EROSION PROBLEM IN KONTAGORA

A MENACE TO THE ENVIRONMENT

BY

SALISU AHMED
REG. NO: PGD/GEO/2000/2001/141

DEPARTMENT OF GEOGRAPHY.
SCHOOL OF SCIENCE AND SCIENCE EDUCATION

FEDERAL UNIVERSITY OF TECHNOLOGY
P.M.B. 65 MINNA
NIGER STATE NIGERIA.

MARCH, 2002.

DEDICATION

This project is dedicated to Almighty God for giving me the wisdom to accomplished my desired aim. It is also dedicated to my entire family in general.

ACKNOWLEDGMENT

After expressing my sincere gratitude to Almighty God who granted me the grace and strength and guided me through out the period of my academic programme.

However, I am greatly indebted to DR. SHOLA AKINYEYE my able Supervisor for taking time to go through my project work, making all the necessary corrections and taking time to discuss with me, offering expert suggestions and criticism, infact no amount of thanks is too much for him. May God help him in his future ambitions as he has help me during this exercise.

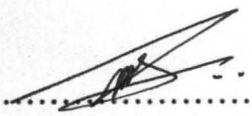
I want to thank the H.O.D Dr. M.T. Usman and all the staff of geography department for their encouragement and guidance in the course of my study, notably among them are professor A. A. Adefolalu, Professor J. M. Baba, Dr. A. A. Sadauki, Dr. Halilu, Dr. A. A. Okhimanhe Mrs. A. E. Odafen to mention just a few.

My sincere appreciation goes to my friends and course mates for their support and encouragement.

DECLARATION

I hereby declare that this thesis was wholly and solely written by me under the Supervision of Dr. SHOLA AKINYEYE. No part of this work had either been wholly or partially presented before for any degree else where.

Information hereby obtained from published works and unpublished work of others have been referenced and acknowledged accordingly.



..... 30-03-2002

SALISU AHMED **DATE**

CERTIFICATION

This is to certify that this project report being submitted by SALISU AHMED to the Department of Geography, Federal University of Technology Minna Niger State is considerable adequate and worthy of presentation for the post graduate project.

..... 05/04/2002.....

SALISU AHMED **DATE**

....

DR. SHOLA AKINYEYE **DATE**

Project Supervisor

....

DR. M. T. USMAN **DATE**

Head of Department

....

External Examiner **DATE**

....

PROF. ABALAKA **DATE**

Dean of Post Graduate School

TABLE OF CONTENT

CHAPTER SIX

LIST OF PLATES **PAGE**

LIST OF FIGURES **AGE**

CHAPTER ONE

EROSION PROBLEM IN KONTAGORA A MENACE TO THE ENVIRONMENT

1.0 INTRODUCTION

1.1 BACK GROUND TO STUDY

Food, clothing and shelter are the three most basic needs and wants of every human being, however land is identified to be an integral element that cannot be compromise. This is because, on land we cultivate to get food and clothing materials and it is on land we build to get shelter.

Erosion is infact a serious problem associated with land ,soil erosion is a process whereby surface layer of weathered rock is loosened and carried away by erosion agents such as running water, wind etc. after which the lower horizon of the soil is exposed. This is one of the environmental hazards that threatens Nigeria of today and thus affect, nearly all parts of the Country.

A little over 80% of our valuable land in Nigeria is ravaged by Erosion (NEST 1991). Shore lines erosion constitutes a serious hazard to Nigeria coastal agricultural land and the impact as a result of these problems enumerated is largely felt by the poor or less privileged class.

Natural erosion is comprises of water, surface flow, which occurs when soil is removed with surface run off during heavy rainfall.

Splash erosion occurs when raindrops strike bare soil causing to splash as mid to flow space in the soil and to the upper layers of soil into a stuctureless compacted mass that dries with hard impermeable crust.

Channelised flow erosion takes place when a mixture of water and soil cuts a channel which is then deepened by further scouring. These types of erosion manifest in several different forms namely rain drops erosion, sheet erosion, rill erosion and gully erosion.

Wind erosion occurs when soil particles are traresported and deposited at various distances forming sand dunes on the sea coast and inland desert formation which is the abrasion of rocks by soil particles which are defected by wind.

Realizing the increasing rate of erosion problem created by the hydraulic force of water in Kontagora which is rendering many people homeless especially those living around Unguwar-Yamma Kwangwara, Nassarawa area, and Unguwar Magajiya, houses and properties were lost and occasionally lives were lost.

