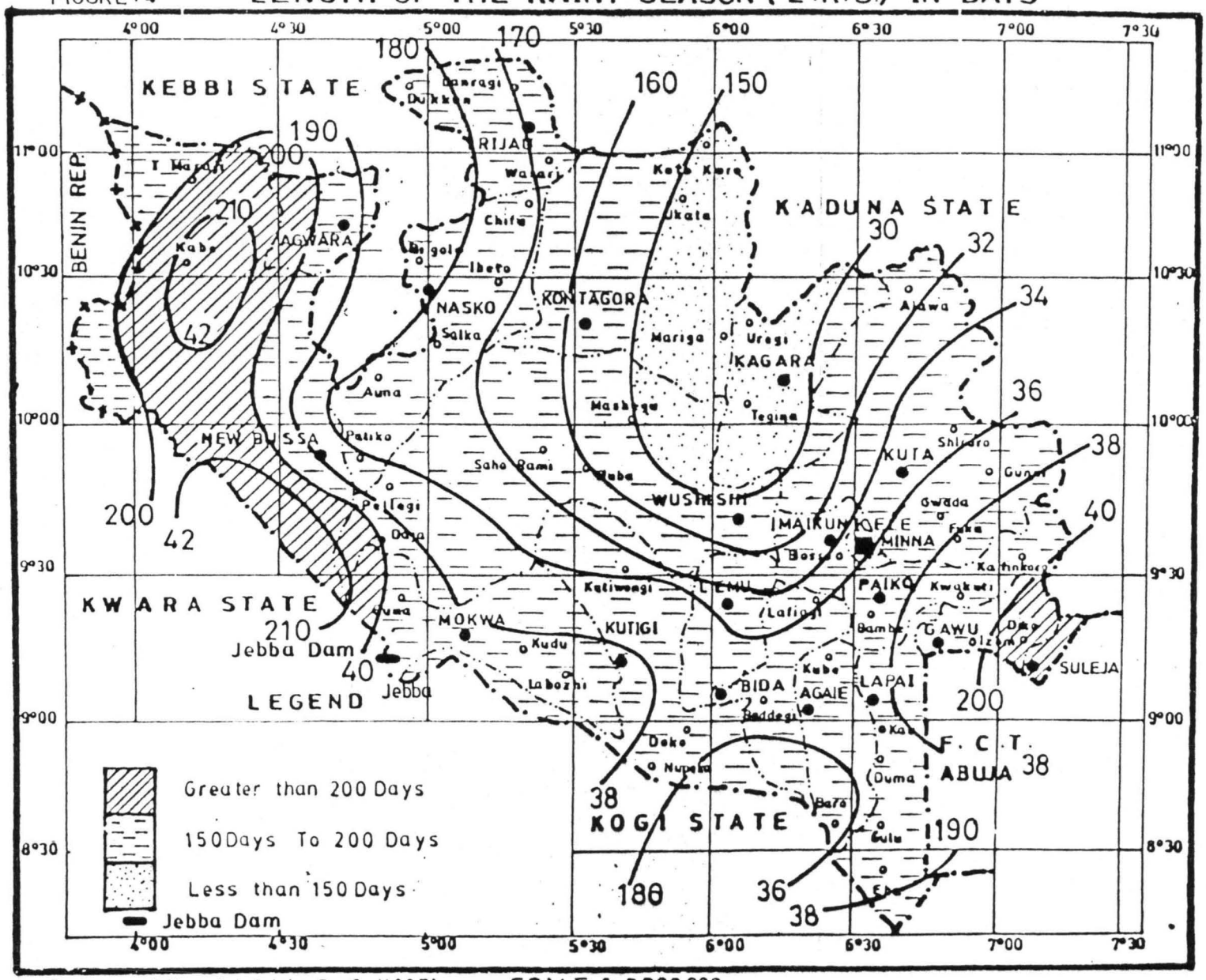
NIGER STATE

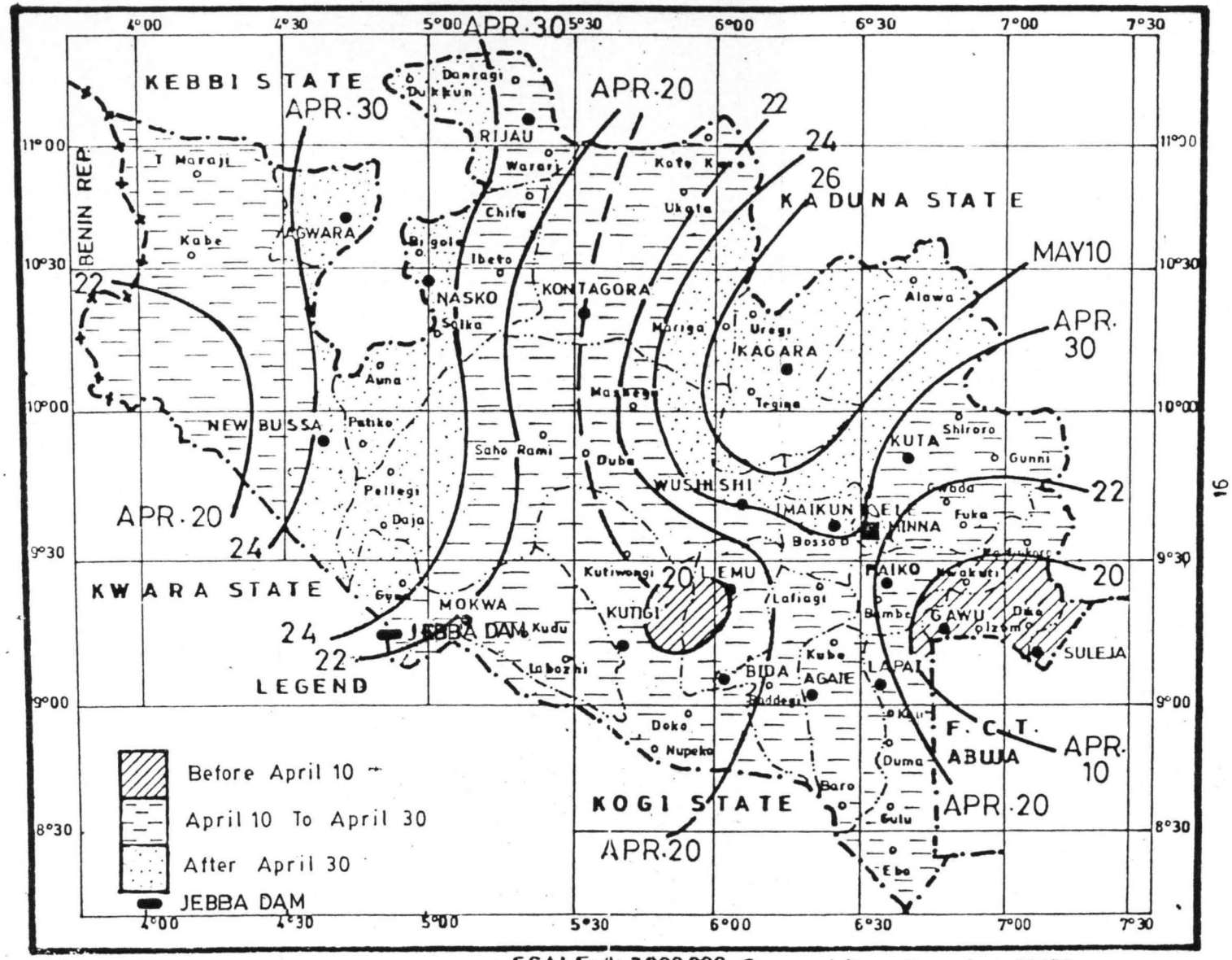
FIGURE : 4 LENGTH OF THE RAINY SEASON (L.R.S.) IN DAYS



Source :- After Adefolalu D. O. (1997) SCALE: 1: 7,000,000

FIGURE 5(a)

NIGER STATE
MEAN ONSET DATES OF THE RAINS



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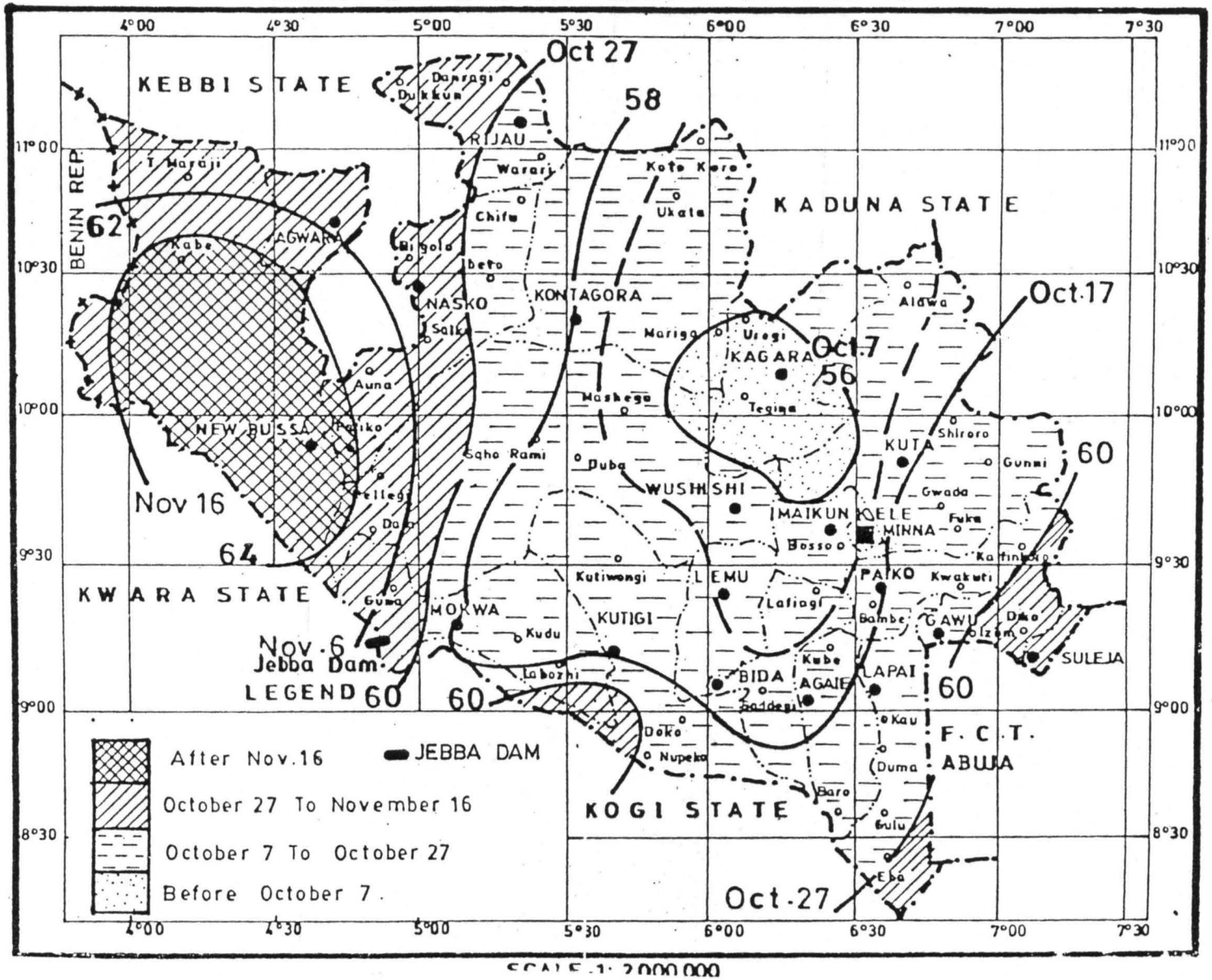
NIGER STATE

FIGURE 5(b) MEAN CESSATION DATES OF THE RAINS



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throughout the year. During the month of November to March, the cooler continental winds from the interior of the continent prevails.

The temperature is between 32 ° – 38 °C maximum and 28 °C minimum and the humidity is very high during the rainy season and very low during the dry season.

1.6.3.3 VEGETATION:

The vegetation of the study area can generally be described as a typical guinea Savanah with a mixture of tress, shrubs, herbs and tall grasses. The southern part of the study area including the hills are found pockets of the flora of the remaining forest patches within the belt which is similar to that of the tropical rainforest due to its nearness to river Niger; while the North East section of the area is purely Savanah with its associated bare ground in some pockets.

The area close to the river are predominantly mixed woodland/grassland in transition.

Plants such as Dongoyaro, Acacia and Comiflora (shea butter) families are common. See figure 6(a), the map of Nigeria showing vegetation pattern of Niger state with respect to the study area.

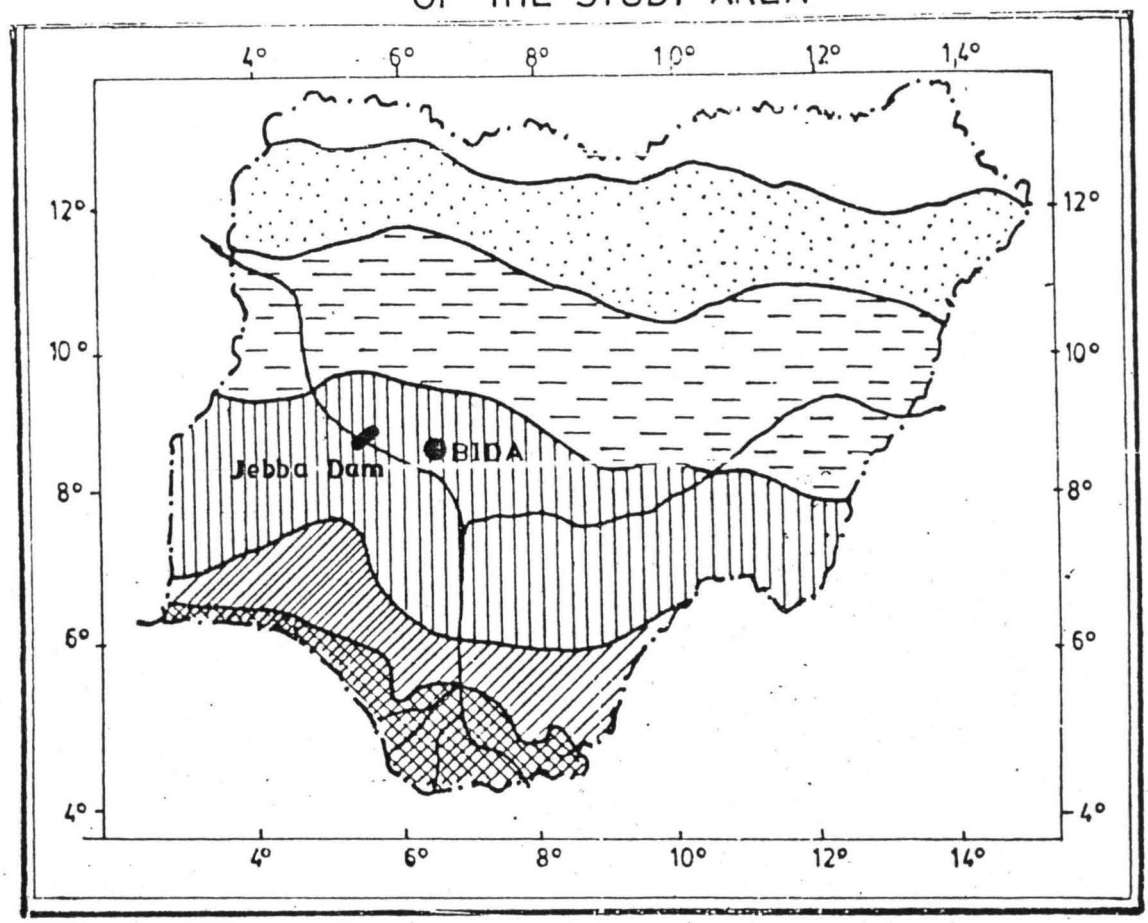
1.6.3.4 GEOLOGY OF THE STUDY AREA:

About 60 – 70% of the total landmass of Niger State is underlain by "hard" rocks of the crystalline basement complex which are believed to be Precambrian in age (shekwollo 1988). The remaining 30 – 40% of the state is covered by sedimentary rock of cretaceous to recent age. The basement complex rocks occur in the Jebba Dam area. This basement complex can further be sub – divided into three broad groups:

1. Migmatites gneisses
2. Quartzites and schists
3. Grauite rocks.

Figure (7) shows the geological map of Niger state.

Fig. 6(a) MAP OF NIGERIA SHOWING THE VEGETAL PATTERN OF THE STUDY AREA



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LEGEND

- Mangrove Swamp
- Rain Forest
- Southern Guinea
- Northern Guinea
- Sudan Savanna
- Sahel Savanna

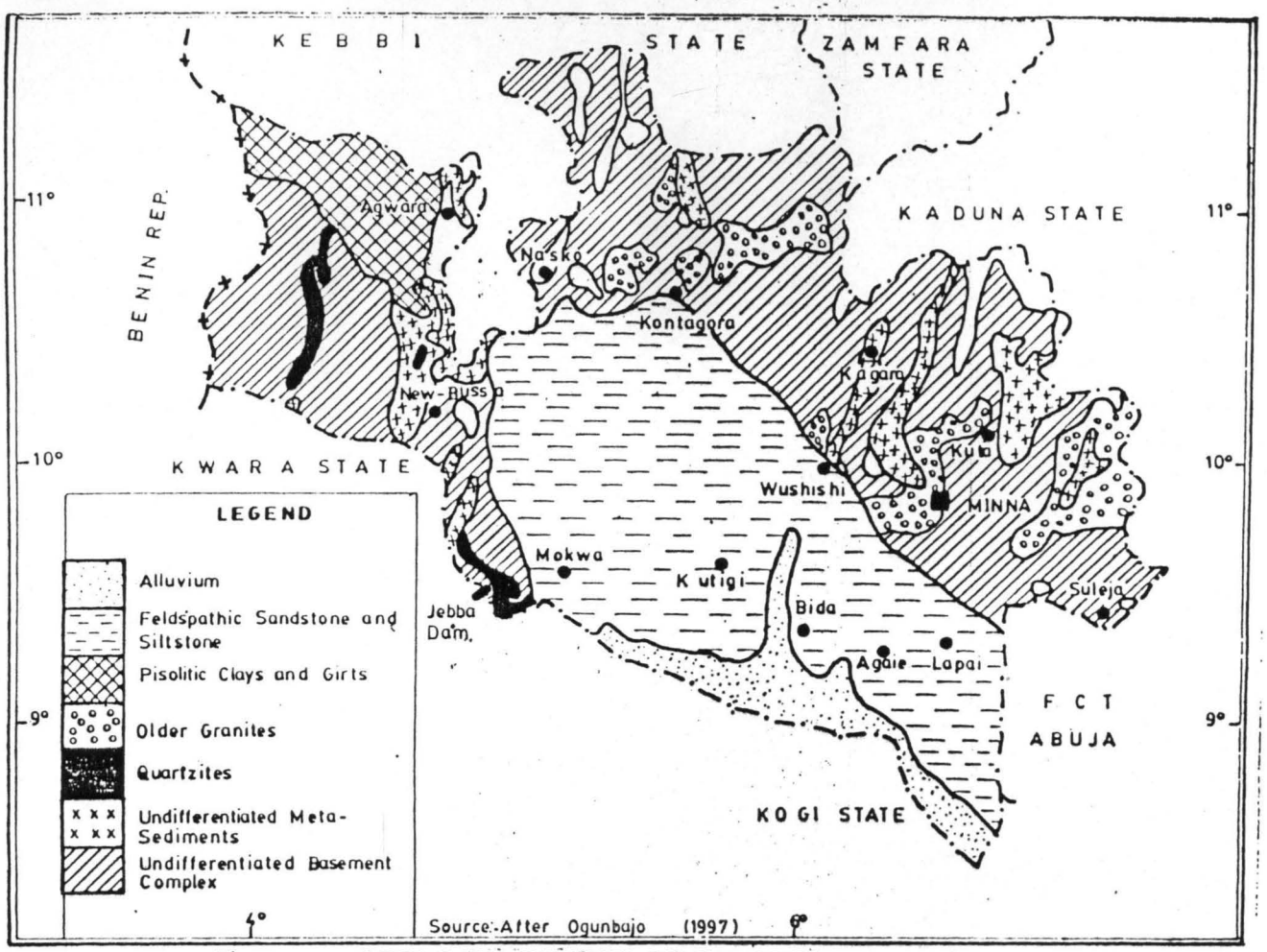


Fig. 7 GEOLOGY OF THE STUDY AREA

The study area is largely associated with quartzites that are not easily weathered and only a thin (layer) of soil cover on the rocks. However, with adequate supply of water, the soils support grasses which can be used for grazing of particular interest are the fadamas which occur in parts of the basement complex areas and around the river down stream in the sedimentary areas. The abundance of water in the area and the seasonal supply of fresh alluvium make these area fertile and suitable for the traditional rice plantation and possibly other grasses including maize, surghum and sugar cane.

1.6.3.5 **HYDROGEOLOGY:**

Hydrology embraces the study of the movement of water both upon and beneath the ground, their chemistry and physics.

The provision of water supplies is the major concern of engineering hydrologist and hydrogeologist. The hydrological cycle in a region is highly influenced by the climatic conditions and the underlying geology; precipitation (rainfall); interception of rain water by vegetation; evaporation and transpiration and infiltration (the process whereby rainwater is absorbed into the soil under gravity).

This will depend on the porosity and permeability of the underlying rocks in the sedimentary areas or the presence of fractures in the basement complex area such as Jebba.

1.6.3.6 **SURFACE WATER:**

These include Rivers Eka, Kaduna, Malendo, Kontagora, Yunko, Chanchaga, Gurara, Dinya and Arinze systems. All the major rivers drains into the river Niger at different points.

Gauging these rivers may be difficult now due to time frame. But gauging is very important because it provides data for calculating the amount of water available and the seasonal variation in the river flow, such information are vital

for flood control measures, irrigation schemes, and dams for hydro – electric projects and water supplies.

In general the volume of water in rivers is controlled by the season and the climatic conditions in the study area, particularly the length of the rainy season.

1.6.3.7 **GROUND WATER:**

The amount of rainfall that infiltrates into the ground will depend on the topography, vegetation cover and human activities such as buildings and roads construction as well as cultivation.

Each of these will tend to increase or decrease the amount of water that goes into the ground. The subsequent water movement in the ground is determines by the underlying rocks.

As stated earlier, the basement rocks occurring in the study area are practically impermeable but the rocks are invariably weathered to varying depths and are covered by loose sediments and soils. The rocks also contain opening or fractures through which water seeps into the ground. See figure (8) hydrological map.

CHAPTER THREE

3.0 RESEARCH METHODOLOY:

In the pursuance of the aims and objectives of this study two approaches have been adopted to the study as to the ways and means of obtaining the relevant information required.

The first approach was to find out sources of published and unpublished information relevant to the study with reference to the established Jebba dam (Hydro power project).

The information obtained from such secondary sources include those on climate, hydrogeology, geology, physiographic (vegetation), maps and existing infrastructural facilities by location and type. The sources of these information were acknowledged.

The second approach centres on the establishment and identification of environmental impact assessment consideration areas through the administration of "structured or coded" questionnaires. The questionnaires which was of two parts was design to provide detailed information on the socio – economic characteristics of the people and the environmental impact of the Jebba Dam on the environment as well as on the general development of its environs both beneficial and negative impacts were given due consideration.

The data collected were collated and analysed carefully. The results of the analysis were used in determining the check list of impacts and their magnitude on the socio – economic life of the people and environmental degradation caused by the negative impacts such as erosion menace, flooding, excessive surface water heating, migration of riparian species and general loss of habitat for some flora and fauna.

In conducting the search, the materials used are discussed below. The methodologies of data extraction and computation procedures for analysis are also discussed in this chapter.

and their migration routes, household survey to ascertain levels of water related diseases etc., Irrigation schemes and crops grown e.g sugarcane, rice and vegetables.

The ground truth is also supplemented by photographs as manifested of the existence of the acdamined activities and landmarks.

3.3 CLASSIFICATION OF ENVIRONMENT

The environment was classified into physical/biophysical environment, socio – economic environment biological environment, political and cultural environment and aesthetic environments respectively for easy assessment.

The impacts of the dam of each level of the environments were enumerated and assessed accordingly. The impact of possible dam failure due to river dredging and channelization; faulting and earth quakes instability of dam embankment etc was given due consideration.

3.4 CHECK LIST OF IMPACT OF THE DAM ON ENVIRONMENT

Finally, a check list of impacts of the dam on the environment were the dam on the environment were tabulated in to cause, problem, effect and possible remedy towards combating the negative effects/impacts of the dam on the environment.

CHAPTER FOUR

4.0 ANALYSIS OF FINDINGS:

The most basic element in research work is data or numerical information gathering, since knowledge depend basically on information and information depend heavily on survey.

In order, to buttress our claims about some fundamental issues raised in the introductory aspect of this work, concerning parameters such as rainfall, relative humidity, temperature, rate of evaporation of surface water and more importantly, to find out some salient basic facts about the study area a probe into the delineated study area was institutionalised by carrying out a comprehensive survey by administering questionnaire.

On the "Spot" assessment of some basic phenomena were, made oral questions were asked to ascertain the authenticity of some claims. Personal visitation were made into some important areas for the purpose of collecting information such as police station to ascertain the level of crime wave after the construction of Jebba dam compared with the level of crime in the study area before the project.

Useful data were collected from Jebba Dam in the hydroelectric power station of (NEPA). These data were collated and analysed accordingly.

About 100 households were surveyed in order to ascertain the existing activities, level of socio – economic activities, impact derivable from the reservoir both positive and negative impact were asked and later assessed. Sampling techniques were adopted in the administration of questionnaire.

At the end of it all, the following information about the study area became vivid and analysed as follows and after which logical conclusion and scientific inferences were deduced from them. Relative humidity, rainfall, and temperature.

4.1 MEAN MONTHLY RELATIVE HUMIDITY:

Relative humidity is the actual amount of water vapour in the air compared with the amount of water vapour the air could hold if it were saturated, this is expressed as a percentage.

Record of relative humidity for a period of ten years base on monthly data was collected from Jebba hydro – electric power station of (NEPA). The records covers 1989 to 1998.

These data were collated and analysed and the mean monthly relative humidity from January to December every year were worked out. Figures 9A – J shows the histogram of the relative humidity a pictorial representation of the mean monthly relative humidity figures for the study area.

What informed the author to use records of 1989 – 1998 was that records of post dam period will suggest whether or not there is impact of the dam on microclimate after comparing the result with fundamental basic principles.

It was glaring that there was a great modification and alteration to the relative humidity of the study area. About 82 – 89% mean monthly relative humidity was recorded as against what it use to be before the projects, 1982 – 85 (see table (1).

The most striking thing is that, the figures were very low during the hydrologic years 1983 and 1993 as evident in figures 9© and table (1) above.

4.2 RAINFALL (MEAN MONTHLY RAINFALL):

Rainfall includes other form of precipitation such as (snow, sleet and hail) is always measured by a rain – gauge.

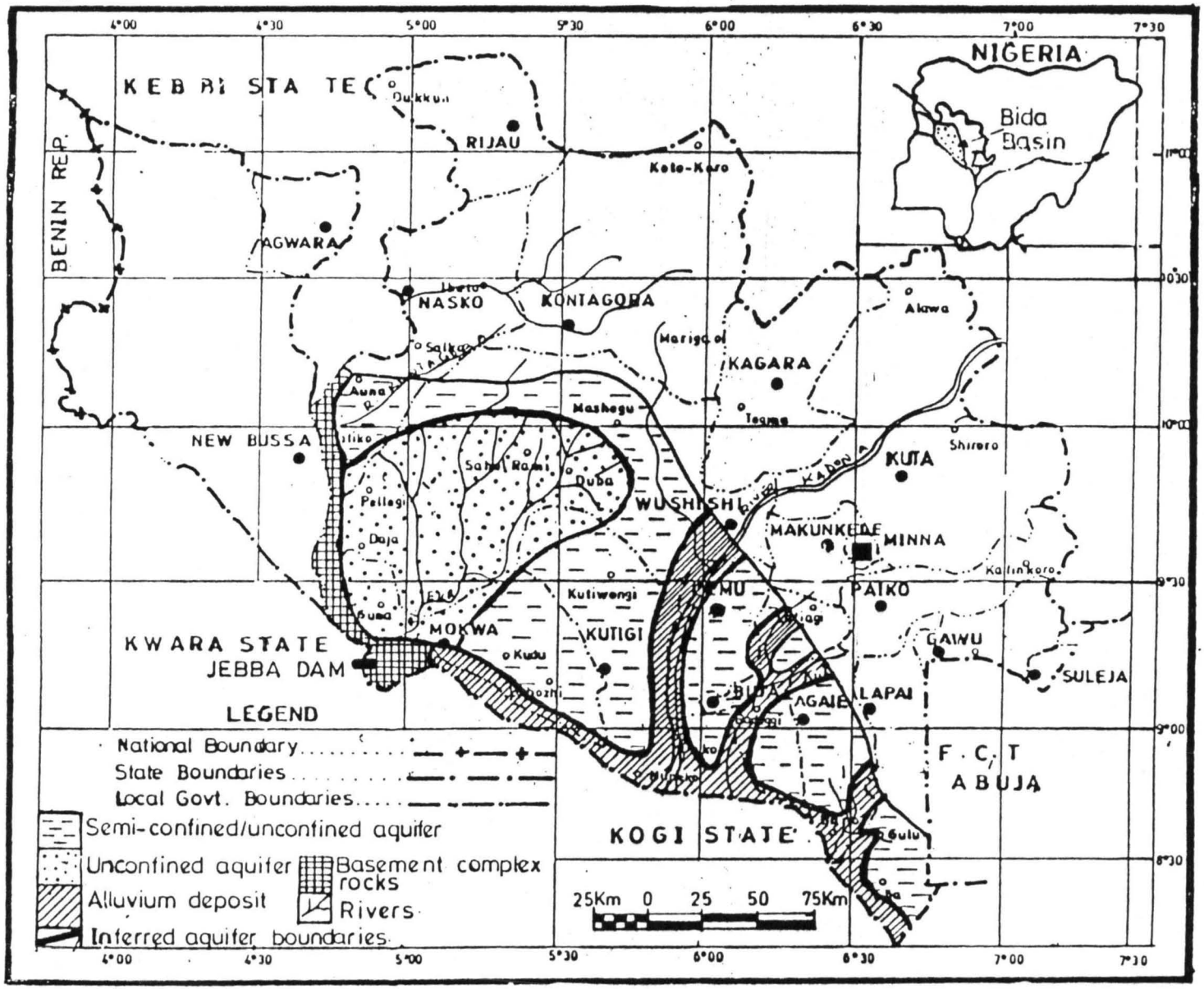
The mean monthly rainfall is obtained from the averages of the total rainfall in a month base on a five-day pentades record.

From the records between 1956 – 1963 it was found out that rainfall amounts recorded happened to be high in the pre – dam period as against post dam period. (see table 2).

TABLE (1a) MEAN MONTHLY RELATIVE HUMIDITY (%)
AT JEBBA DAM 1982-1985
PRE-DAM PERIOD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	NIL	NIL	68	69	89	81	85	82	83	85	83	69
1983	61	65	69	74	64	72	77	75	75	76	73	73
1984	52	54	74	77	81	82	85	88	85	81	73	68
1985	65	54	71	78	81	85	85	87	87	80	80	59

Fig. 8 HYDROLOGICAL MAP OF THE STUDY AREA



than 100,000 people. At least 80,000 had to move when the Volta Dam was built in Ghana.

In Kariba, Bowmaket (1973) noted that recession of macrophyte stands occur during years of large water level fluctuation and extension during years of small fluctuations.

Two years study of Kariba Dam on the Zambesi by Mclachlan (1970) reveals that the rate of "natural" bush clearing can in some cases be high to about 23 percent of tree destroyed. Scouring of soil away from the root system of dead trees in the draw down zone by waves can cause the trees to fall over (Mclachlan, 1981).

The government of Angola and Namibia embarked on the feasibility of a hydropower project on the lower Canene River, (1995 – 1997), which marks the international boundary between the two countries. The EIA was carried out by an independent group of about 30 regional and international experts collecting base – line data on the physical, living and human environments. The key issues in the EIA are the impacts on human use of terrestrial and riparian resources, as the loss of land by inundation may servely affect grazing areas and a zone of riparian vegetation along the river.

Another case study is a hydropower project in the Southern Highlands of Tanzania, where the EIA screening was basically on scheme comparison and selection.

The impact studies carried out of an existing reservoir in Southern Mozambique focus on method and competence development using the experience from observed changes.

In a nutshell, with the foregoing studies background from literature that uses both conventional and non – conventional method in carrying out the EIA of Dams and their implication on the eco – system, I believe whole heartedly, that there is justification for carrying out the (EIA) Environmental Impact Assessment of Jebba Dam.

Most importantly, providing lasting solutions to the various impact scenarios that may be ranging from Environmental Health hazards and socio – economic impacts to dam failure emanating from adverse environmental effects.

3.1 DATA COLLECTION

The materials collected for identification and assessment of the dam are, 1982 – 1985 mean monthly relative humidity (%) re – dam period; 1989 – 1998 mean monthly relative humidity (%) post – dam period; 1956 – 1962 mean monthly rainfall (mm) pre – dam period, average monthly maximum temperature between 1989 – 1998 post – dam period, Evaporation loss (m3/sec) between 1989 – 1998 a period of ten years post – dam period and average water discharge (m3/sec) post —dam period 1989 – 1998; average monthly inflow (m3/sec) 1992 – 1997 post – dam period.

These parameters were developed into graphs, histograph to give the pictorial representation of each element and their relationship to each other

The correlation between humidity and rainfall was tested by using person's correlation co – efficient as $r = \frac{2(x - x)(y - y)/N}{S \times Sy}$

Where:

R = Person's correlation co – efficient

N = Number of paired data values

S x Sy = Standard deviation of X and Y, respectively.

The frequencies of occurrence of the various elements during the pre – dam period were compared with the occurrences during the post – dam period to ascertain whether or not there are deviation or departure from the normal trend.

The impacts of such departures were greatly assessed to bring out the actual impact either beneficial or otherwise.

3.2 ON THE "SPOT" ASSESSMENT OF MAJOR IMPACT

Ground truth was conducted or carried out for familiarisation. The ground truth were carried out in some selected areas using stratified random sample for the survey.

Surveys of important economic – activities such as fish cropping, types of gear used in fish cropping, fish types and fish trading. Number of herds of cattle

TABLE (1b) MEAN MONTHLY RELATIVE HUMIDITY (%)
AT JEBBA DAM 1989-1998
POST-DAM PERIOD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1989	51	43	69	71	79	83	85	86	85	84	76	67
1990	62	59	61	73	85.	81	85	86	86	85	74	74
1991	71	65	66	69	78	82	86	87	85	77	73	61
1992	41	35	62	72	80	80	80	77	81	73	59	55
1993	35	53	58	64	71	80	79	79	80	76	71	47
1994	50	57	68	77	81	81	81	82	83	81	63	37
1995	42	42	63	70	75	80	82	85	83	80	69	67
1996	65	63	62	65	72	80	80	85	82	79	69	63
1997	55	32	54	70	76	81	82	81	81	79	74	57
1998	45	49	40	67	75	82	80	83	84	80	75	63

TABLE (2) MEAN MONTHLY RELATIVE RAINFALL (mm) AT JEBBA DAM 1956-1963 PRE-DAM PERIOD

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	MEAN ANNUAL
1956	0.00	0.00	1.43	13.53	36.01	66.04	111.30	106.56	139.46	177.25	122.52	125.1	899.2	74.93
1957	0.00	0.00	0.27	16.17	70.59	126.74	203.04	255.03	336.61	392.47	408.53	478.78	2,288.23	190.68
1958	0.00	0.00	0.00	36.29	68.27	121.76	141.17	164.93	223.79	272.56	275.91	322.03	1,626.71	135.56
1959	0.00	0.00	0.00	4.05	20.55	60.89	113.71	142.05	187.57	214.44	218.28	205.38	1,166.92	97.24
1960	0.00	0.00	10.45	30.80	66.06	103.44	154.23	201.25	258.62	311.02	317.68	370.63	1824.18	152.01
1961	0.00	0.00	5.36	29.28	59.93	111.52	164.34	210.25	264.75	329.44	330.48	385.56	1890.91	157.57
1962	0.00	0.00	0.50	28.71	85.23	123.71	160.93	210.99	266.45	315.38	337.92	399.01	1928.83	160.73

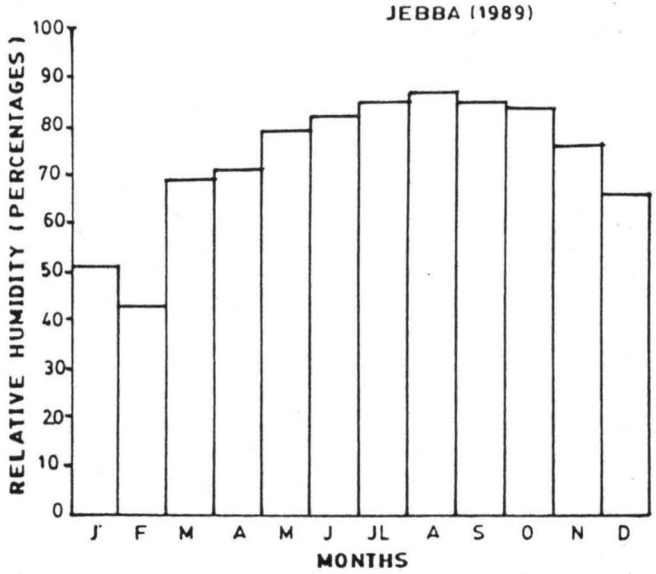


Fig. 9(a) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

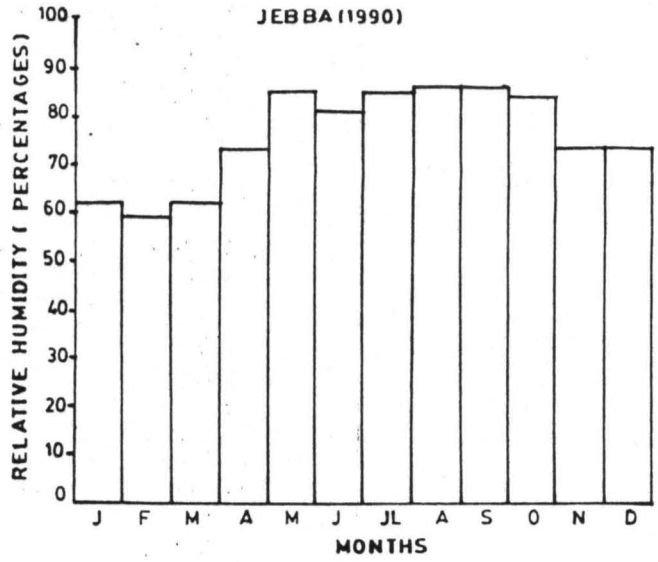


Fig. 9(b) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

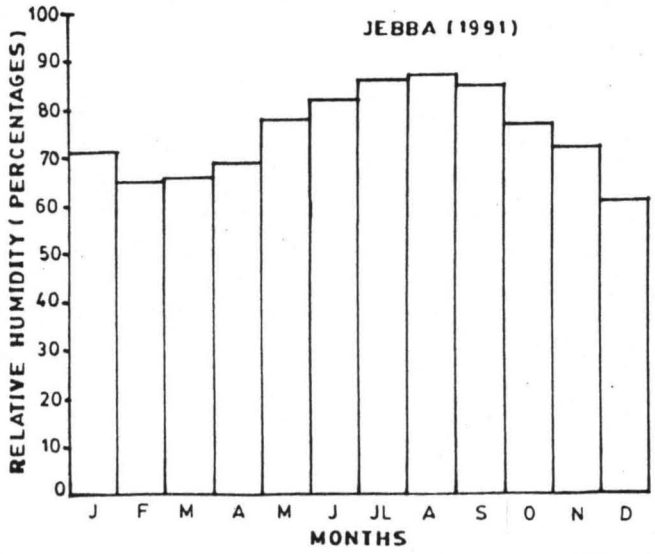


Fig. 9(c) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

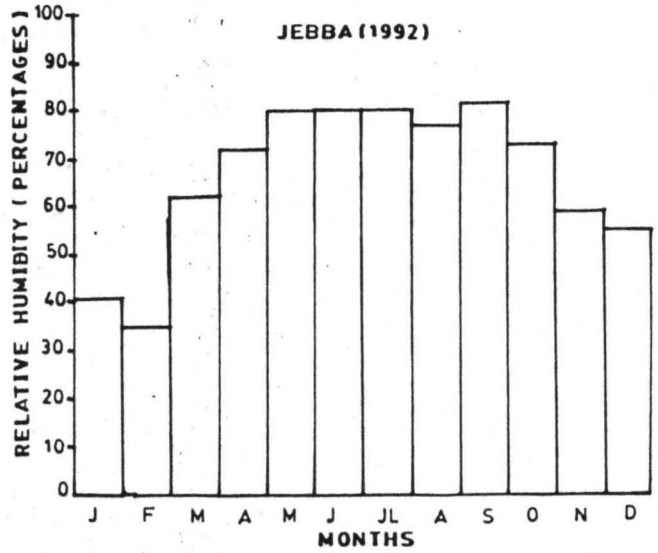


Fig. 9(d) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

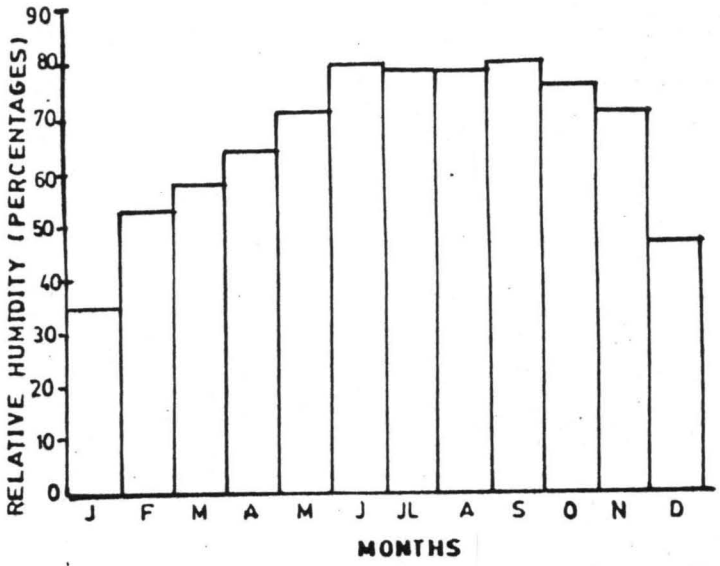


Fig.9(e) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1993)