These foregoing reasons prompted this study and make an impact assessments of erosion problem in Kontagora and a case study of a channelised erosion of surface run off which has now turned the channels to deep gully erosion due to the drainage failure by erosion washing of water channels at Gangaren Dan Umma (Unguwar Yamma) in Kontagora metropolis.

Erosion occurrence in this area is the result of run-off from rainfall, too large to be confined in available low water channels. In the event of flood erosion damage houses, properties and structures

within the erosion plain of the stream. The erosion occurrence in the area under study is visible and the probability of further occurrences quite high. This could be due to one obvious reasons ranging from high discharge due to the large catchment area discharging into the narrow channels, or due to the changes in the land use pattern within the catchment. The threat of the erosion consequences is noticeable at two specific areas.

1. Houses and structures along the stream channel.
2. Along the road drainage channel.

Stream and rivers are naturally the most prevalent type of open channel. Usually their beds are unstable and their backs are subject to scouring at high flows. Brushes, debts and other sediments can reduce the hydraulic capacities of a channel. This is the case with the channelled drainage system in Kontagora.

The existing channels along the roads during and after a heavy rainfall is alarming high. It over flows, its banks submerging houses and roads and threatens the structures along its path. At such periods, the velocity of flow is high. Large discharge is collected into drains as run-off due to the considerable large radius of catchment. Sometimes the over flows are large enough to cause residents owners to engage in flood erosion combating efforts in order to protect their houses, properties and lives.

Also due to high discharge into the channels from other subordinates channels there is an increased velocity of flow with water flowing out of the channels at first and then without any definable pattern into the main stream. As such much has to be

done to improve the working condition of the existing drainage in order to stop the erosion menace or flood with consequent properties and environmental damages.

1.2 CAUSES OF SOIL EROSION

Physical or human factors or a combination of both can caused soil erosion. Physical factors that leads to soil erosion include the following, Nature and composition of soil, climate, topography.

Nature and composition of the soil, soil is the top layer of the earth crust that is capable of supporting plant growth. As soil science has developed, it has become known that the soil is a dynamic layer in which many complex Chemical, Physical and Biological activities are going on constantly. Soil is far from being static, lifeless Zone, it is a changing and developing body.

The composition of a soil has been derived from the underlying rock no matter how long a soil has been in process of formation, the original 'raw material must therefore have some effect on its ultimate nature'. The process by which parent-rock material is broken into small fragments are known collectively as weathering.

Soil can also become adjusted to conditions of climate land form and vegetation and can change internally when these controlling conditions changes. Thus soil formation is a function of many variables which can be stated in an equation: S = (CL, O, R, P, T).

Where S = Soil property

F = Which is dependant on the following

(function)

CL	=	Climate
O	=	Organism (biological activity)
R	=	Relief
P	=	Parent material
T	=	Time

(Jenny's equation, the American soil scientist)

Climate exerts a dominant influence on soil formation if determines the intensity of weathering, leaching and rate of organic decomposition. In fact specific soil forming processes are characteristic of each major climatic zone. In the hot or warm humid area in general where there is excess precipitation over evaporation the predominant movement of water in the profile is down wards.

Consequently, organic matter and metallic cations are washed from the soil surface and may be deposited in the sub-soil, (erosion).

Topography and altitudes affect the formation and nature of soils in passive way. The major relief in fluences are steepness of slope and position weather high or low soil. Soil characteristic change from hill to top to valley bottom.

It also affect soil properties by influencing slope angles. The greater the slope, all things being equal, the greater the amount of material removed. Gentle slopes are characterised by thicker soil layer.

This sequence of soils from hill top to valley bottom is called CATENA. But in this project the slope is moderate or gentle time is

a passive factor. This the amount of time required for a soil to reach its matured form varies widely according to the circumstances, it depends upon the environment locality, parent rock, climate, plant cover.

The soil on which people depend on for survival unfortunately does not form in a year or two. Soil takes thousands or million of years to form a soil layer one metre deep. Yet due to human activities, they are being degraded, fertility loss, thus erosion occurs in wanton fashion. Inappropriate cropping techniques, deforestation, clearing land for construction purposes (roads and settlement), mining activities bush burning, over grazing thereby removing the vegetative cover and over cultivation and excessive farming are all major contributions to soil erosion influenced by man.

(See photographs of related factors).