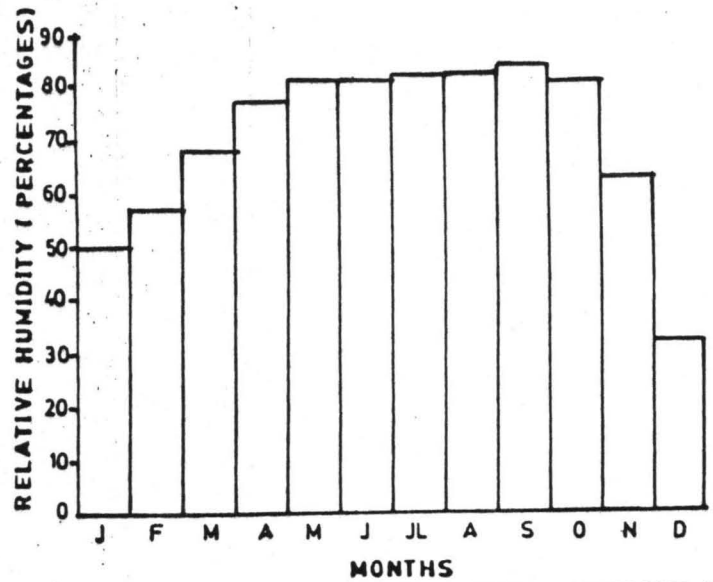


Fig.9(h) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1994)

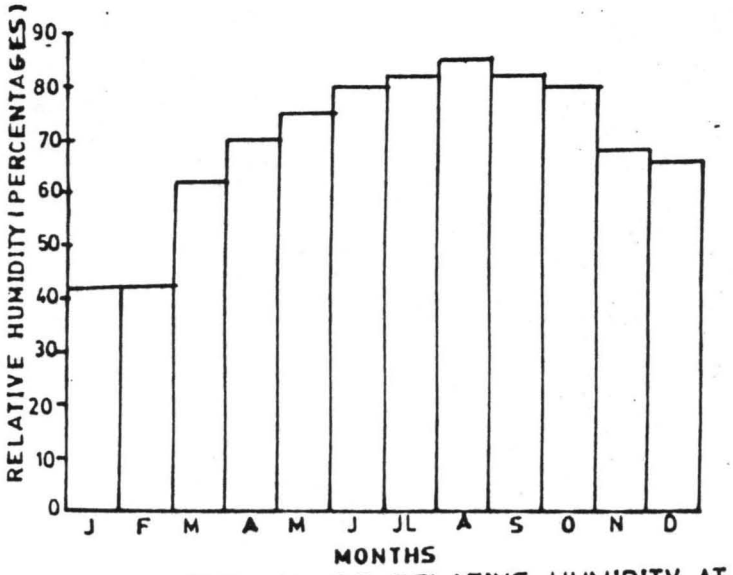


Fig.9(g) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1995)

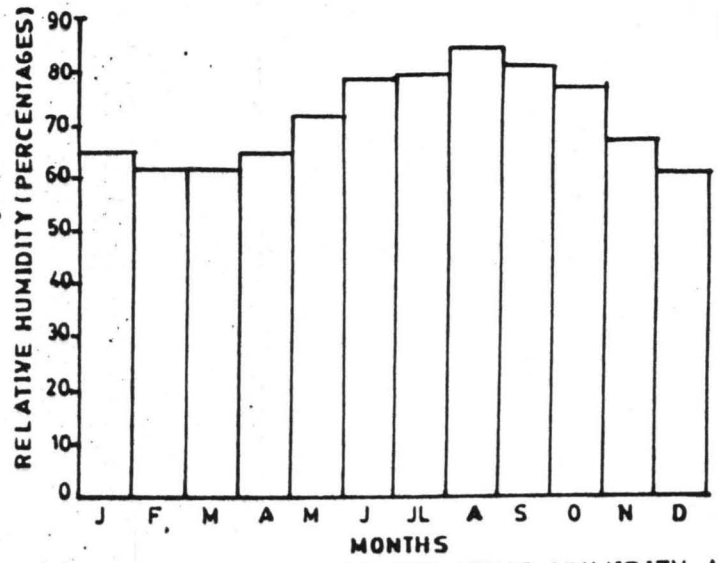


Fig.9(h) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1996)

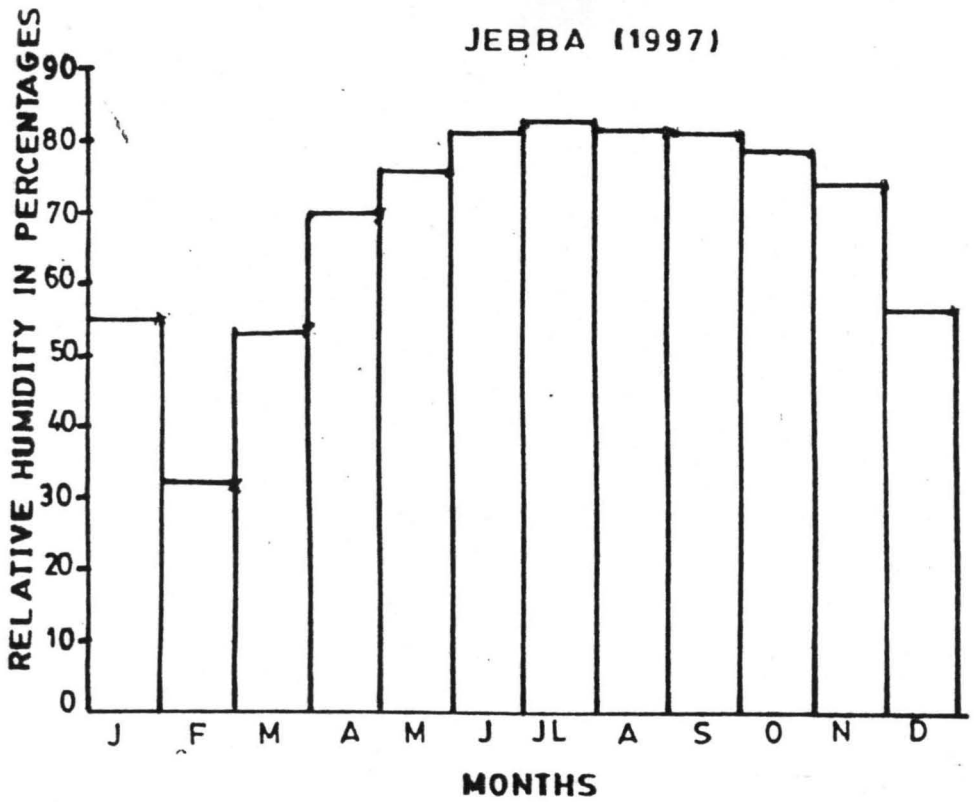


Fig. 9(i) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

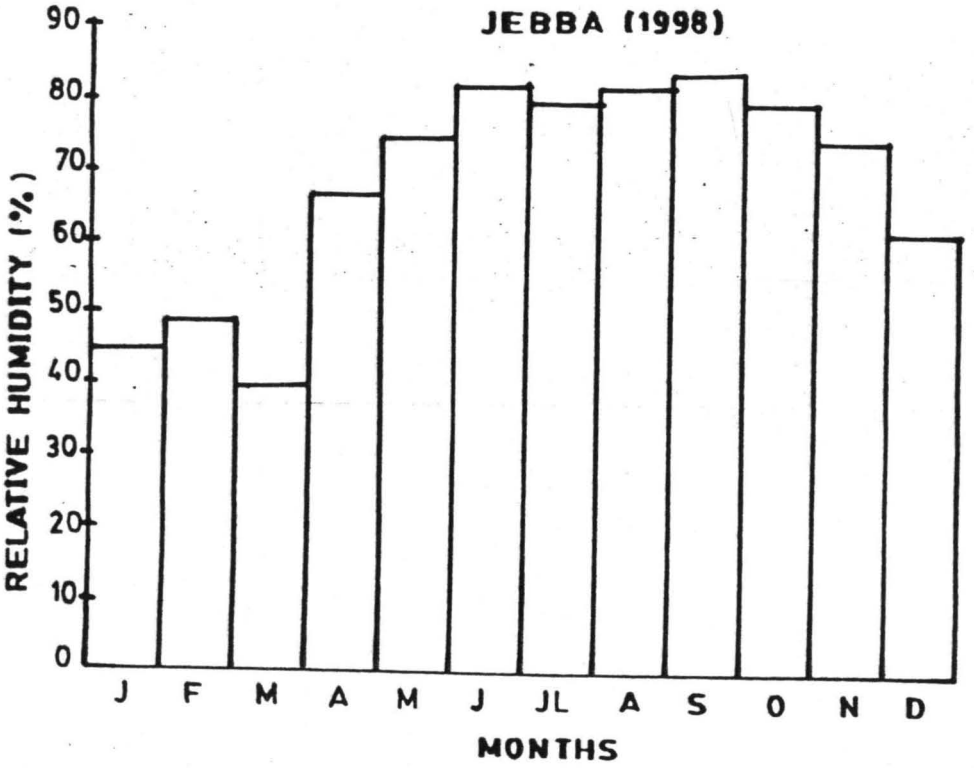


Fig. 9(j) HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

This was attributed to the mere fact, that vegetative cover play a significant role in modifying weather. During the construction period, a large track of land was cleared making the whole environment to look bare for some years. The bareness made it possible for wind to deflect the air that is moisture ladden even though the humidity is very high. See figure 10(a) – J.

As from 1991, the situation changed a little departure from the previous years was experienced as shown in figure 10 j

The highest rainfall were recorded in the months of June and August about 360mm. It is interesting to note that there is a correlation between rainfall and relative humidity. That is there is a relationship between mean monthly relative humidity and mean monthly rainfall as rainfall use to be high during high humidity. This was tested by using person's correlation coefficient ® as.

$$r = \frac{(z(x - x)\,(y - y)\ /N}{S \times Sy}$$

Where:

r = Pearson's correlation coefficient

N = Number of paired data values

S x Sy = Standard deviation of X and Y, respectively.

In a standardised form $r = (Z \times Zy)$

Where $Zx = \frac{(X - Y)}{Sx}$ and $Zr = \frac{(Y - Y)}{Sy}$

Zx = X Variable transformed to Z – score

Zy = Y Variable transformed to Z – score

N = Number of paired data values

4.3 AVERAGE MONTHLY MAXIMUM TEMPERATURE:

Temperature is the degree of hotness or coldness of a place or a substance. The average monthly maximum temperature is obtained from the averages of the total temperature recorded in a month.

The figure 11 (a – h) below shows the graph of the mean average

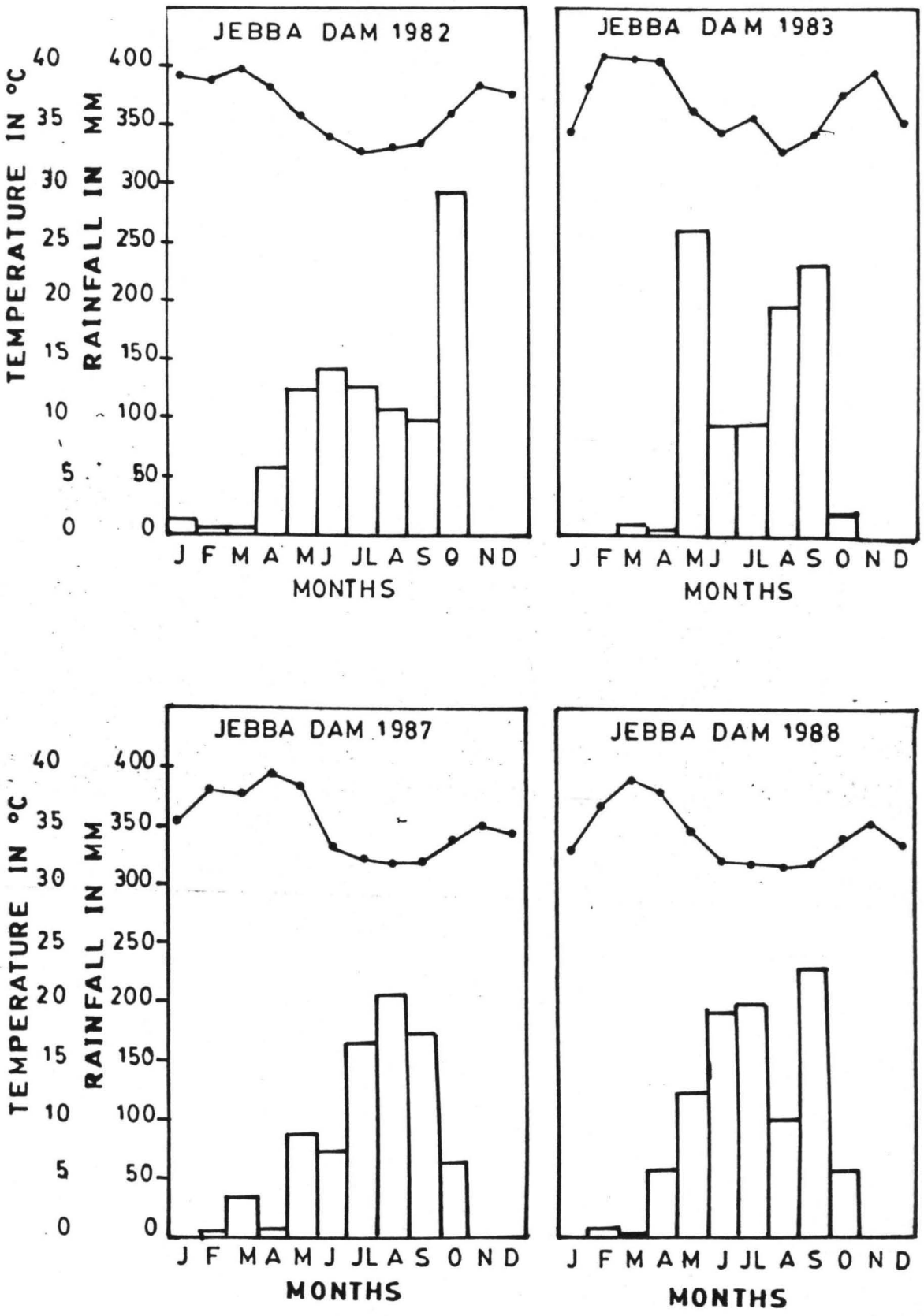
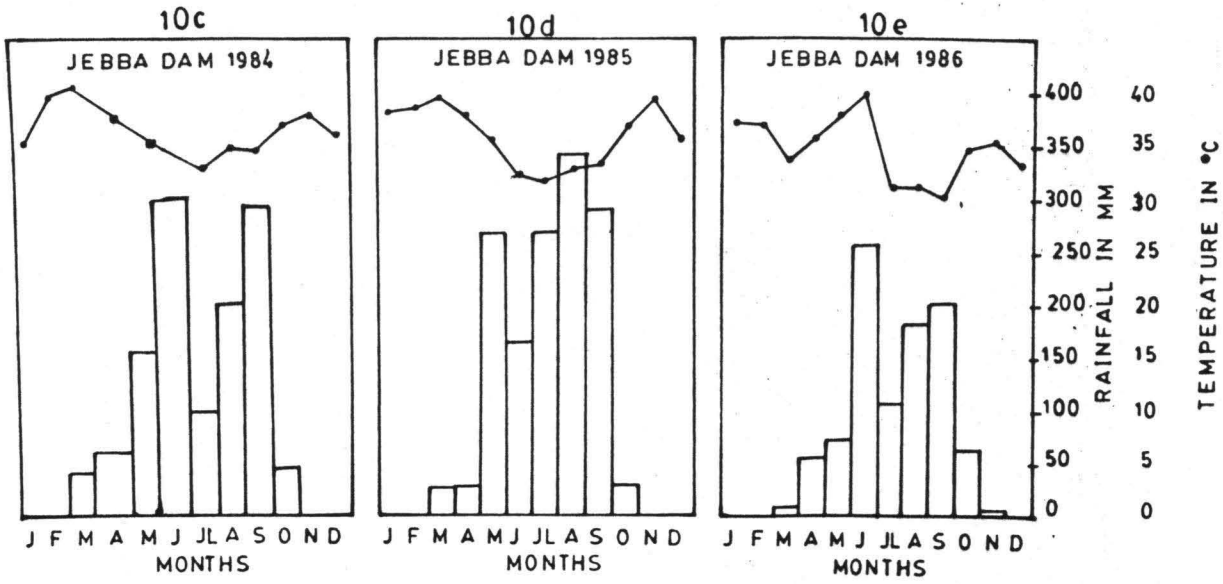


Fig-10a-j MEAN MONTHLY RAINFALL IN MM AND MEAN MONTHLY MAXIMUM TEMPERATURE (°C)



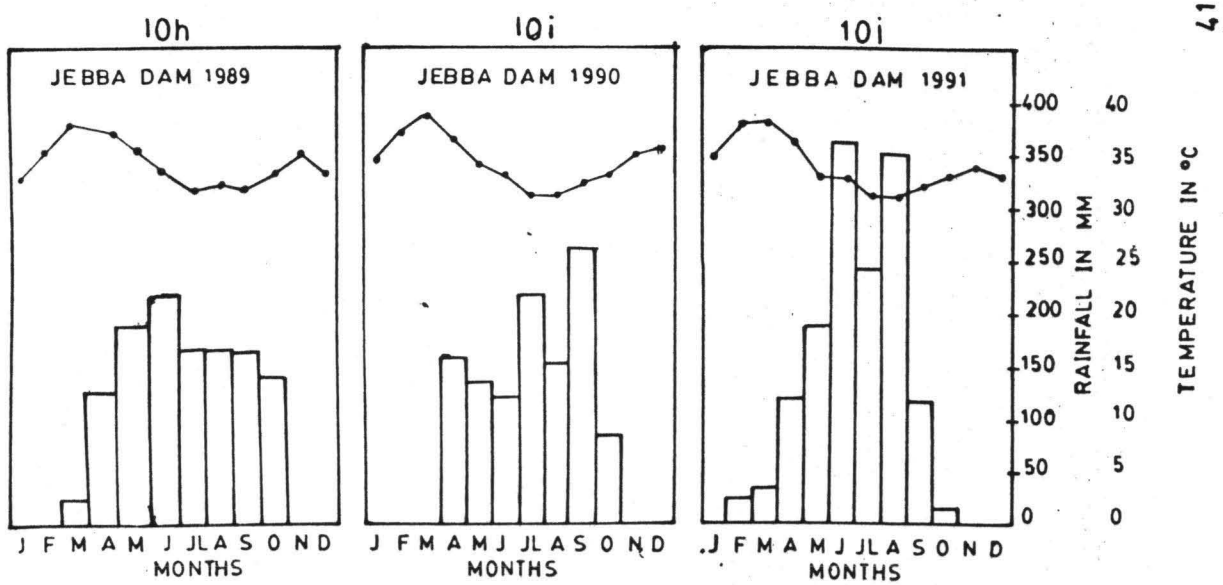


Fig. 10a-j MEAN MONTHLY RAINFALL IN MM AND MEAN MONTHLY MAXIMUM TEMPERATURE (°C).

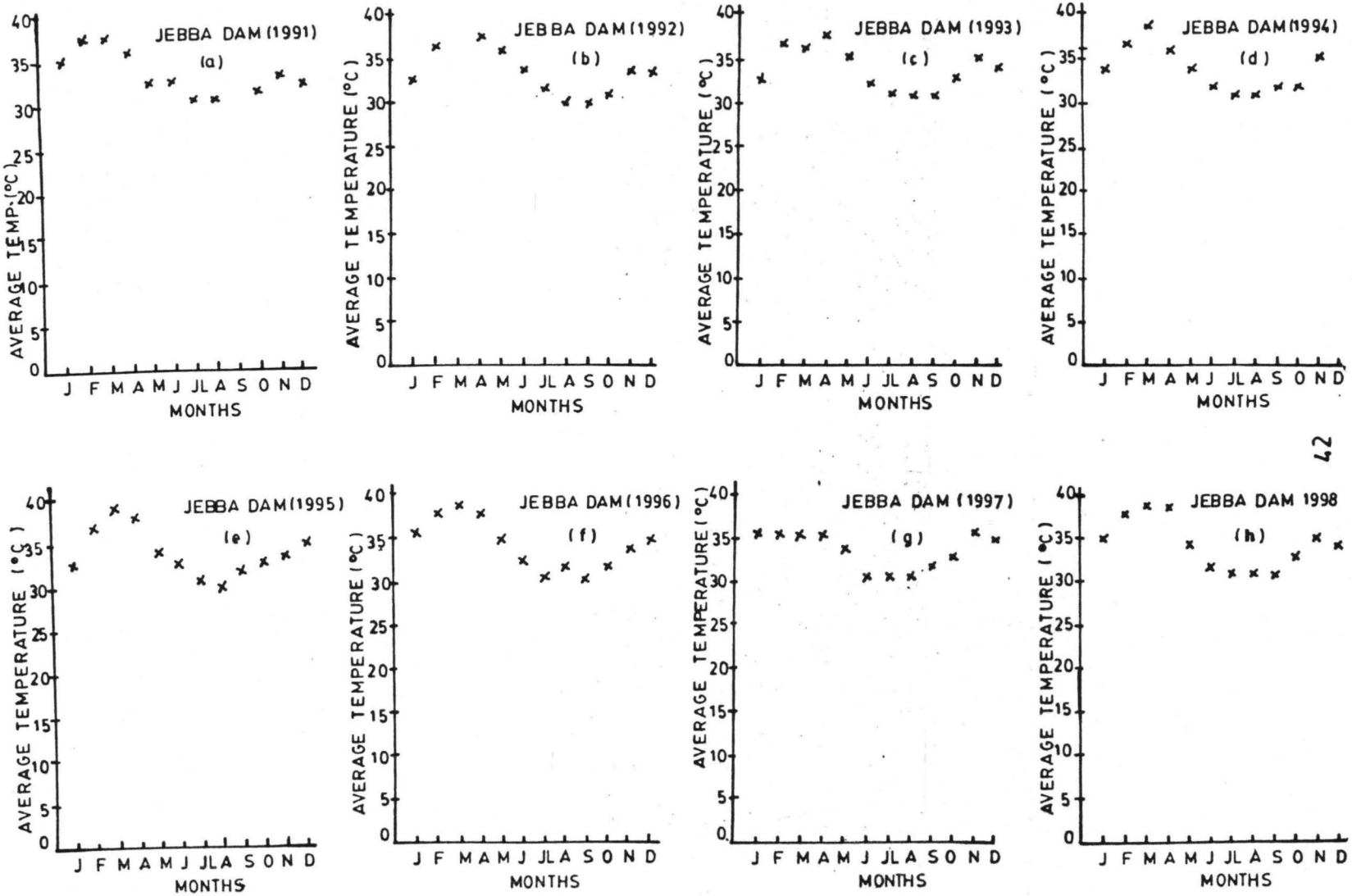


Fig. 14a - h AVERAGE MONTHLY MAXIMUM TEMPERATURE (°C) AT JEBBA DAM (POST DAM)

monthly maximum temperature and that of the average monthly temperature over a period of ten years (post – dam period 1989 to 1998.

The significant of these parameters outlined above to Agricultural engineering is that the strength of materials, quality, quantity and design can be fashioned out in line with the climate variation of any geographical location bearing in mind these important variables.

The highest temperature was recorded in the months of march and April due to low humidity and cloud cover. The lowest temperature was recorded in the months of July, August and September due to high humidity and heavily cloud cover.

Generally, there was a high temperature recorded during the post – dam period which attested to the fact that the reservoir has a great influence or impact on the microclimate of the study area.

4.4 AVERAGE RESERVOIR EVAPORATION LOSS (CM3/SEC)

In line with the high temperature there was a high evaporation from the water surface in the reservoir. The average monthly reservoir evaporation loss (m3/sec graph shows that the months of March and April respectively has the highest evaporation loss. See figures 12 (a) – (j) the graph of reservoir evaporation loss (M3/sec) plotted for a period of ten years 1989 – 1998.

The peak of the evaporation loss is in March and there is a decline from the month of May to October due to high humidity. These parameters are viable in determming and designing storage facilities in terms of types, materials to be used, time and location. There is a relationship between temperature and evaporation, high temperature leads to high evaporation loss while low temperature will equally lead to low evaporation loss.

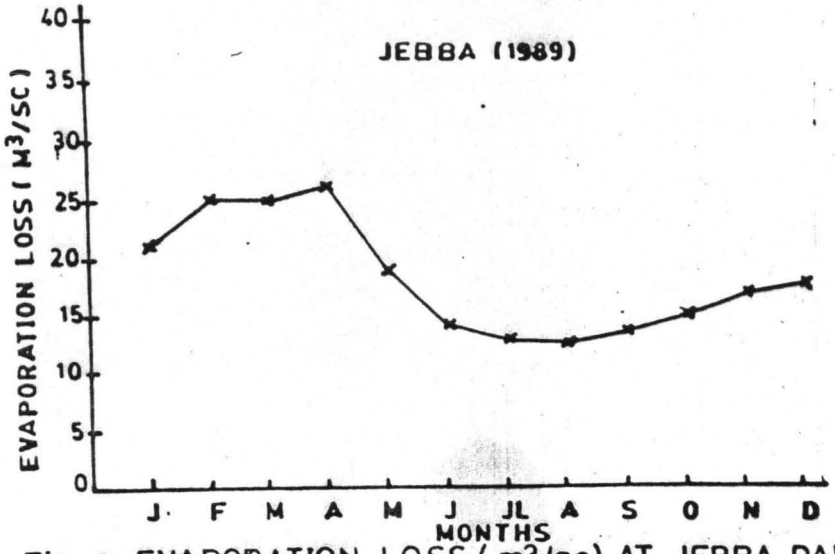


Fig. 12a EVAPORATION LOSS (m3/sc) AT JEBBA DAM

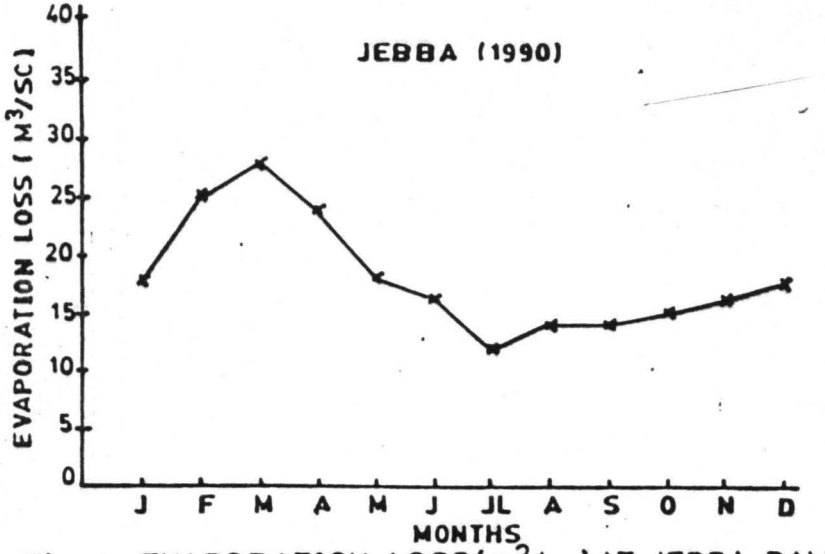


Fig. 12b EVAPORATION LOSS(m3/sc) AT JEBBA DAM

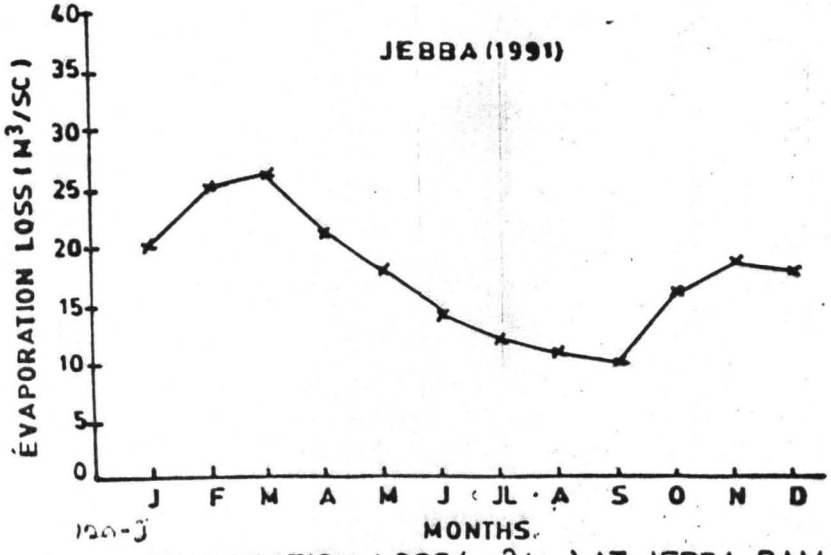


Fig. 12c EVAPORATION LOSS (m3/sc) AT JEBBA DAM

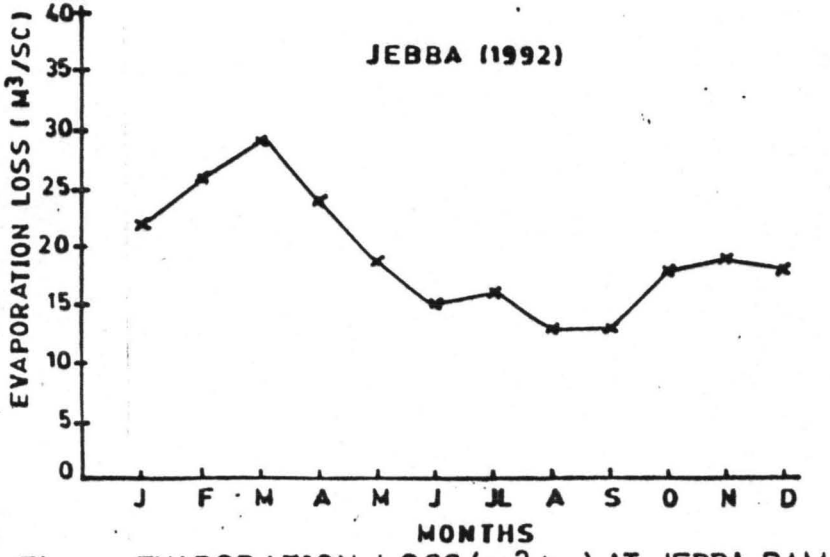


Fig. 12d EVAPORATION LOSS (m3/sc) AT JEBBA DAM

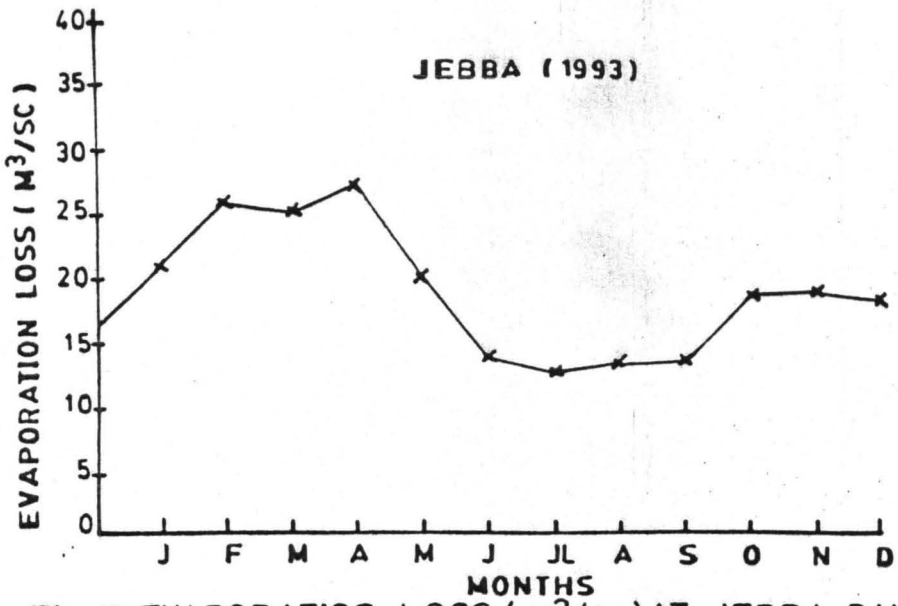


Fig. 12e EVAPORATIOS LOSS (m3/sc) AT JEBBA DAM

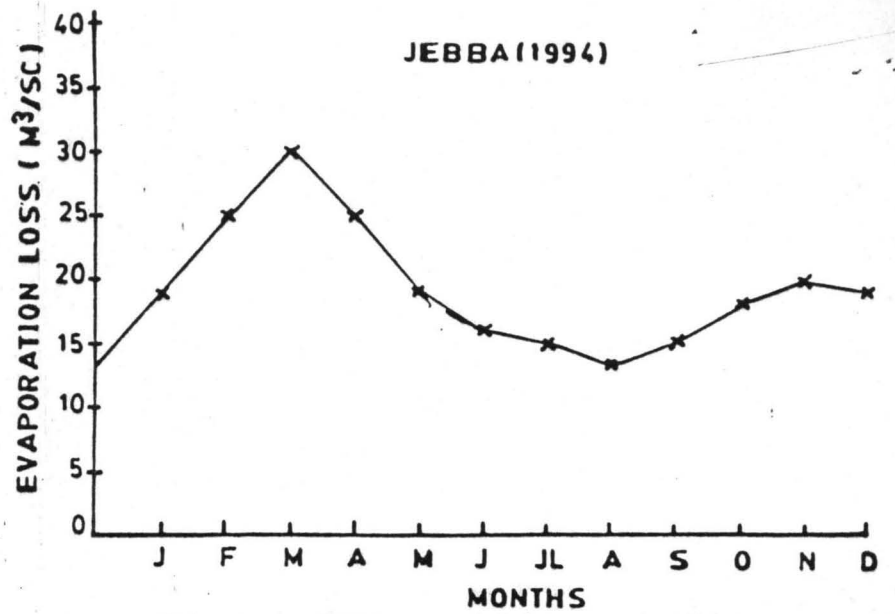


Fig. 12f EVAPORATION LOSS (m3/sc) AT JEBBA DAM

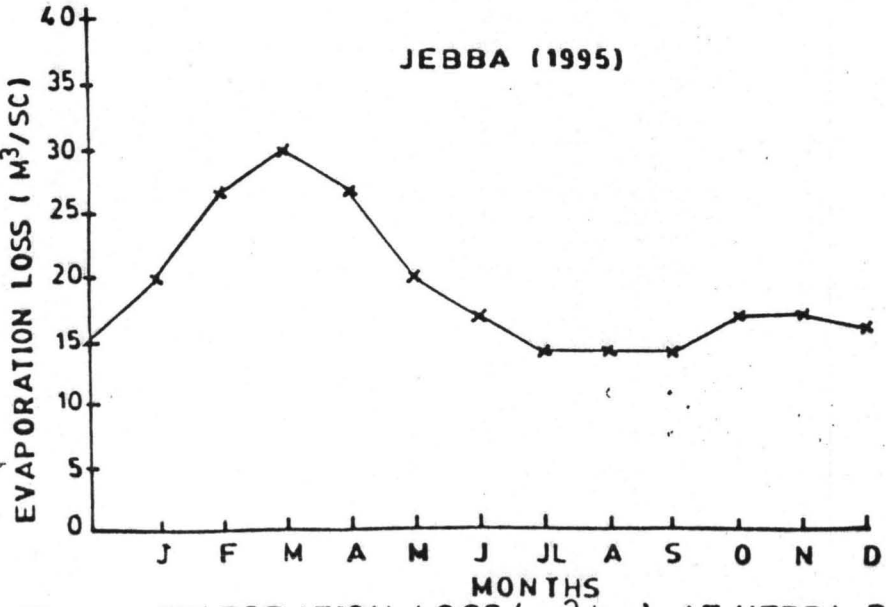


Fig. 12g EVAPORATION LOSS (m3/sc) AT JEBBA DAM

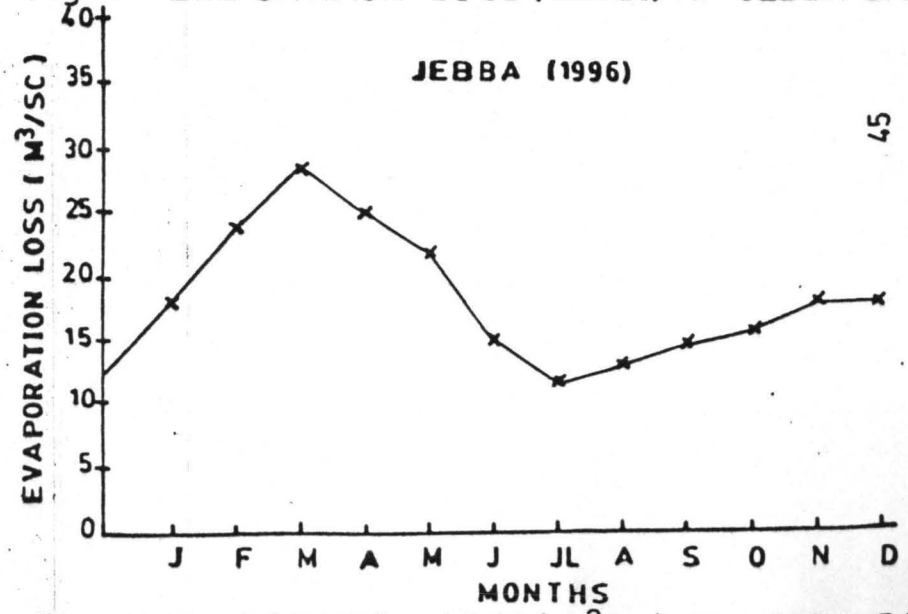


Fig. 12h EVAPORATION LOSS (m3/sc) AT JEBBA DAM

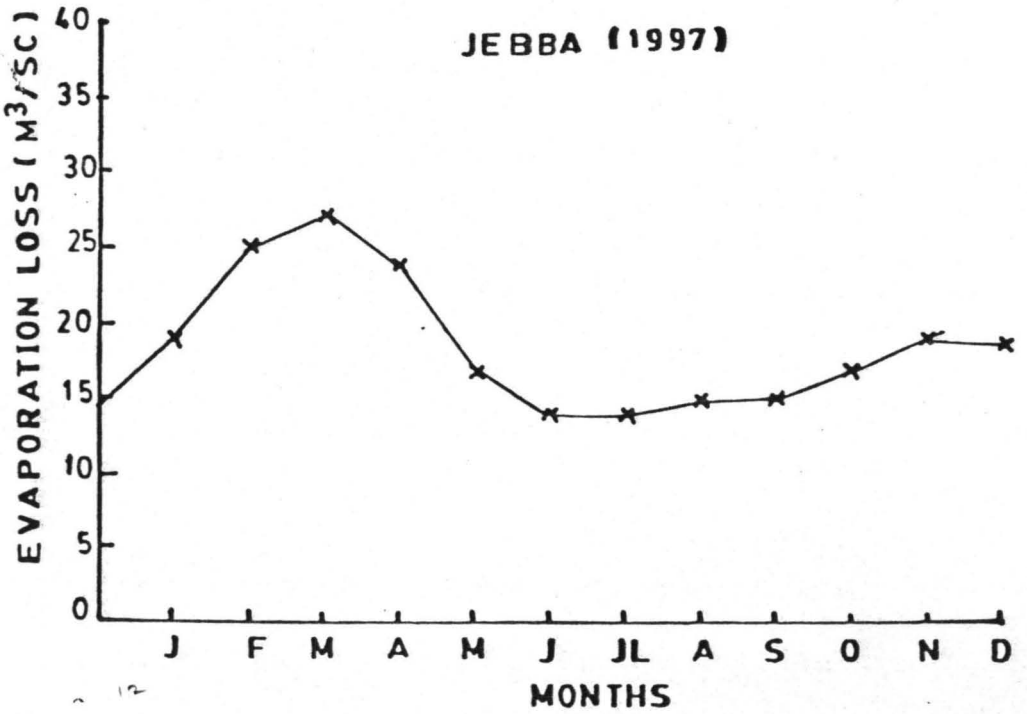


Fig. 12i EVAPORATION LOSS (m^3/sc) AT JEBBA DAM

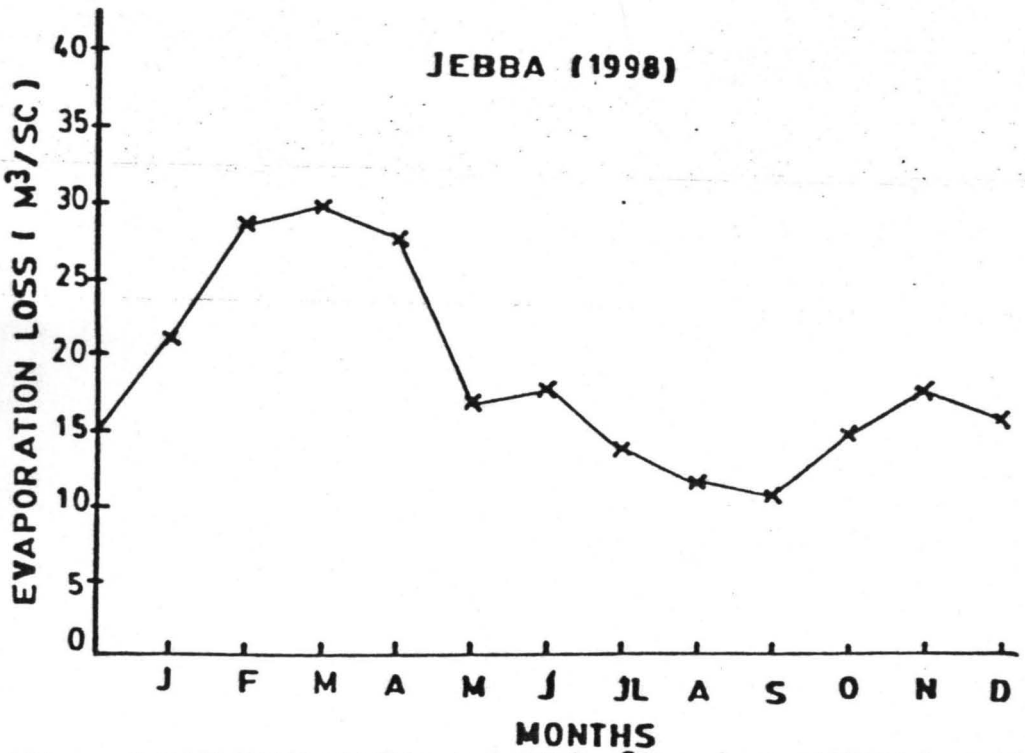


Fig. 12j EVAPORATION LOSS ($m^3/sc.$) A JEBBA DAM

The table 3 below shows the vital data collected in respect of the Jebba Dam.