The would watch institute estimates yearly top soil less at 25 billion tones roughly the amount that covers Australia, wetland.

In Niger State however, in addition to soil erosion, (splash/run off river/stream) degradation of soils also takes the form of loss of fertility. The later is currently serious and is worsening. The worry have relates to severe socio-economic disruption suffered by rural people whose livelihood depends entirely on the productivity of their soil.

Human activities such as grazing and bush burning and Urbanization, remove the homeostatic mechanism of the system (soil) causing instability in soil.

Cultivation which used to be practiced with long follow periods is now increasingly being practiced without fallow periods due to the increasing high cost of land and increase in population pressure and in some places the invariability of land due to changing-economic circumstances e.g sinking of book holes to alleviate water problem has lead to land degradation.

Narmadic herdsmen in areas like Niger, Sokoto and Katsina States, frequently burn bushes to encourage the early flush of grass for their grazing. At the peak of the dry season, these files are so intense that vegetation and litter are destroyed and soil is thus exposed to erosion.

Absence of vegetation cover causes drought, sedimentation and alleviation, the degradation of soil structure and texture, loss of water retention capacity, floods, all these conditions reduced soil profile thickness and soil fertility.

These in turn result in a progressive decline of crop harvests, increasing number of crop failures, wind, damage to crop wit uprooting or leaf damage, increase in surface run-off, reduce percolation, formation of erosion channel and gullies, reduction of surface water, crises in tree germination, harsh living condition for people, plants and animals, less biological diversity through the loss of species etc.

1.3 PROBLEM STATEMENT

With respect to identifying the research problem (Erosion) is considered to be of great importance. This is because the indices associated with this environmental menace (Erosion) is vividly seen and its impact is being felt almost every year.

However a close examination revealed that this environmental problem (Erosion) is traceable to peoples attitude towards the MISUSE OF LAND, lack of maintenance culture unpatriotic, complete neglect of smaller problem until they grow bigger, and lastly our corruption attitude which is now the bedrock of our Country's problem Nigeria.

Therefore it is crucial to educate the citizens about the disastrous environmental impact of Erosion in Nigeria of 120 million people with a population growth of 3.3% crammed within a land mass of about 928, 768m^2. As a result of the Country's population explosion, shifting cultivation and bush fallowing traditional system that were very suitable for our ecological conditions with minimum risk of erosion are no longer satisfactory.

Therefore this project intends to suggest ways by which this environmental problem erosion can be minimised. "Erosion problem in Kontagora a menace to the environment".

1.4 JUSTIFICATION

Realizing the enormity of the problem created by soil erosion disaster in Niger State especially in Minna environs in 1986 and 1999 which rendered many people homeless especially those living

at Kpakungu, Tunga area, Bosso area, lives and properties, various plots of farm land were destroyed.

It is the light of this that this project intends to look into this problem of soil erosion in Kontagora Niger State and hope that the frame work will provide a base line information on the following.

(i). Causes of soil erosion in Kontagora.
(ii). Its variable frequency and intensity or magnitude
(iii). Preventive measures to avoid future damage to the environment from soil erosion.

1.5 AIMS AND OBJECTIVES.

The aim of this project is to determine and examine the causes of Erosion in Kontagora; within this broad aim, the specific objectives are:

1. To proffer an effective solution to soil erosion.
2. To provide basic information about the magnitude of an extent or the speed or its randomness in Kontagora Niger State.
3. To access the consequences of soil erosion.

1.6 SCOPE OF STUDY

For the fact that Kontagora has no real river except for those of tributaties that serves as a main source to the earth Dam at Tungan Kawo and for the fact that data for the erosion flow characteristic are

insufficient, the work in gathering all required data analyzing countless alternatives in order to come up with an accurate and satisfactory result will be extremely difficult, if not impossible.

However detailed of erosion control will be fully discussed under the recommendation. Attempt would also be made to look into some land use laws of town and Country planning regulation with specific references towards management of environmental menace (Erosion) in our towns and cities.

Data consisting of rainfall and the aerial photography of Kontagora will be used.

1.7 STRUCTURE OF THESIS

The structure of this research work will include among others, coming to conclusion as a matter of immediate concern articulate measures to be included in managing our land and ways of controlling Erosion as an Environmental menace.

However this work would be restricted to Kontagora metropolitan centre only. Attempt would also be made to look into some organisation charged with land use and development control with specific references towards management of environmental menace (Erosion) in our Urban centres.