Normal Rating Level	103.0m
Allowable draw down	4.0m
Usable storage capacity	1.1 Billion m^3
Live storage capacity	3Billion m^3
Length of the dam	100km
Maximum flood level	83m
Normal height	77m
Minimum Height	73m
Full Power House discharge	75m
POWER INSTALLATION	
Number of generating Units	6 turbines
Total Rated output	560,000Kw
Rated net Head	27.6m
$4.0m^3$ of water will	1mw of electricity
generate	

4.5 AVERAGE WATER DISCHARGE AT JEBBA DAM POST DAM PERIOD 1989 - 1998

The table (4) below shows the water discharge from Jebba Dam for a period of ten years. The monthly average for each year was plotted and it was discovered that the highest discharge was recorded in the month of September showing a departure from the normal months of July and August that has the highest rainfall amounts respectively.

The graph in figure 13(a) & (b) shows the trend of the discharge in m^3/sec.

TABLE (4) AVERAGE WATER DISCHARGE (m^3/SEC) AT JEBBA DAM (HYDRO-POWER) POST-DAM 1989-1998

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR AVERAGE
1989	991	613	574	744	836	717	672	1039	1357	1466	691	917	885
1990	848	690	629	683	1078	958	390	507	1163	759	835	841	782
1991	622	782	579	631	681	1243	1556	1927	1239	1304	857	852	1023
1992	1075	763	704	757	740	864	689	451	667	1073	1039	917	812
1993	856	1011	1058	948	620	462	370	366	881	685	641	601	708
1994	702	788	854	810	777	660	621	1275	1746	1579	1464	1283	1047
1995	1505	1643	1442	1027	1133	1094	1024	1253	1362	1459	1339	909	1266
1996	1034	1044	983	782	762	606	785	842	1176	1181	1133	953	940
1997	1213	1229	1053	1133	756	831	765	432	1110	945	777	767	918
1998	756	957	849	901	816	1109	1303	1387	1451	1387	1422	1223	1130
MEAN AVERAGE	800	793.3	727	1701	683	712	681	1079	1013	986.5	850	772	793

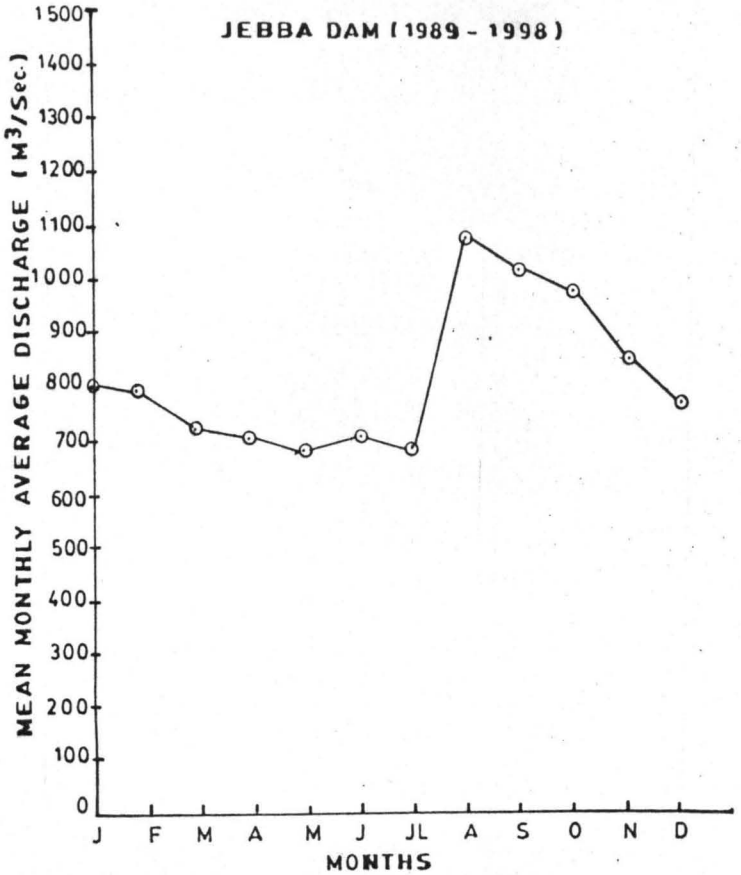


Fig. 14a MEAN MONTHLY AVERAGE DISCHARGE (M^3/Sec.) FOR TEN YEARS (1989-1998) AT JEBBA DAM (POST DAM).

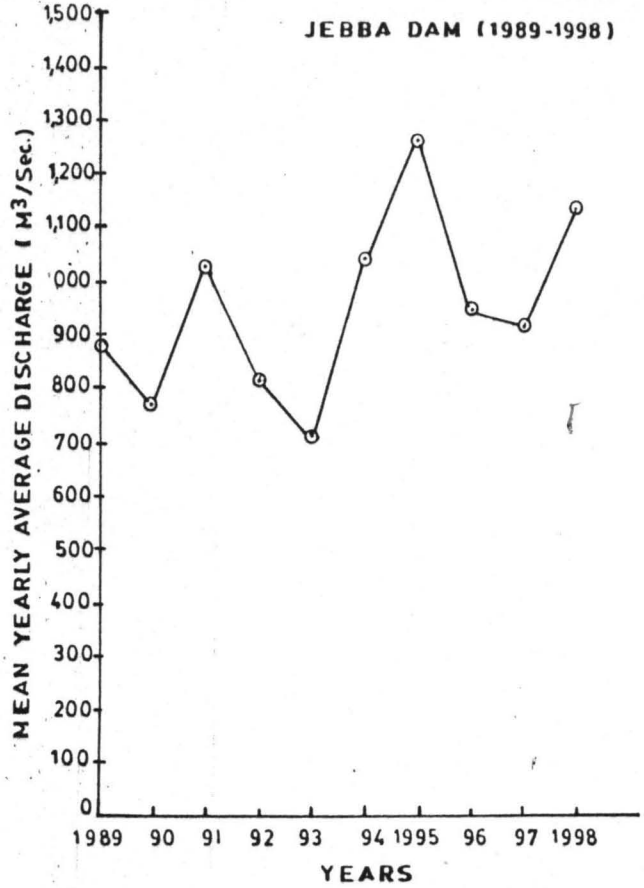


Fig. 14b MEAN YEARLY AVERAGE DISCHARGE (M^3/Sec.) FOR TEN YEARS (1989-1998) POST DAM.

TABLE (4b) SHOWS AVERAGE MONTHLY INFLOW M3/SEC

MONTH	92	93	94	95	96	97
JAN.	1018	840	676	1517	947	1135
FEB.	804	1029	781	1636	1023	1335
MAR.	741	1001	843	1422	969	1045
APRIL	785	881	839	1059	789	1093
MAY	741	603	747	1125	781	711
JUNE	872	402	637	1086	609	872
JULY	552	378	613	976	736	726
AUG.	470	445	1209	1308	861	553
SEPT.	817	959	3106	1358	1287	1119
OCT.	1019	736	3175	1413	1169	919
NOV.	1038	651	1469	1201	1003	742
DEC.	917	610	1263	1089	1045	738

4.6.0 FISH AND FISHERIES

4.6.1 GENERAL OBSERVATIONS:

The few general aspects of the fish and fisheries observed in the course of this study were the fishing environment and its activities. The fishing environment was observed to have been seriously affected by the dam construction. The river had been dammed severally and the watercourse had been shifted hence, the few fishing villages has to shift.

The fish fauna was affected as the irrigation intensities has reduce drastically due to the alteration in their natural habitat. There were also indications of the impact of the dam/reservoir on the fish trade.

4.6.2 EXISTING FISH FAUNA

It is a fundamental fact that after a lacustrine/riverine environment is formed, down stream, some fishes formerly existing in the water adopt and adjust

themselves to the new environment, while the remaining species gradually disappear and become replaced by different species.

During the course of investigation, the following species of fish were found to be common and put for sales by traders

TABLE (5) A SUMMARY OF THE FISH FAUNA SAMPLED AT THE DAM SITE AND COMMON ON THE STUDY AREA

FAMILY	GENUS	SPECIES
Tilapia	Tilapa Zilli	
Claridae	Clarias	Clarias anquillaris
Clchlidae	Oreochromis	Orechromis niloticus
Saratheradon	Saratheradon galilea	
Characidae	Alestes	Alestes baremose
Mochokidae	Synodontis	Synodotis Spp

These species were found to be abundant according to the order of listing them even though there are fluctuations, due to feeding, behaviour, fishing gear used seasoned fluctuations and intensity.

The Tilapia fishes comprised about 69% of the catches by number of each of the trader selling them to determine it. The author interviewed the trader and fishermen alike before arriving at this figure.

4.6.3 FISHING GEARS:

By the on the 'spot' assessment of the various gears used in cropping fish, the table below summarises of the gears, in order of importance and the intensity of potential fish cropped by each gear.

S/N	TYPE OF GEAR	NUMBER	%
1.	Cast net	70	22.72
2.	Hook and line	67	21.75
3.	Longline	54	17.53
4.	Traps	49	15.90
5.	Gillnet	38	12.33
6.	Beach seine	30	9.74
		308	100%

The result of the finding on fish gear use on Jebba dam was clear that cast nets were the most common and frequently fishing gear used by fishermen at the time of study. These gears were locally sources privately as government has hands off in subsidising and supplying gears to potential fishermen.

The fishing vessel in us includes, Fibre Boat, Canoe and Calabash some children are found using tubes down stream.

On the average, fishing activities are more pronounced in the study area. This has increased tremendously the generation of internal revenue base of the people in the study area. The issuance of tax receipt for the sales and cropping of fish, the revenue base of the local government must have been boosted through various fishing activities in the study area.

4.6.4 POST HARVEST HANDLING:

The post harvest handling can be subdivided into two namely: Immediate and Later post harvest handling. It was observed that fish landed, were immediately handled in various traditional and modern ways such as leaves wrapping, cleaning and washing, gutting, chilling and wholesome burning.

In the later post harvest handling, the following traditional methods were found to be commonly used – smoking, salting, smoking frying and other methods of storage by iced refrigerator and deep frizeers and electrically smoked.

4.6.5 SOCIO – ECONOMIC ASPECTS:

As a general observation and from quantitative analysis, it was found out that over 60% of the community within the vicinity of the reservoir were full – time fishermen of age groups ranging from under 25 to over 49 years. Out of this population over 22% combine fishing with arable farming.

The allowable draw drow of 4.0m has a great impact on the fishing activities.

The fishermen market their fish catch in Jebba town, Mokwa and Kpaki market respectively on a daily basis and this is done in the three forms: Fresh, smoked and salt – dried.

4.6.6 ASSESSMENT OF JEBBA DAM PROJECT ON FISH TRADING:

Total number of traders Engaged in fish trading before Jebba Dam Project in the study Area.	-	Total number of traders engaged fish trading after Jebba dam project in the study area

Total Number of traders
Engaged in fish trading before
Jebba Dam Project in the study
Area.

$$\frac{54 - 180}{54} \times \frac{100}{1}$$

233.33%
========

See plate 2 showing a group of fish traders in one of the villages downstream.

Source: Fish Traders Association Jebba.

4.7.0 LIVESTOCK:

The following livestock were found in the reservoir area under study: Cattle, Sheep, Goats, rabbits and Poultry (Chickens, Ducks, Geas and Guinea fowl). The major economics project derived from these animals include Meat, Milk, Hide and Skins, Poultry Eggs and animal manure.

The approximate population of livestock in the catchment area of the reservoir is presented in Table (7). The figures were obtained from the on the spot assessment and from response to administered questionnaire in the study area.

LIVESTOCK POPULATION BEFORE AND AFTER THE CONSTRUCTION OF JEBBA DAM AS OBTAINED IN 1998 DECEMBER.

LIVESTOCK	PRE –DAM	POST – DAM
Cattle	3,859	8,000
Sheep	2,979	6,675
Goats	2,005	4,700
Rabbits	500	600
Chickens	18,000	36,000
Ducks	2,080	5,060
Guinea fowls	750	2,500

From the above figures cattle constitute the largest groups of domestic ruminants in the area follows by sheep. The proportion of goats is just about half of that of cattle.

It is interesting to note however, that these values are closely related and in agreement for cattle, sheep and goats.

TABLE (8) PERCENTAGE CONTRIBUTION OF LIVESTOCK SECTOR TO FARMERS TOTAL INCOME (%) PROPORTION OF FARMERS (5) CONTRIBUTION TOTAL INCOME

0 – 25	6.62
25 – 50	31.61
50 – 75	42.04
75 – 100	19.73
	100%

The increase in the population of livestock in the post dam period can be linked with improve fodder, forage, water supply during dry season and more importantly due to the irrigating tendentious of the Fulani's cattle rearer down south during the dry season in search of variable grazing areas.

Most livestock farmers attested to the fact that the construction of the dam has reduced considerably the incidence of seasonal our irrigation from the area in search of greener pastures for their stock.

4.8.1 GRASS TYPE:

The vegetation of the area is purely Guinea savanna type as claimed in the introductory part of this work under vegetation tag (physiographic). The various species of grasses found in the area include: Hyparrhenia rufa (Jaragua grass) Hyparrhenia dissoluta, Andropogon gayanus (southern Gamba, Brachiaria brizantha, Brachiaria mutica, Imperata cylindrica (Spear grass) etc.

4.9 FARMING PRACTICES:

Agriculture is the second economic man stay of Nigeria after crude petroleum. The study area is purely an agrarian society. Result of the survey showed that prior to the commencement of the dam construction, farming in the valleys that stretched over 100km involved the production of Sorghum, Swamp

Rice, Maize, Cassava , Yam and Sugarcane. On the other highlands or higher grounds, Sorghum, Maize Millet (late), groundnut, Cowpeas, Cassava and Yam.

Vegetables such as Amarrathus Spp, Okro, Pepper and Tomatoes are equally grown under irrigation.

Crop rotation was the usual practice by farmers. Most farmers planted groundnut after harvesting Sorghum or Maize, maize after groundnut, yam after groundnut, Sorghum after yam etc.

Majority of the farmers used family labour for farm management while others used hired labour to compliment that of the family. The impact of the dam is mainly in terms of water supply for the irrigation schemes during the dry season.

The money accrue to the farmers from the sales of farm produce were used to buy some household needs or ploughed back into farming or other gainful economic activities.

It is interesting to note that almost all the farmers live in personal houses of their own taste.

4.9.1 OTHER SOCIO – ECONOMIC ACTIVITIES:

Economic growth is defined as an increase in per capital real income over time. On the other hand, economic development is defined as the process by which the real per capital income increases over time through changes in the quality and quantity of productive factors and the institutionalisation of the growth process. In particular, development implies not merely the growth, the development of infrastructures and administrative framework essential to sustained and cumulative growth.

No doubt, the construction of Jebba dam/reservoir (hydro – electric power) has affected the economic growth and more importantly, the economic development of the study area in particular and that of Nigeria as a whole.

The impact on socio – economic diversification cannot be over emphasised in the areas of industry, commerce and trade. A lot of large,

medium and small scale industries developed in the study area due to construction of the Jebba dam. These includes: Jebba Paper Mill, Jebba Paper Converter, Bacita Sugar industry, Sunil Sugar Industry, Coca-Cola depot, and a host of others such as metal works, furniture works, Fish smoking, Bakery and other confessionaires etc.

Going by the propulsive nature of both the power generated from the dam and associated industrial development that came into being, as a result it has open up a lot of economic frontier in the study area.

In effect, the economic diversification must have had a substantial revenue generation rate to both local and state government by increased revenue through tax deduction from the workers in the various industries, schools, hospitals, hotels, restaurants/canteens etc..

Revenue from registration of business premises will have been boosted.

4.9.2 POWER SUPPLY AND GENERATION:

Power supply is one of the major development inputs in harnessing fully the potentials of the natural resources endowment of a nation hence, the establishment of the Jebba dam must have contributed in no small measure towards the development and transformation of the entire national natural resources.

As a vehicle or engine of development, the rural areas linked with power supply from Jebba dam (hydro – electric power station) must have been transformed socially, culturally and economically, by open up development access via small scale industries and domestic trades.

The impact of such development is significant in the life of people in areas of curtailing the in flux of people into the urban centres. The mono –cultured nature of the rural economy is therefore diversified into a dual economy by having multiplicity of economic activities ranging from electrically propelled food processing and packaging industries.

ESTIMATING THE IMPACT OF ELECTICITY GENERATED BY JEBBA DAM HYDRO – ELECTRIC POWERS STATION

Electricity generated before Jebba dam + Electricity generated after Jebba dam Hydro power station

Electricity generated before Jebba Dam (Hydro – Power)

$$= \frac{760MW + 578.4MW}{760MW}$$

$$= \frac{1,338.4MW}{760}$$

$$= 1.761$$

$$= 1.761$$

With the increase of about 176.1 percent of electricity derived from Jebba dam hydro – power station as impact (positive) the problem of epilepic nature of electricity supply before the project has been solved by stabilizing the supply.

4.9.3 HOUSING:

In harnessing the potentials offered by Jebba dam a lot of people were attracted into the study area to explore the opportunity to their own advantage. The local jobs opportunities generated due to the establishment of the dam and other hydro –power related facilities made it possible for job seekers to migrate into the study area thereby increasing the population.

The unprecedented population explosion resulting from the influx must have had a great effect on the demand for housing.

To this end, the existing housing stock could no longer meet the ever increasing demand therefore, leading to housing stress and its attendants social cost and problems arising from stress of facilities, utilities and other social infrastructures.

Crime wave has increase due to the economic development of the area and more importantly, Jebba, the study area is almost the main point to most travellers from the north and equally from the south, hence most potential travellers use to have a stop over, either to eat, refuelling and temporary relaxation before taking up. Most hoodlums has taken the advantage of this to rob innocent people of their personal effects and cash.

CHAPTER FIVE

5.0 IMPACT OF JEBBA DAM (HYDRO – ELECTRIC POWER) ON THE ENVIRONMENT:

Simply stated "development" is the process or aggregate of processes aimed at improving the living condition and circumstances of human beings, both directly and indirectly.

If we take the word "environment" in its widest sense, then any form of development which involves the use of material resources, including man-made ones, space and amenities that constitute or form part of the milieu of our existence is bound to make some impact on the environment.

All such impacts can either have adverse or beneficial effects on the quality of the environment or the sum total of the resources comprised within it.

These impacts may be primary or secondary, short – term or long term, irreversible and Irretrievable impacts. For simplicity, primary impacts are cause generally by project "input" and secondary impacts are generally "project put". Primary impacts are generally easier to analyse and measure, while secondary impacts are usually more difficult to measure. Secondary impact may, in fact, be more significant than primary impacts.

For example, the primary impacts of the dam project will include a change in land use, land ownership, vegetative species, composition, noise of equipment, dust during land clearing, and more importantly, a change in electricity output. While the secondary consequences will be a significant reduction in a rare endangered wildlife species.

Moreover, secondary impacts are indirect or induced changes, and typically these will include the association investments and changed patterns of social and economic activities to be stimulated or induced by the project as it will be seen in the later part of the work.

Short – term impacts are those that are immediate impacts of short duration; such as noise, dust, erosion, flood application of herbicides to remove

undesirable species, but the long lasting or cumulative effects of these agents may permanently damage other vegetative growth or result in disruption of ecological balance.

The importance of given special consideration to both short – term and long – term effects is to enable us to assess the cumulative impacts of the project which either significantly reduce or enhance the state of the environment for future generations.

The "Irreversible" impacts apply primarily to non – renewable resources. Endangered species, fossil fuels, minerals, or wilderness situation through sub – soil exposure often involve Irreversible effects.

"Irretrievable" effects are the adverse effects on some value that will be lost and cannot be restored, such as an endangered or threatened animal that may become extinct, or destruction of unique habitats for wildlife, increase of freshwater flow into river Niger, changing the balance of fresh and salt water, change of flow of water in river Niger due to impoundment and Irrigation scheme down stream, change in labour and capital investments.

5.1 THE IMPACTS IN THE BIOPHYSICAL ENVIRONMENT

5.1.1 VEGETATION:

In fact, no component of the earth surface or landscape is more directly related to land use and environmental change as vegetation. Beside being the most visible and noticeable part of most landscapes, it is also a sensitive parts of the landscape that are mostly threatened during physical development projects such as Jebba Dam of great magnitude and other related human activities that are directly involved physical development.

In the biophysical environment, the secondary impacts of Dam/reservoir development can be especially important. For example, removal of vegetation spanning over one hundred kilometer (100km) which is the length of Jebba Dam can rather be imagined this has induced excessive soil erosion in and around the vicinity of the study area and more importantly led to sedimentation in the

receiving Niger river even though of a smaller magnitude due to Kainji Hydro – power station up stream.

Notwithstanding, this will in turn reduce the amount of sunlight that can penetrate the water, hence reducing the dissolved oxygen (02) in the ater (H2o). As a result caused an adverse effect on the aquatic life and the water quality of the river. The mere fact that vegetation plays a functional role in the landscape such as controlling of run off, soil erosion, slope stability, micro – climate and noise these has been impaired due to mass clearance of vegetation during the construction process.