CHAPTER TWO

2.0 STUDY AREA.

2.1 LOCATION.

Kontagora is one of the historic towns right from the then North Western State and to the present Niger State. It is one of the big towns in Niger State. It is the local government head quarters of Kontagora Local government.

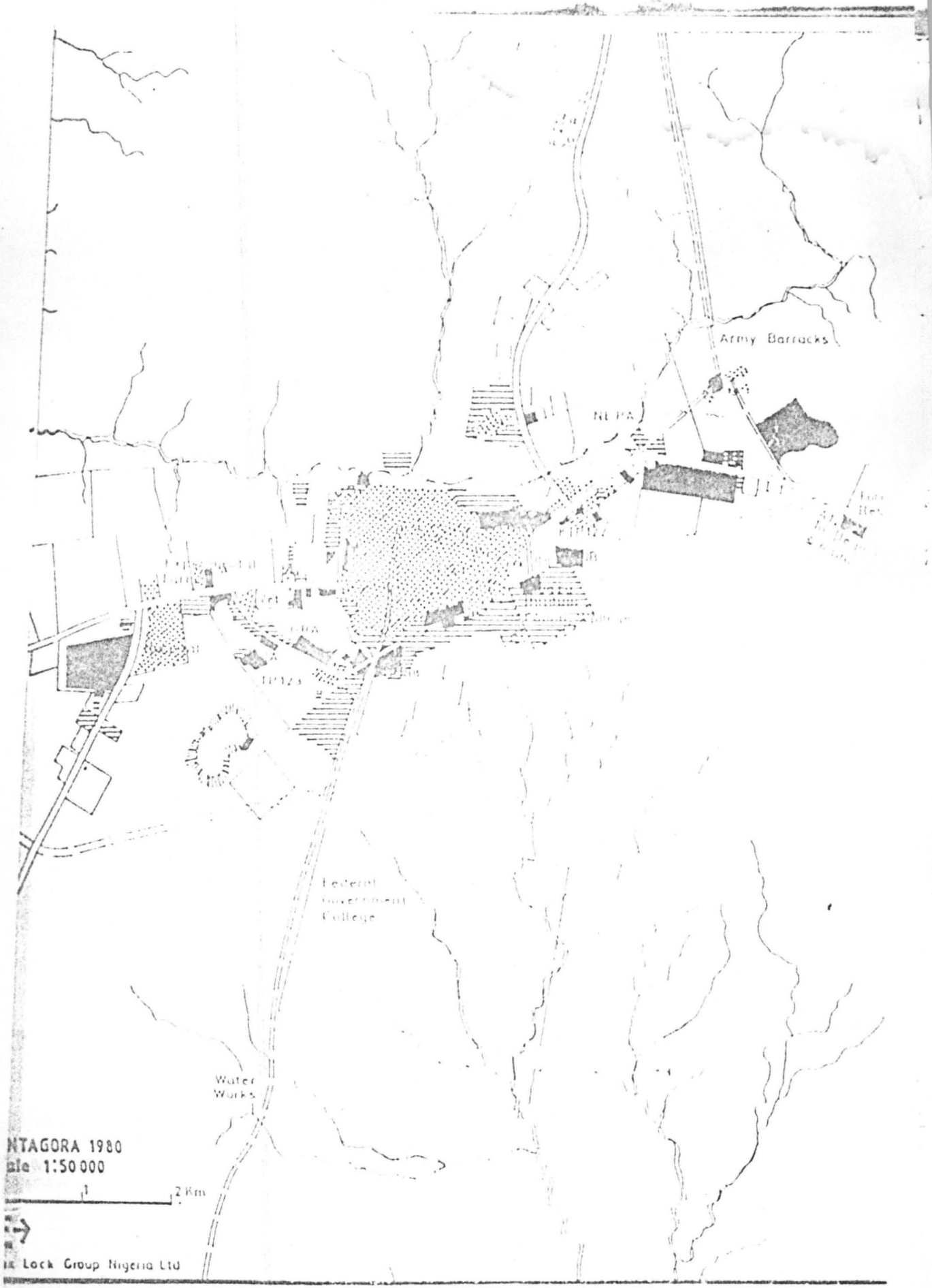
If lies 10^0 22'N and 50^0 29'E on the boundary between the Nupe sand stone to the South-West and the base complex to the north-east. (See fig. 2.1)

The metropolitant town lies along a major road junction on the national road network. A major trunk A1 road that links the north and South divides the town and A1 road branching north-westwards to Sokoto and A 125 going north-eastward to Kaduna. It also lies on the boundary of the two main geological features of Niger State. The base complex to the north-east and the NUPE sand stone to the South-West.