For instance, under barrier – free conditions, the level (magnitude) of sound from a point source decreases at a rate of six decibels with each doubling of travel distance. Placed in the path of sound, and vegetation absorbs and diverts energy and is somewhat more effective for sound in the high frequency bands (those above 1000 – 2000 hertz).

In forests the litter layer (decaying leaves and woody materials) appears to be most effective in sound absorption but it is regretted that these functional roles played by vegetation can no longer be achieved due to the incursion of the natural vegetation by the influx of cattle rearers, farmers and other categories of people into the study area in a bid to meet their livelihood.

5.1.2 CLIMATE:

Climate is a by – product of the complex interactions between the atmosphere, hydrosphere, cryosphere and lithosphere. The atmosphere is the envelop of air that surrounds the earth, while the hydroshpere represents the water portion that occupies about 70 percent of the earth's surface. The cryosphere is the mass of frozen water substance (e.g ice sheets, glaciers, pack ice and snow), and the lithosphere is the land surface.

The climate directly influences most economic activities, and these have measureable effects on atmospheric circulation which in turn, affect climate (feed back) mechanism.

The climate is equally linked to all of Earth's other systems through the transfer of energy and matter.

There is increasing evidence that humanity, in its restless pursuance of economic growth, is contributing significantly to the problem via clearing of vegetation, bush burning, erosion, flooding and emissions of various gases of different grades. The atmosphere, oceans and land are all beset by problems resulting from human activities such as the construction of dams and reservoir, the ultimate effects which remain uncertain but pregnant with catastrophe.

Our planet Earth is surrounded by a blanket of gases which enables it to act like a green house. A green house keeps the inside temperature warmer than it would otherwise be.

In a similar manner, certain gases, like the "green house gases" (GHG) which are present in the atmosphere in only small quantities, prevent some energy received from the sun re – escaping to space. They trapped re – emit long – wave (infrared) radiation emitted from the earth. This natural phenomenon makes the surface of the earth about 33°C warmer than it would otherwise be and allows life forms to exist as we know them.

The trapping and re – emitting of heat by these gases in the lower atmosphere is referred to as "greenhouse effect".

The major natural green house gases include water vapour, carbon dioxide (Co2), methane (CH4), Ozone and nitrous oxide (N2o).

While the greenhouse effect is a normal component of nature, there is a general concern about the rapid increase in the last decades due to human activities, especially the burning of fossil fuels. For example, the atmospheric concentration of C02 was only about 280ppmv at the pre-industrial period compared to 315ppmv and 356 in 1958 and 1993 respectively.

Relating the climate change or modification to the study area, the trend of climatic parameters over the last ten years depict a tremendous alteration from what its use to be in the pre-dam period.

The post-dam period shows dearly that there is a great impact of the dam on climatic parameters and subsequent variation as shown in temperature, relative humidity, evaporation and rain fall.

5.1.3 HYDROLOGY.

Generally, dams radically alter river hydrology upstream and down stream. In effect, permanently (i.e for the life span of the dam) create a high level and artificial types of aquatic environments. This novel environment is characterised by the nature of operation of the dam in question. Put in another form the characteristics of these novel environments are determined largely by the operation of the dam.

As mentioned earlier in the introductory aspect of this study, the study area lie within the basement complex rocks area of Nigeria. The rocks are typified of hard massive granitic rocks which are intruded into older rocks which are mainly schistoes. The nature of the rocks make them potentially poor aquifers for underground water storage.

But with further geological activities such as folding, shearing fracturings folding and weathering may however improve their capacity as reservation rocks.

The study revealed that water is stored in either the weathered zone or fractured zone.

Alluvia channels of rivers are another source of ground water exploitation. Ground water occurrence is in small geological sub – basin in the study area.

Mainly in the valleys, troughs through which rivers flow and in fracture zones. The hydro – geology of the study area cannot be adequately studied due to lack of relevant data. Therefore, there is the need for a detail work, which should involve monitoring or observation of borehole drilling and the subsequent data collection.

On a general note, the survey of existing ground water situation shows that hand dug wells are few due to the nature of the nature of the topography of the area.

See plate ..... showing the nature of the relief of the study area. The gradient of the slope is high as the whole environment is characterised by undulating and steep slope.

Most of the hand dug wells are shallow and in the neighbourhood of 6 – 10m, while water levels range 7 – 9m. The hand dug wells tap their water from either the zones of weathering or alluvia basins.

5.2 THE IMPACT OF DAM HEATING ON WATER QUALITY

Throughout history and from wealth of experience it has been confirmed that generally, reservoirs result in many improvements in the quality of water for most domestic and commercial uses. Among the major beneficial effects of impoundents are reduction in dissolved silica, evening – out of variations in dissolved minerals, hardness, PH and alkalinity, reduction in bacteria count and reduction in biochemical oxygen demand (BOD) and turbidity.

These changes are usually associated with increases in alga growth and carbondioxide and often-dissolved Iron (Fe) and a reduction in dissolved oxygen in deep water.

Indeed, change in temperature is one of the major mediators of changes in water quality in reservoirs.

Thermally stratified's reservoirs often have a large effect on the quality of the water discharged. In hydroelectric schemes such as Jebba dam (hydro – power) is characterised by bottom discharged usually of stratified water, the following problems are noticed and prevalent down stream:

a. High levels of hydrogen sulphide that create odour problems.
b. High level Iron (Fe) and manganese(Mn) contact also created treatment problems when down stream water is used for water supply.
c. High level euthrophication down stream de to lost of essential nutrients;
d. Low level dissolved oxygen demand (BOD) down stream is released.
e. In several occasion, hydrogen sulphide laden water is released, killing fish down stream.

5.3 IMPACT OF THE DAM ON BIOLOGICAL ENVIRONMENT (BIOTA)

The effect of reservoir heating on Aquatic Biota cannot be over emphasised. The changes in habitat that are wrought by dam construction and impoundment of free flowing water river bring about great modifications in species composition, population density and areas utilised by various species of fish, macrobenthes and floating planktonic organisms.

These changes are brought about indirectly by modifications of some environmental parameters such as water a, level of dissolved oxygen and mineral content that forms the success of one species or type of organism over another and by fluctuating water levels.

Jebba dam/reservoir is one of the strongly stratified dams, hence the biotic community found within reservoir and around the catchment areas developed purely on the influence of the thermal regime which has influenced the living conditions in the bottom water.

Numerous mechanical phenomeral such as specific grantly, riscosity, turbulent eddy diffusion inflow – out flow and internal seiches that are found to be temperature dependent had considerably influenced plankton stratification.

In the study area it was discovered that in the succession among the plantonic algae predominate during the rainy season while blue – green algae predominate during the dry season.

At Jebba dam where average water depth is 12m and the maximum depth is 65m near the dam, stable thermal stratification is established annually from February to May and in several years strong sulphide odours persist in March and April, which is evidence of strong thermal stratification.

During this period, oxygen concentration drops rapidly to near zero creating problems of growth of sulphur bacteria in the down stream sedimentation in the intake water to the turbines.

More importantly, turbine discharge is deoxygenated at this time and the water released down stream remains devoid of oxygen for about a distance up to 1 km before it picks up adequate oxygen from the air.

The negative impact is that fishermen have to abandoned this water from February to May even though at other period of the year, the stretch is fished and fishes are cropped.

5.4 IMPACTS ON SOIL

One of the most striking environmental impact encountered during the process of construction of dam is the exposure of sub – soil in and around the river chatchment area.

This is largely because several factors easily lead to this exposure. It includes erosion frequently caused by water or wind due to the removal of vegetation. The serever erosional process resulted into loss of the valuable shallow top soil of vast agricultural land thus leaving the sub soil.

The constant cultivation practices embarked upon by the farmers and moreover, the deep tillage system that characterised such system on a particular area will on the long – run lead to exposure of the sub – soil, forming a long – term impacts.

This situation has greatly been enhanced particularly with the introduction of heavy equipment employed during the cultivation and land excavation processes. The heavy equipment used had churned the soil so thoroughly that the shallow top soil chrucked beneath the sub – soil which would subsequently be exposed.

Now, when all these processes of sub – soil exposure happen, the resultant exposed subsoil constitutes a big problem. The reason is that subsoil pre –se is very in suitable for crop production.

Bear (1965) pointed out that subsoil is "raw". This rawness in semi – humid region is largely due to lack of organic matter in them, with resulting low supplies of nitrogen and available phosphorus for plant use.

In humid regions there is the additional possibility of toxicity from reduced forms of Iron (Fe) and manganese (Mn) when tight day sub soils are brought up to the surface. Such toxicity may continue long enough to be injurious to plants especially young seedling.

Album University test (1965) revealed that acidic subsoil will definitely allow little root penetration but rather when lime is present root seem to take off from deeper moisture, and this is an added cost (a negative impact).

Cunninggham (1963) worked on exposed soil and found out that much organic carbon (C), total nitrogen (N) and organic phosphorus (P) was lost from soils fully exposed. This was attributed to increase in soil temperature which hastened the rate of decomposition. If however, the soils are exposed for a ling time (about 5 years) it will produce less mineral (N) Nitrogen and has smaller caution exchange capacity, exchangeable cautions – especially K and lower PH than shaded soils.

Hence, cover crops are recommended to prevent soil being exposed all the year round.

Exposure also compact soil, impede drainage through significant layer and will makes the soil erode more easily.

Again, Batchelder and Jones (1972) worked on top soil and exposed subsoil and reported that exposed subsoil are infertile and have low available water retaining capacities.

Surface soil removal often expose large areas of infertile subsoil deficient primarily in Nitrogen (N) and phosphorus (P) and some micro – nutrients especially Zinc (Zn). Some exposed subsoil shrink and crack severely during which infiltration is improved but decreased evaporation.

In addition to physical factors, chemical problems such as excess acidity, Al, Mn, which can be detrimental to root growth in acid subsoil often result. Therefore, caution should be exercised while applying chemical fertilisers. The soil should be tested to know the actual nutrients land amount to be applied to

the soil before embarking on fertiliser application. The timing and method of application is equally very important to avoid turbidity and acidification of the soil.

Following intense rains soils loss is often severe in exposed subsoil, particularly if unmulched. This is definitely due to poor aggregate. The amount and the location of run off has been greatly increased due to the exposure of the soil to the agent of denudation through over – grazing and continuous cultivation by the use of heavy machinery. As a result the water quality of return flows with regard to nutrient loading, dissolved oxygen, temperature, herbicides, total solids, salinity, sediment loading and turbidity of the river down stream and increased tremendously.

Some stream beds have also been widened due to surge of flood water during the rains. It is recommended that preventive measures to prevent and control water logging, salinisation and alkalisation be introduced and integrated into the water-shed management. Such measures should include the establishment of shelter belts, scattered farm tree models, wooded lots, alley cropping and more importantly establishment of permanent cattle ranching scheme.

5.5 SOCIAL IMPACTS:

It was observed in the course of this study, that Jebba dam has influenced positively the socio – economic potential of its catchment area in many diverse ways.

Quite a great number of the rural dwellers has been benefiting directly and indirectly through the provision of water for domestic uses and through abundant supply of fodder for their livestock. The availability of good quality water and pasture all the year – round as indicated by most farmers interviewed has a significant impact in the performance of their livestock in terms of faster growth rate, higher milk yield, good quality products, improved reproductive performance and high level reduction in incidence of diseases (through water supply) as other major benefits of the Dam.

Worthy of mention is the boost to fishing activities, these and many other related water activities has been harness fully and consequently higher financial benefits and returns from sale of livestock, fish, packaged iced water and other allied products from farm produce has be achieved tremendously through dogged determination of the dwellers within the vicinity of the catchment area.

5.5.1 EFFECT OF VEGETAL COVER REMOVAL ON SOIL:

As rightly indicated in the earlier part of this study, the vegetation within the reservoir was cleared some years or decades back and the displaced villages moved to the outskirts of the dam area down stream area and also cut down the vegetation in and around them for farm operations and fuel wood. These activities have generated and initiated sheet and rill erosion in these areas. Various streambeds have also been widened due to frequent surge of floodwater during the rains.

5.5.2 MIGRATION OF PEOPLE TO THE STUDY AREA:

The influx of people migrating to this area on annual basis after the dam construction have also been increased judging from the conglomeration of settlements characterised by diverse ethnic groupings in Nigeria.

Consequently, more of the vegetation around the reservoir will be cleared for farming, other economic activities and more importantly for fire wood due to the excaviating price of domestic fuel such as kerosine.

There will also be more migration of the cattle Fulani's especially during the dry season into the area. The impact on soils will be enormous as the structure of already fragile soils will be destroyed giving rise to erosion and sultation of even the reservoir and streams and also heavy leaching of soil nutrients. Trampling of the soil by the cattle will equally result in high soil exposure as earlier discussed.

5.5.3 FUEL WOOD CONSUMPTION:

A great number of the inhabitants of Jebba and surrounding villages depend heavily on firewood for domestic fuel use. This has exacerbate intensive deforestation to meet both the domestic need and for sales.

Women search for fuelwood for cooking and for sale. This has pushed the trees and shrubs in the area to the critical limit of survival. Fuel wood falls within the categories of exhaustible renewable resources or critical zone renewable resources. This category represents the resources that are renewable if the rate of cropping does not outweigh the rate of natural replenishment.

If the rate of cropping/deforestation is higher than the rate of natural afforestation/replacement then the forest may not return and consequently lead to desertification.

This is rampant and evidently shown in the area as women could be seen carrying firewood from the surrounding of the town.

In Jebba and other villages along the highway in the study area, piles of firewood are very ubiquitously displayed for sale (doted and decorated the major highway).

Some buyers comes from nearby towns like Ilorin, Ogbomosho and Ibadan since Jebba is situated along a Federal road which encourage inter state business between the town and other towns outside the state. See plate ..... a vehicle conveying firewood from the study areas.

Firewood though cover a low percentage of the business activity along the road compared with the sales of smoked fish but it is very prominently displayed as an indication of aggressive deforestation in the area.

As a mitigating measure, aggressive afforestation therefore should be embarked upon in order to forestall desertification encroachment which may later lead to the depletion of the popular ozone layer.

5.6 IMPACT OF IRRIGATION SCHEME AROUND THE DAM ON THE ENVIRONMENT:

The primary goal of any irrigation is to maintain balance in the moisture content of the unsaturated soil zone, most especially the root regime within the range in ensuring optimum crop yields. The modification of the moisture content due to irrigation may, however, immensely alter the hydrological cycle quantitatively and qualitatively.

The changes caused by the alterations of moisture of the root zone over the years include the following:-

a. **Modification of the atmosphere branch of the cycle:** The addition of water vapour in the air has produced clouds formation and consequently increase precipitation effectiveness of the study area. This is evident in the rainfall data collected and analysed over a period of ten years (1989 – 1998). Likewise the humidity (relative) of the area has been enhanced see figure 9(a) – (J) showing the trend of relative humidity since 1989 to date. Generally the trend has been attributed to the increased water body due to impoundment.

b. **Modification of ground water regime:** The development of horizontal ground water flow from the irrigation lands raised the water table of the later. The irrigated soils and transportation of silt by ground water flow accelerates salt accumulation under the called dry drainage areas.

c. **Modification of surface run – off:** Increase in the amount and intensity of catchment runoff results in higher erosion potential and greater sediment transport control of river discharge by reservoir (dam) and the reduction of solids transported in streams because of reservoir retention, results in deterioration of river beds due to settling sediment transportation. The settling of suspended load in dams causes not only a reduction in the available storage capacity but also removes a significant part of plant nutrients from the water.

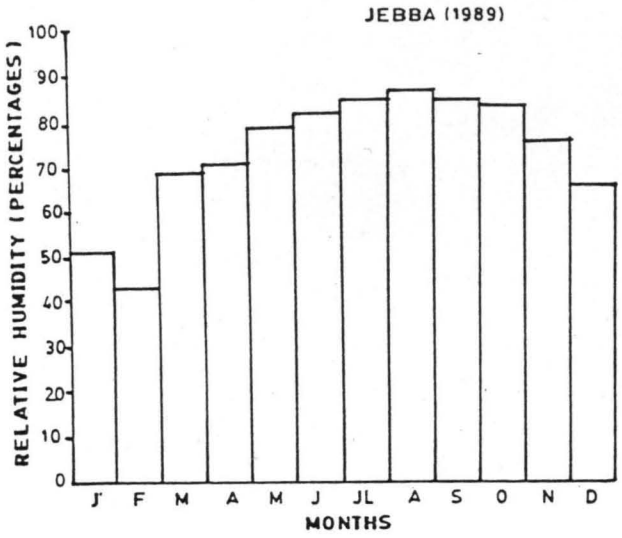


Fig. 9a HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

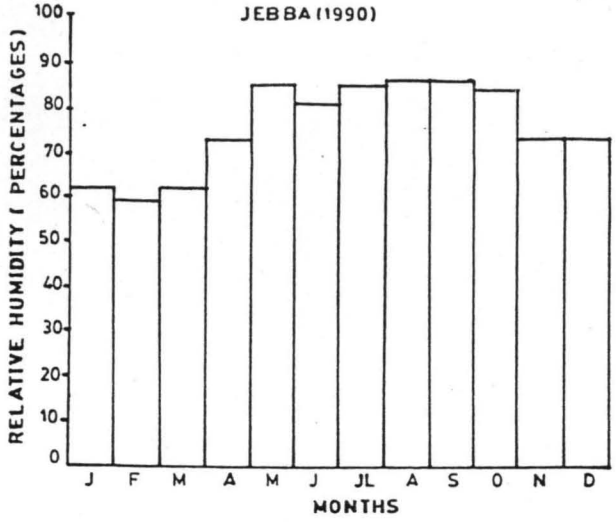


Fig. 9b HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

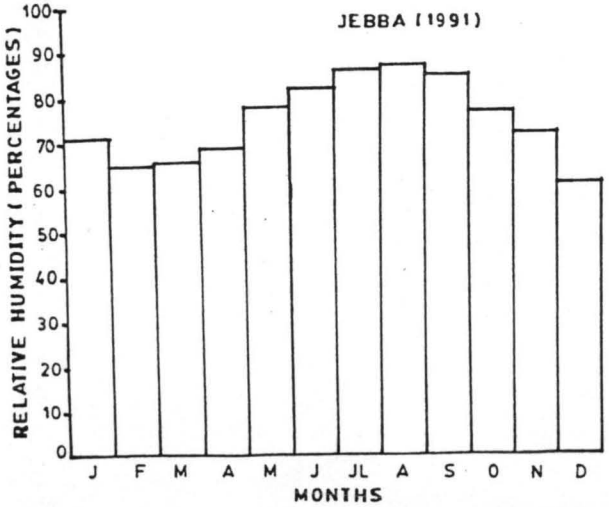


Fig. 9c HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

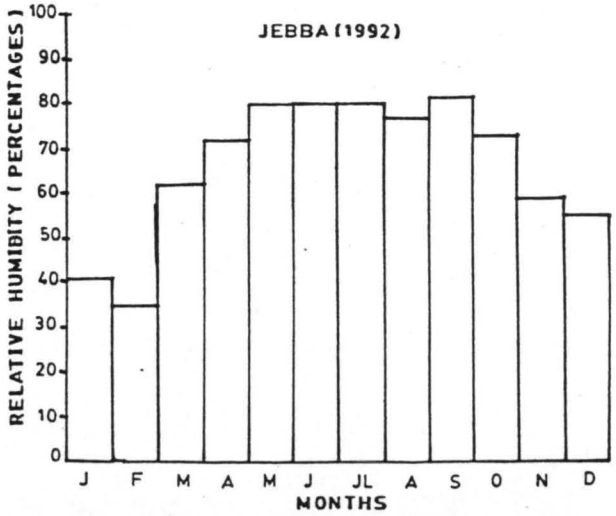


Fig. 9d HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

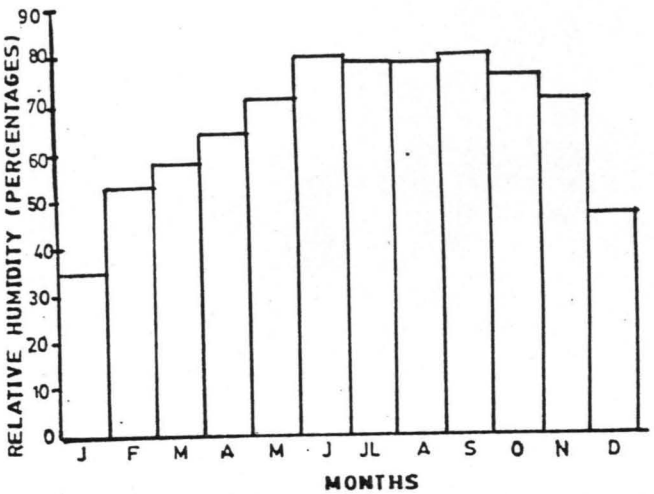


Fig. 9e HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1993)

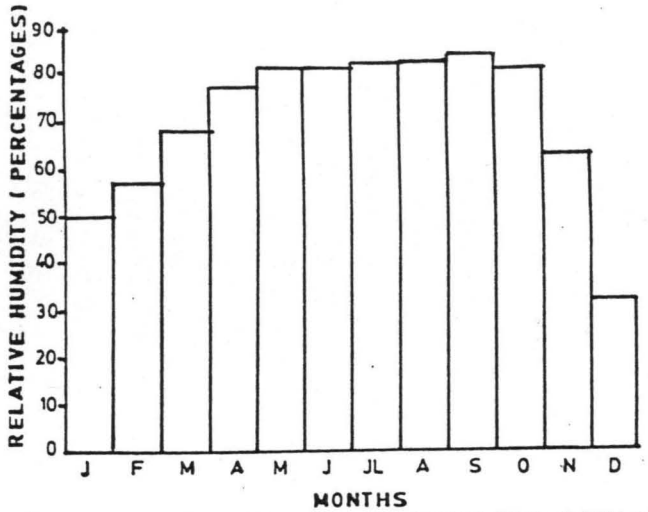


Fig. 9f HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1994)

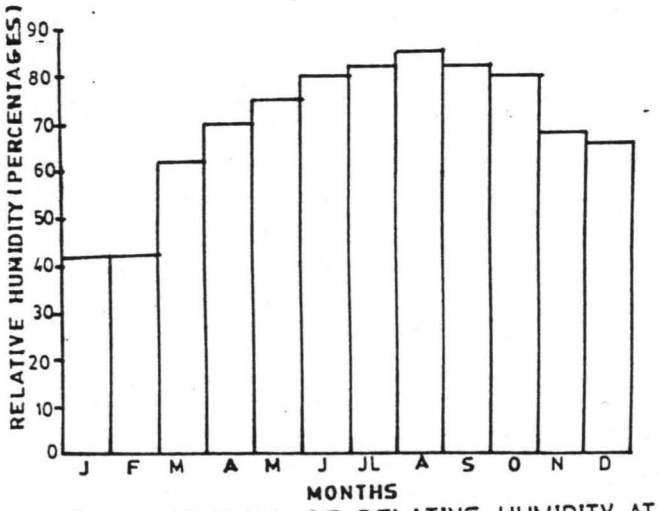


Fig. 9g HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1995)

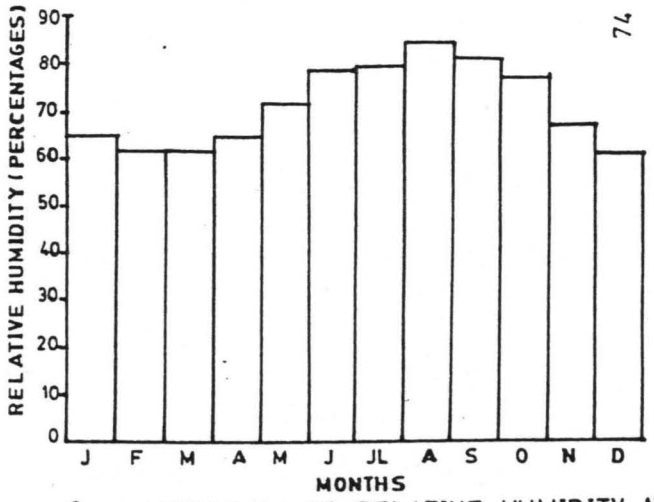


Fig. 9h HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM (1996)

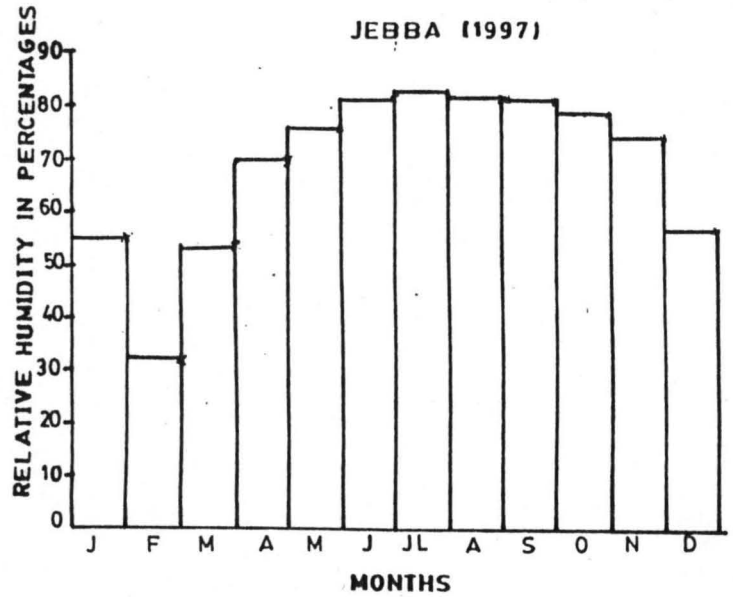


Fig. 9i HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

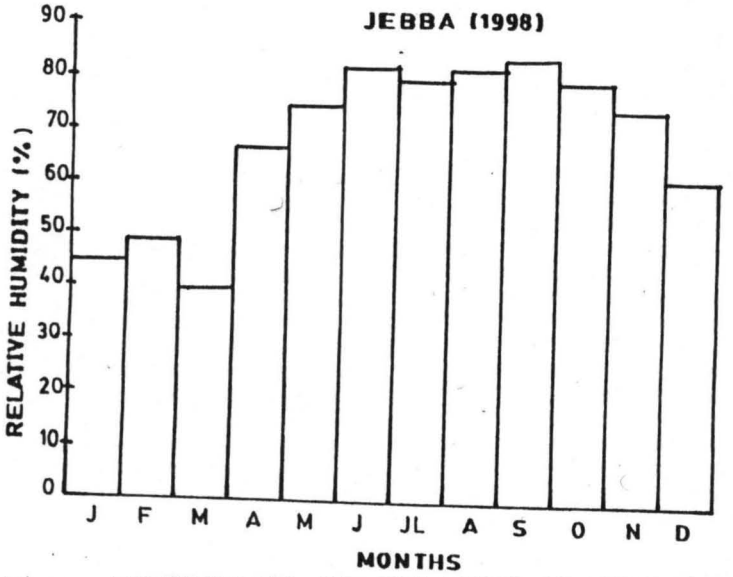


Fig. 9j HISTOGRAM OF RELATIVE HUMIDITY AT JEBBA DAM

d. **Modification of water quality outside soil moisture zone:** Soil concentration increase during storage, conveyance and distribution of water due to evaporation. Potential qualitative changes include change in temperature and suspended load, pollution caused by nutrients and pesticides from surface runoff and by salts transported by water percolating into the canals, and deterioration caused by the affluent of the drainage system.

5.6.1 IMPACT OF IRRIGATION ON NATURAL VEGETATION AND WILD FAUNA:

The irrigation scheme embarked upon due to the available of water from the dam during dry season has given rise to a disturbance in the natural vegetation, flora and fauna. Hydrophyllous plants has been on the increase in the area as well as large varieties of other weeds that appeared and flourished due to improved soil moisture via irrigation. This has also caused disturbances to wild fauna. Animals such as wild pig and deer often disappear and wild ducks has increased. The population of birds such as sparrows, pigeons, doves etc also increase. Some perennial weeds, such as cynodon dactylon, cypenis rotundus and convelrulus species are common, some in-sect pests such as corn stock borers, stem borers and vegetable leaf worms are prevalent.

5.6.2 IMPACT OF IRRIGATION ON PUBLIC HEALTH:

The establishment of the irrigation scheme has rendered the whole area more vulnerable to diseases. Irrigation water can serve as transfer medium and a habitat for vectors and intermediate hosts. Good farm management can reduce the infestation,

The positive impact is that all the year – round vegetable and other crops that are grown under rain fed agriculture are made possible during the dry season thereby increasing the good diet of the inhabitants.

The increase yield and consequent good financial returns from the sales of the produce has increased in income of the individual farmers involved and equally enhanced the revenue base of the study area.

Employment opportunity is also an added advantage.

5.7 POSSIBLE IMPACT OF FAILURE OF DAM ON THE ENVIRONMENT DOWN STREAM:

The majority of dams in Nigeria are earth embankments. Furthermore, there has been an appreciable increase in the planning and construction of embankment dams as a result of the establishment of the River Basin Development Authorities (RBDA).

The most serious negative effects of dam construction is usually associated with dam failure. For instance, the incident of Bagauda Dam along the tributary of River Kano in 1986 caused untold hardship to the settlers downstream which brought about a great loss of properties.

Tiga Dam (incident) occurred in 1970. The dam was equally constructed on River Kano. Zobe dam incident occurred in May 1983 built on the Karaduwa river in Sokoto. All the incident resulted in the relocation of people with its attendants socio – economic problems and pyshological effects.

In summary dam failure may be due to the following factors:

- Slope instability due to build – up of excessive pore pressure, rapid draw – down or construction materials having inadequate strength; Jebba dam at present has allowable draw – down of 4.0m. The normal rating level is 103.0m.
- Over topping of the dam due to inadequate spillway capacity, impact operation of spillway gates or unusual flood events;
- Excessive erosion of the downstream slope as a result of heavy rainfall;
- Excessive, seepage and piping through pervious foundation not properly treated or protected;
- Internal erosion of fine grained soils in the embankment.

- Excessive or differential settlement of the dam and of the foundation;
- Other causes of failure in embankment dams are those related or due to earthquake, landslide, mining etc. but they are less frequent.
- Human errors should not be overlooked as a contributing factor in dam failure.

Human errors are manifested in inadequate design, improper supervision of construction, erosion flood estimates, inadequate pre – construction investigation; wrong decisions in the use of materials, improper evaluation of the results of field investigations.

In all three major failure situations are notable:

a. Construction failures;

b. Failures at initial impounding (Dam newly completed) and

c. In – service failures.

The failure mechanism likely to occur during construction is that caused by (slipsand slides) called share.

Share failures may cause instability in the embankment slopes which may involve the foundations.

An embankment may fail at initial impounding. In this case, failure may be attributed to excessive seepage and leakage through the embankment and its foundation. Share failure may also occur as in the case during construction.

Earth dams will deteriorate with age in service. The magnitude and extend as fast as to lead to a failure. In – service failures may be ascribed to the various factors earlier mentioned. There could be serious settlement arising from primary consolidation of the core and also from poorly compacted fill after initial impounding. Moreover, crest settlement slopes (slope instability).

Failure of dams in – service may be due largely to internal erosion. The actual scenario of failure of a particular dam is a complex process but the failure may be initiated by one or a combination of the above principal causes.

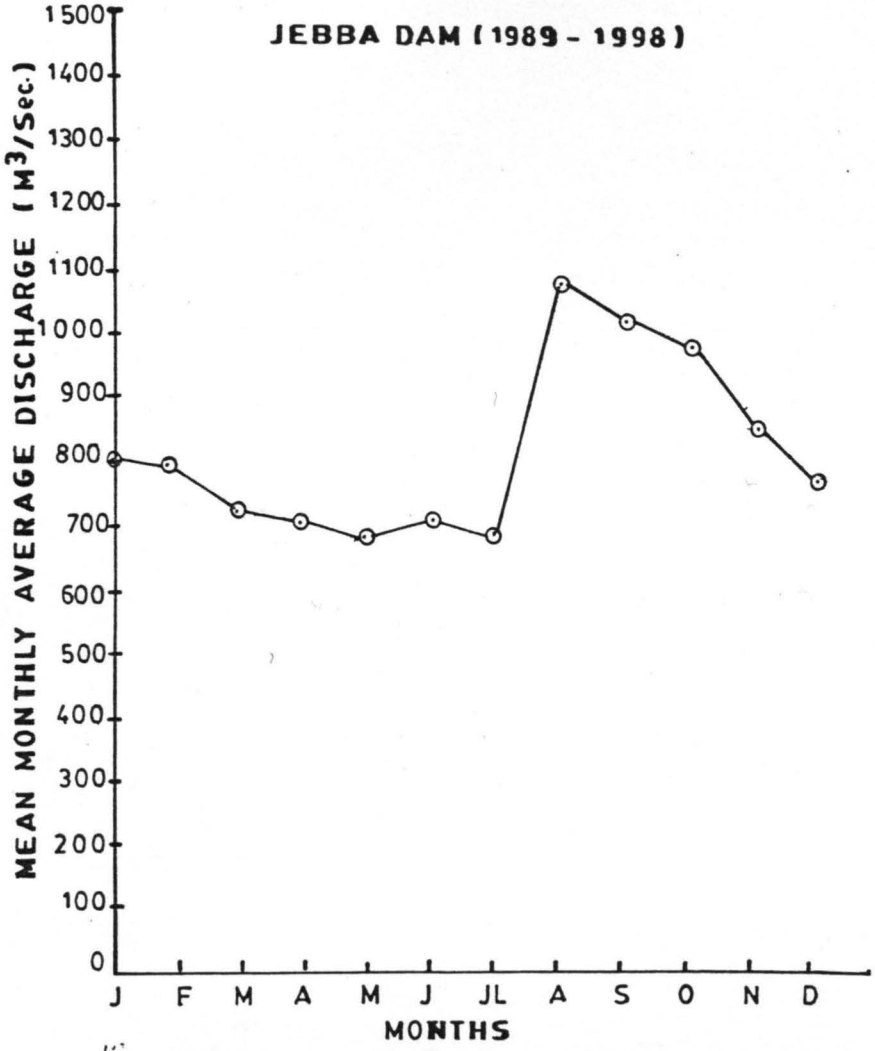
Jebba Dam has a useable storage capacity of about 1.1 billion (M^3) while the live storage is estimated to be 3 billion (m^3) of water.

The tail water as regards maximum flood is about 83m while the minimum is 73m. Under a normal state, the normal height is 77m. The full power house discharge is put at 75m. On the average, the mean monthly, yearly and average discharge at its peak is 1090m^3/sec and 1,260m^3/sec. See figure 14(a) and figure 14(b) respectively.

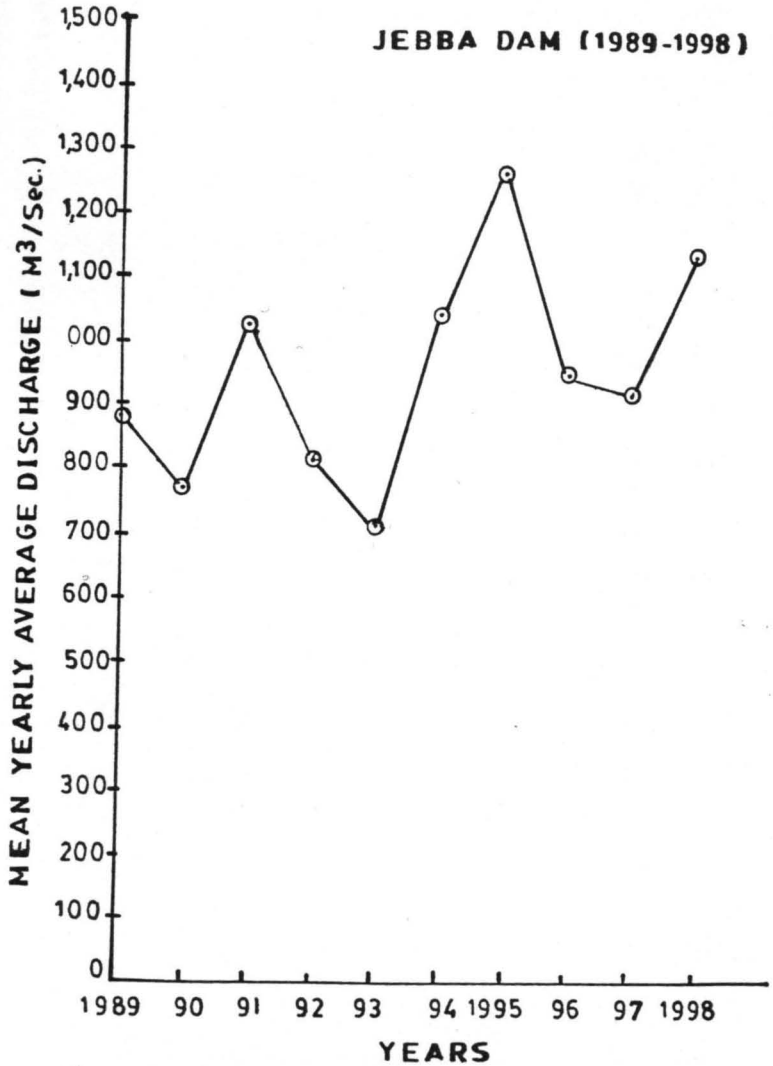
In event of collapse of the dam, a flood of about 3 billion m3 will be released. Between the dam and River Kaduna at Nupeko, the flood will move on a slope of a very high gradient this will be further enhanced by the water from river kaduna in short the impact will be felt in all the catchment area of River Niger even to the deltal area. Since other tributaries of River Niger down stream and that of River Benue will contribute to the increased volume of water hence, the tendencies of having more flood able area down stream will be so high.

Consequently, the damages and loss of property along the river course will be of great magnitude.

This will lead to loss of flora and fauna down stream and greater economic loss.



Fig·13a: MEAN MONTHLY AVERAGE DISCHARGE (M^3/Sec.) FOR TEN YEARS (1989-1998) AT JEBBA DAM (POST DAM) ·



Fig·13b: MEAN YEARLY AVERAGE DISCHARGE (M^3/Sec.) FOR TEN YEARS (1989-1998) POST DAM ·

CHAPTER SIX

SUMMARY OF MEASURES OPEN TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

6.0 DAM FAILURE:

Due to the scope of this study, hydro-chemical analysis could not be carried out due to the colosal amount of its financial capital outlay. The importance of chemical analysis is that it reveals the actual mineral presence and deposits upstream of the dam which when dissolved in water might have a strong chemical reaction with the concrete used in the dam construction and this affect the safety of the dam.

It is imperative to establish a routine monitoring of the stability of the dam in order to guide against unexpected catastrophe that could cause untold damage to lives and properties.

This may involve the use of remote sensing equipment to detect any fault in the geological, hydro-geological and structural settings which are usually fairly complex in nature.

The nature of jointing or fracturing, the presence of pegmatite dykes and the occurrence of gneiss-schist inter bedded zone, are areas prone to failure and hence, should be given prime consideration and attention, particularly at the foundation level.

Aggressive afforestation through shelter belt establishment around the reservoir to check excessive run-off and possible sedimentation.

6.1 ANIMAL LIFE.

The population of game animals around the dam is on the decline. This is due to access created during vegetation clearing for transmission lines through intensive hunting.

A vigorous survey of game animals (birds and animals) and their habitats should be carried out with a view to rehabilitating some species that are almost extinct.

Nile monitors (Varanus exanthematicus), Savanna monitors (varanus niloticus) are notable reptiles that migrated to the dam area for good habitat. These reptiles should be allowed to reproduce to the optimum level before their cropping could be done.

Mammals such as Bush pig (Potamochoerous porcus), Grasscutter rat (thryonomys Sp) Bacts (various genera and species), Roan antelope (Hippotragus equinus) Monkeys black and white colobus (colobus polykomas) etc should be conserve and rehabilitated for proper game reserve and wildlife tourism.

Recreation and educational use by local residents is an important function of those protected tracts of habitat that are located at the extreme western corridor.

Families can go there for picnics and other social outings. School groups can visit the dam area and the natural habitat (parks and other protected areas in order to learn about local fauna and flora, to be introduced to the subjects of biology, ecology, geography, sociology and engineering and many other topics related to the region.

6.2 WASTE WATER MANAGEMENT:

- Protect public health (with emphasis on control of the disease vectors associated with Schistosomiasis, Onchoceraasis, Desyentery, and Malaria etc.
- Protect the aesthetic characteristics of the water courses by maintaining stream flows and quality.
- Minimize the impact of runoff from urban, agricultural, and other man – made uses of the land on the stream system.

- Provide water quality management facilities effectively free of nuisance conditions.
- Minimize (in as much as it is impossible to eliminate) the operational, maintenance, and replacement cost liabilities in any technologies selected for water quality management.
- Anticipated some of the long – term water quality effects of urbanization in the surrounding villages and Jebba town and more importantly, on the Lokoja reservoir planned for development down stream.

6.3 SOIL AND AGRICULTURE:

It is recommended that urgent measured be taken to combat desertification through aggressive afforestation programme.

The problem posted by sub – soil exposure should be tackled with equanimity. This can be done by preventing and controlling water logging salinisation, and alkalinisation, by reclaiming deteriorated land; by improving irrigation and drainage system; by modifying farming techniques to increase productivity in a regular and sustained way, by developing new irrigation and drainage schemes where appropriate, always using an integrated approach; and through improvement of social and economic conditions of people dependent upon irrigation agriculture (United Nation's,1977).

Farmers must be educated about the evils of tree felling coupled with over grazing. They must be encouraged to plant trees possibly of economic importance (fruit trees of some kind) to serve as wind breakers to prevent wind erosion.

There is need for cooperation between aquatic biologists, hydrologists, engineers, economists and agriculturist at all stages of planning, implementation and management of irrigation systems programmes to handle potential aquatic problems must be incorporated in the project planning and management proposals.

This makes the study relevant to engineering. In irrigation schemes, efforts should be geared towards preserving and propagating beneficial flora for a sustainable development.

6.4 FISH LIFE:

Once there is a dislodgment in the natural environment, fish fauna and water quality in and around the inundation site are mostly affected.

The likelihood of predator fishes establishing themselves especially the clarids and the herbirorous cichlids are high.

Therefore, a possible recolonization by the fish from the rivers in the following stages are open.

a. Feeding and breeding only in the rivers;
b. Feeding and breeding in dam and rivers
c. Breeding in lakes only feeding in lakes according to corbet (1961) and
d. Feeding and breeding in dam and river only.

Fishing activities would peak up and then decline in response to the instability of the fish fauna. This world have direct bearing on the socio – economic activity of the fishing community.

The above problems could be ameliorated through the following measures:

i. By providing a fish gate for fishes to migrate downstream for either spawning or feeding.
ii. By allowing fishermen to have free access to the dam only at open seasons (to be determined by the authorities)
iii. Provision of viable Ranching would be an effective way to replenishing dwindling stocks.
iv. Introduction of hybrids fish into the reservoir for breeding and feeding

Monitoring and checking of the linmological parameters at regular intervals should be carried out to forestall the problem of euthrophication and ensure the conditions remain optimum for fish production.

6.5 SOCIO – ECONOMIC IMPACT:

The Jebba dam has created an enabling environment for revenue generation and more importantly led to the urbanization of Jebba town even up to Mokwa and Bode – Sadu in Kwara state.

One of the major effects of the project on the social and economic life of the people within the catchment area is the availability of water for domestic, industrial, agricultural and animal consumption.

To crown it up is the generation of electricity, which has, created a centripetal and centrifugal forces in area of trade, industrial development and urban development.

The problem associated with urbanization in developing world include: Transportation problem, Housing, in terms of congestion, overcrowding, sprawl development, drainage problem, waste disposal and generation problem, crime wave, fire hazards and a host of others.

These numerous problems could be addressed through harmonious and proper planning of the various land uses in our urban development.

Proper waste management planning and control will make the environment a better place for living, playing, working and recreating.

In a nutshell, table 9 shows the summary of responses of the various households interviewed towards the effects of Jebba dam.

Gladly enough, the positive impact on the average out numbered the negative effects base on strong economic term. On the whole, the general well being of the people in the catchment area of the reservoir have been uplifted economically and socially.

TABLE (9)

SUMMARY OF RESPONSE TO THE EFFECTS OF JEBBA DAM

Effect	Response	Frequency	(%) Per.
Occupation	Yes	67	87.3
	No	8	10.7
Occupation	Positive	70	93.3
	Negative	5	6.7
Income	Yes	70	93.3
	No	5	6.7
Income	Positive	70	93.3
	Negative	5	6.7
Access to Market	Improved	63	84
	Nill .C	12	16
Access to farm	Improved	45	60
	Worsened	30	40
Access to electricity	Improved	58	77.3
	Indifferent Worsened	17	22.7
Access to health facility	Improved	43	57.3
	Worsened	32	42.7
Access to Transport	Improved	73	97.3
	No response	2	2.7
Access to portable water	Improved	57	76
	Not reliable	18	24
Access to Forage	Improved	73	97.3
	Worsened	2	2.7
Access to Tourism	Improved	60	80
	Indifferent	15	20
Access to School	Improved	75	100

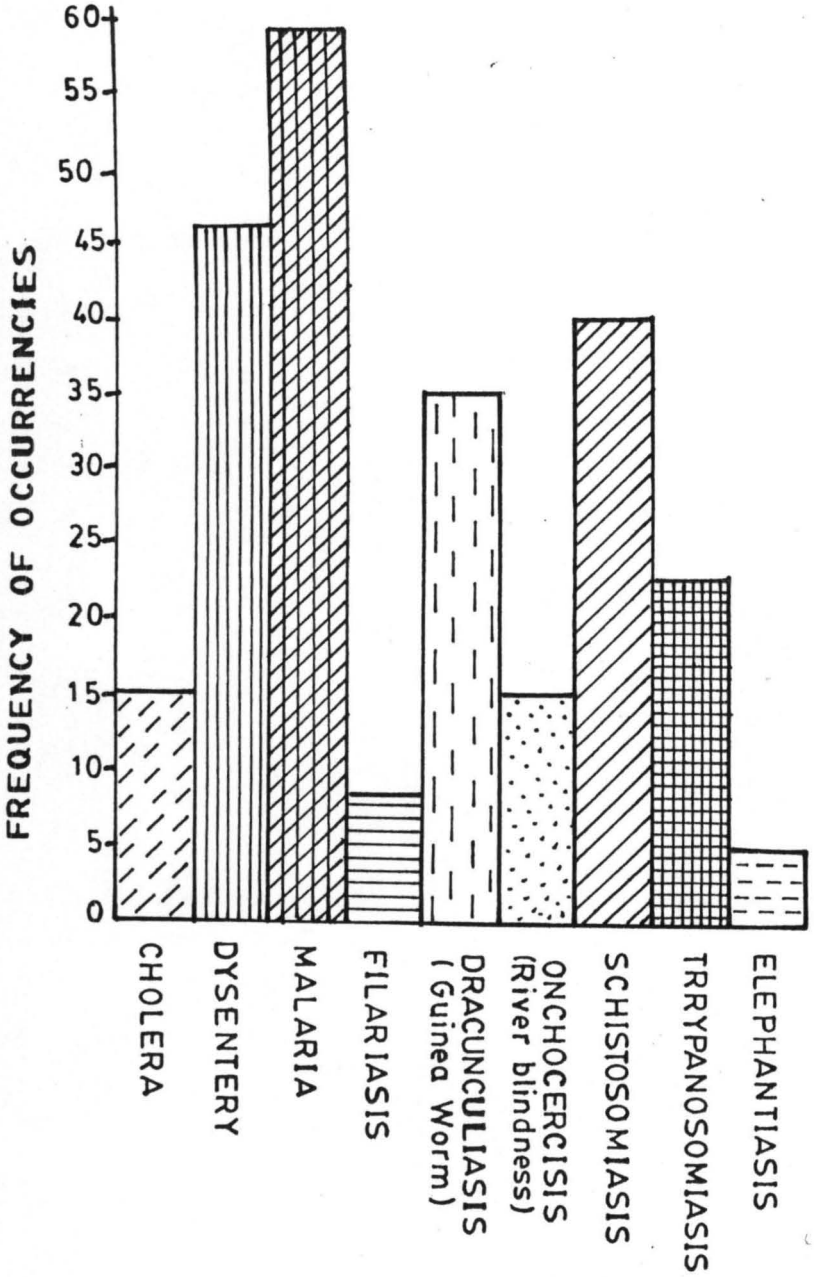


Fig.14 OCCURRENCE OF DISEASES AMONG VARIOUS HOUSEHOLDS INTERVIEWED.

Source:- Field Survey

	Worsened	-	-
Access to Industry	Improved	73	97.3
	Indifferent	2	2.7
Access to communication	Improved	74	99
	Worsened	1	1

6.6 ENVIRONMENTAL HEALTH:

Health is wealth, the effect of the dam/reservoir on health of the general populace within the vicinity of the dam has been difficult to quantify as many of the inhabitants were ignorant of the symptoms of the diseases being described to them.

On many occasions, malaria could not be clearly distinguished from other diseases generating feverish conditions.

At the hospital, records were highly aggregated as cases were not recorded and classified according to the location (residence) of the patients.

However, the following cases were recorded in the field Heads of households were interviewed and asked of the cases of different diseases ever recorded in their household since the time they moved into the study area.

Figure 15 shows the histograph of the occurrence of diseases among various households in the study area.

Malaria and dysentery has the highest frequencies respectively this can be ascribed to the breeding ground provided by stagnant pool of water down stream and good habitat provided by various households environment due to improper manner in which waster products are being disposed.

The occurrence of schistosomiasis is due largely to the prevalent swimming habits of the children in the pool of water down stream as a result of water discharge from the dam.

The study showed that the incident of high rate of malaria, guinea worm, dysentery and schistosomiasis as the commonest diseases in the study is

attributed to the influx of people to the study area and more importantly, due to over stress of facilities such as health care facility, inadequate open spaces, bad terrian, congestion and overcrowding due to inadequate houses to meet the housing need of the people hence there is the likelihood of diseases being spread like the fire in the desert during harmattan under this type of situation.

As such, in the absence of adequate healthcare system and environmental education and awareness, diseases incidents are likely to escalate.

Remedial action through drugs revolving scheme should be embarked upon and campaign against guinea worm eradication should be intensified.

There is however, the need to have a viable clinic in each of the surrounding villages for the spot attention while the General Hospital remain the only referral hospital to diagnosis serious ailments.

Children should be educated not to swim in a pool of dirty and cloudy water to prevent them from contacting schistosomiasis and onchocercisis (river blindness)

Table 10 summary of effects of and solutions to the Environmental Impact of Jebba Dam tag (Checklists of effects)

Table 10: **SUMMARY OF:-**

CHECKLIST OF EFFECTS AND SOLUTION TO THE ENVIRONMENTAL IMPACT OF JEBBA DAM

PROBLEM	EFFECT	REMEDY
Damming Process	Alteration of seasonal flood Alteration of ground cover and land transformation. Decline in fish species Fish fauna Instability, Modification of weather, Alteration of drainage and ground water hydrology.	Occasional release of water from reservoir to regulate the volume of water. Provision of fish gate to control fish movement. Adequate provision of controlled fishing Ranching.
Construction Works	Alteration of natural vegetal cover thereby caused deforestation. This led to Environmental degradation. Alteration of communication routes, Dusts, Noise and vibration through rock blasting, loss of natural habitat. Soil dereliction via surface excavation and cutting and filling.	Provision of shelter Belt Watershed management via vigorous/aggressive Irrigation scheme. Provision of agricultural waste to fill the excavated land for its reclamation.
Water Bodies	Contamination of water body through biological and traditional way of cropping fish down stream. Increased incidence of diseases vectors such as mosquitoes, and diseases salinisation. Alteration/introduction of artificial glare.	Stiff legislation against the use of traditional method of cropping fish downstream. Diseases monitoring and control. Provision of mineral chemicals to reduce salinisation. Adequate and proper Routine monitoring of the stability of the dam. Establishment of Early worming system that can give signal.

Displacement of local Inhabitants	Psychological problems. Socio – and cultural problem of readjustments to new location.	Resettlement of all displaced Inhabitants. Provision of viable and feasible Irrigation scheme for displaced farmers. Provision of basic facilities/utilities. Organization into reliable co –operative societies.
Reduction in Aesthetic Values of the environment of artificial	Alteration of the natural scenery and land forms. The viewa, vists, scenci areas and places of historic archaeological sites has been altered drastically.	Preservation and conservation of the natural landforms and places of historic sites.

CHAPTER SEVEN

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION:

A great deal of both the beneficial and negative environmental impacts of Jebba Dam/reservoirs (hydroelectric power) on the environment have been identifies, elaborated upon and in most cases enumerated.

However, this work is not exhaustive, there is still room for further research to take place most especially in the area of chemical analysis of some environmental phenomena which have not been mentioned in this work. None the less, an appreciable level of success has been attained.

It is left for humidity to appreciate and recognize the important of environmental quality and more importantly, see the need to carrying out environmental impacts assessment (EIA) of major projects that may have great effects on our environment. By so doing, large potential impacts could be substantiated and their mitigation measures implemented accordingly.

7.2 RECOMMENDATIONS:

Having identified and assessed the environmental impact of Jebba Dam hydro (electric power) on the environment its various levels, it is important therefore, to enumerate the following measures towards solving the already identified problems as follows:

- Re – invigorate the afforestation programme in and around the study area by the introduction of shelter belts along major development corridors. To serve as wind breakers, muffle noise, control soil erosion, prevent direct glare from the sun by providing shade and modify micro climate and hydrology etc. See figures (15)
- Introduction of effective and efficient waste management programme via enforceable policy programmes and legislative. This can be achieved through dogged commitments of the various organs of government and its

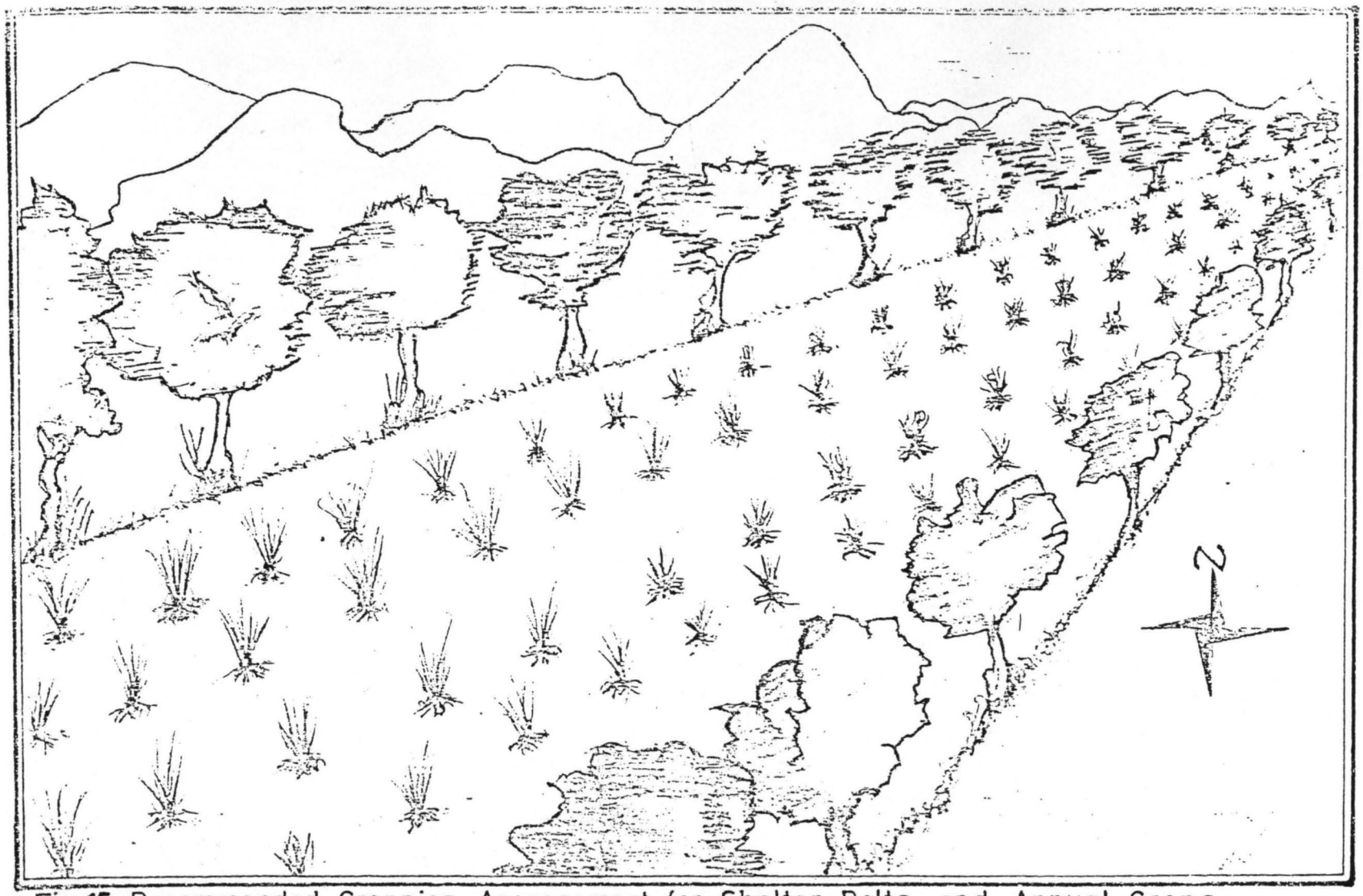


Fig.15: Recommended Cropping Arrangement for Shelter Belts and Annual Crops.

affiliated parastatals such as (FEPA) Federal Environmental Protection Agency, (SEPAS) State Environmental Protection Agencies, UNEP, UNO, UNDP,UNIDO, WMO (World Meteorotorical Organization), FAO, EEC and other good spirited private organization (NGOS).

- Adequate environmental monitoring through remote sensing application.
- Re-organization of the energy sub-sector and provision of efficient, economic, safe and convenient domestic fuel such as kerosine, gas and electricity.
- Aggressive conservation and preservation of natural resources and places of historic, Architectural and Archeological significance.
- Above all co-ordinated good physical planning will go along way in achieving balance and harmony amongst the various conflicting and competing landuses in our urban setting.
- Lastly, checking the menace of flooding and possible dam failure.

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APPENDIX 1

ENVIRONMENTAL IMPACT ASSESSMENT STUDIES OF JEBBA DAM.

QUESTIONNAIRE

Please answer the following question correctly. Your answer will be treated as confidential as possible.

(1) Time and Date of Interview ----------

(2) Are you aware of the Jebba Dam Project?

(i) Yes (ii) No.

(3) When did you become aware?

(i) Before the construction (ii) During construction (iii) After construction.

(4) Were you displaced from your original location as a result of the dam?

(i) Yes (ii) No.

(5) If Yes, were you compensated

(i) Yes (ii) No.

(6) Has the location of the dam affected the weather of the area?

(i) Yes (ii) No.

(7) In what ways?

(i) Increase rainfall (ii) Decrease rainfall (iii) Increase temperature (iv) Decrease temperature.

(8) Has the dam any effects on the fish fauna down stream?

(i) Yes (ii) No.

(9) What effects?

(i) Increase production (ii) Decrease production.

(10) Has the construction of the dam affected the size of your land holden for livestock production?

(i) Yes (ii) No.

(11) If yes, has it increased or decreased?

(i) Increased (ii) Decreased.

(12) In your own opinion, did the present dam meet the need of

(i) Crop farmers only (ii) Livestock farmers only (iii) both Livestock and Crops.

(13) Do you have access to the dam?

(i) Yes (ii) No.

(14) Do you pay money before using the dam?

(i) Yes (ii) No.

(15) If yes, how much ----------

(16) Who collects the money ----------

(17) When do you use the dam?

(i) Rainy season (ii) Dry season (iii) Both Rainy and dry seasons.

(18) How far is the dam from your abode?

(i) Less than 1km (ii) 1 - 2 km (iii) 2 - 4km (iv) 4 - 6km (v) 6 - 8km (vi) More than 8 km.

(19) Are your animals already benefiting from the project?
(i) Yes (ii) No.

(20) In what ways are they benefiting?
(i) Forage (ii) Water (iii) Others (specify).

(21) Has the construction of the dam made you economically better?
(i) Yes (ii) No.

(22) In what way?
(i) Increased livestock production (ii) Increased Crop production
(iii) Increased Crop and Livestock production. (ii) others

(23) In what ways has the construction of the dam affected the performance of your animals?
(i) Faster growth (ii) more milk (iii) Increased fertility
(iv) Better health.

(24) Do you intend to increase the size of your animals as a result of the construction of the dam?
(i) Yes (ii) No.

(25) Do you experience less problem of feed scarcity during the dry season since the construction of the dam?
(i) Yes (ii) No.

(25) Did your migrate into this area because of the dam?
(i) Yes (ii) No.

(26) Have you changed your settlement as a result of the dam?
(i) Yes (ii) No.

(27) If yes, why? ----------

(28) Do you have other sources of water for your livestock other than the dam?
(i) Yes (ii) No.

(29) Are they reliable?
(i) Yes (ii) No.

(30) What source of water do you consider best for your animals?
(i) Dam (ii) Well (iii) Stream (iv) River (v) Borehole
(vi) Others (Specify).

(31) Give your reasons ----------
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(32) Do you think the construction of the dam has affected Wild animals?
(i) Yes (ii) No.

(33) If Yes, list the effect

Good effects	Bad effects
(i)	(i)
(ii)	(ii)
(iii)	(iii)
(iv)	(iv)
(v)	(v)

(34) Do you think the construction of the dam has affected local vegetation?

(i) Yes (ii) No.

(35) If Yes, list the effects.

Good effects	Bad effects
(i)	(i)
(ii)	(ii)
(iii)	(iii)
(iv)	(iv)
(v)	(v)

(36) Has the construction of the dam reduced or increased the incidence of overgrazing?

(i) Reduced (ii) Increased.

(37) Do you think the construction of the dam has affected the quality of Livestock production?

(i) Yes (ii) No.

(38) If Yes, list the effects.

(i) ----------

(ii) ----------

(iii) ----------

(vi) ----------

(v) ----------

(39) What kind of advice do you have to offer?

(i) ----------

(ii) ----------

(iii) ----------

(iv) ----------

(v) ----------

(40) What is your occupation? ----------

(41) What kind of crops do grow?

Name them ----------

(42) Does the dam have any effect on your occupation?

(i) Yes (ii) No.

(43) If Yes, in what form?

(i) Positive (ii) Negative.

(44) If Negative, in what ways?

(45) If positive, in what ways?

(46) Has your income been affected as a result?

(i) Yes (ii) No

(47) If Yes, in what form

(i) Positive (ii) Negative.

(48) If positive, in what way?

(49) If negative, in what ways?

(50) What type of human disease do you think is new in this area or too common which can be associated with the dam construction?

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(51) Has any of your household members had a case of it?
(i) Yes (ii) No.

(52) Do you think there is going to be new positive benefits from the dam?
(I) Yes (ii) No.

(53) State them ----------

(54) Do you think there is going to be new negative effects fromt the dam?

(55) State them ----------

(56) Has any household be affected by flooding as a result of the dam?
(i) Yes (ii) No.

(57) If yes, how many times ------ and how many households were affected -----

(58) If No, what is responsible for its non-occurence?

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(59) Is there any damages done to life and property?
(i) Yes (ii) No.

(60) If Yes, quantify the damages in Naira value ----------

(61) What was the response of the government towards the affected families?

(62) Are there contingency plans in case of the occurence of down stream flooding in the future? Details (i) Yes (ii) No.

(63) State them if Yes ----------

(64) Are there plans for the migrants who will be attracted to this area as a result of new opportunities ?
(i) Yes (ii) No.

(65) If Yes, state them ----------