(See fig of the town growth and that of the town today.)

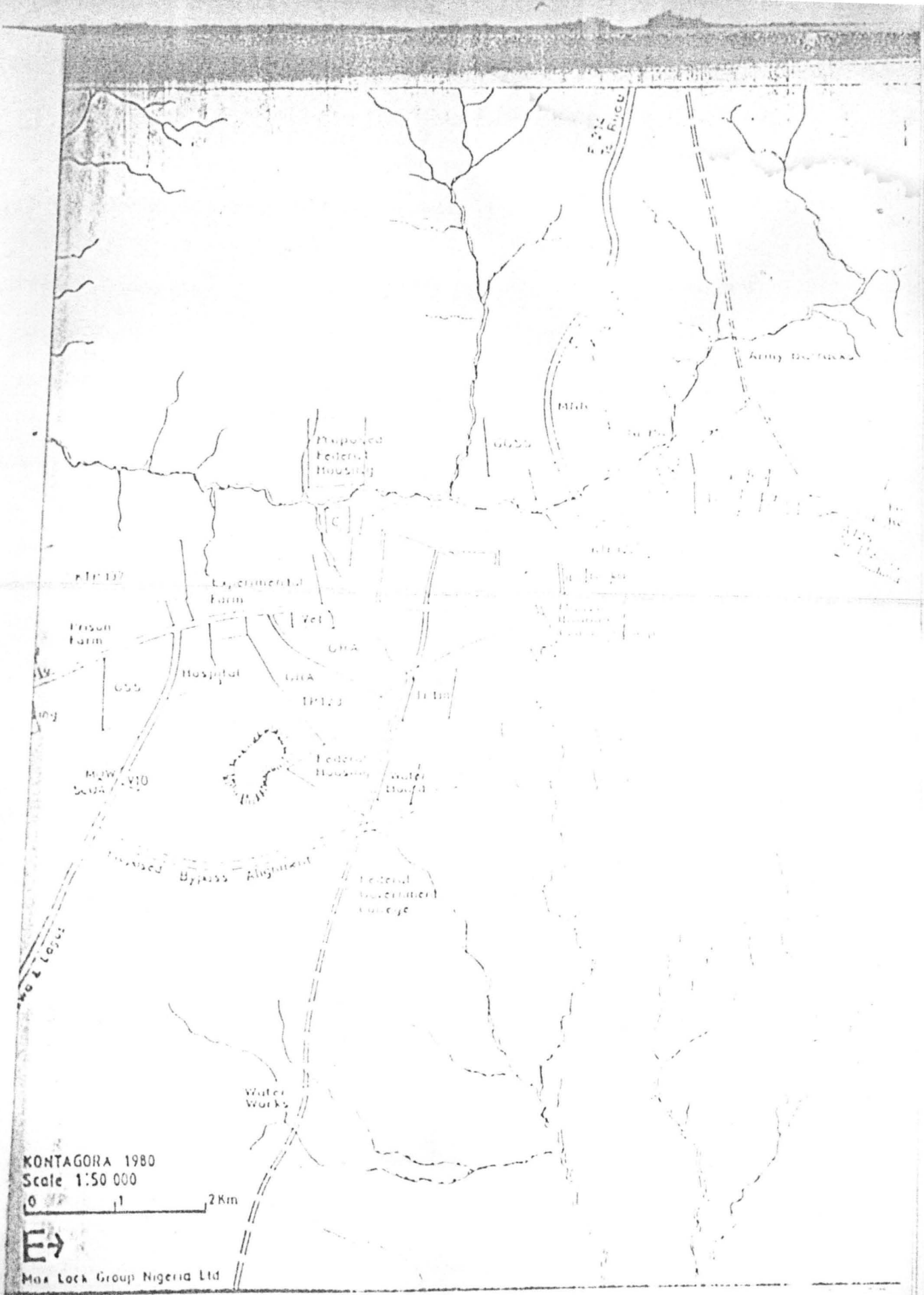
2.2 DRAINAGE SYSTEM

Three distinct separate river system surround the catchment area of Kontagora.



Growth of the Town

Pre 1962



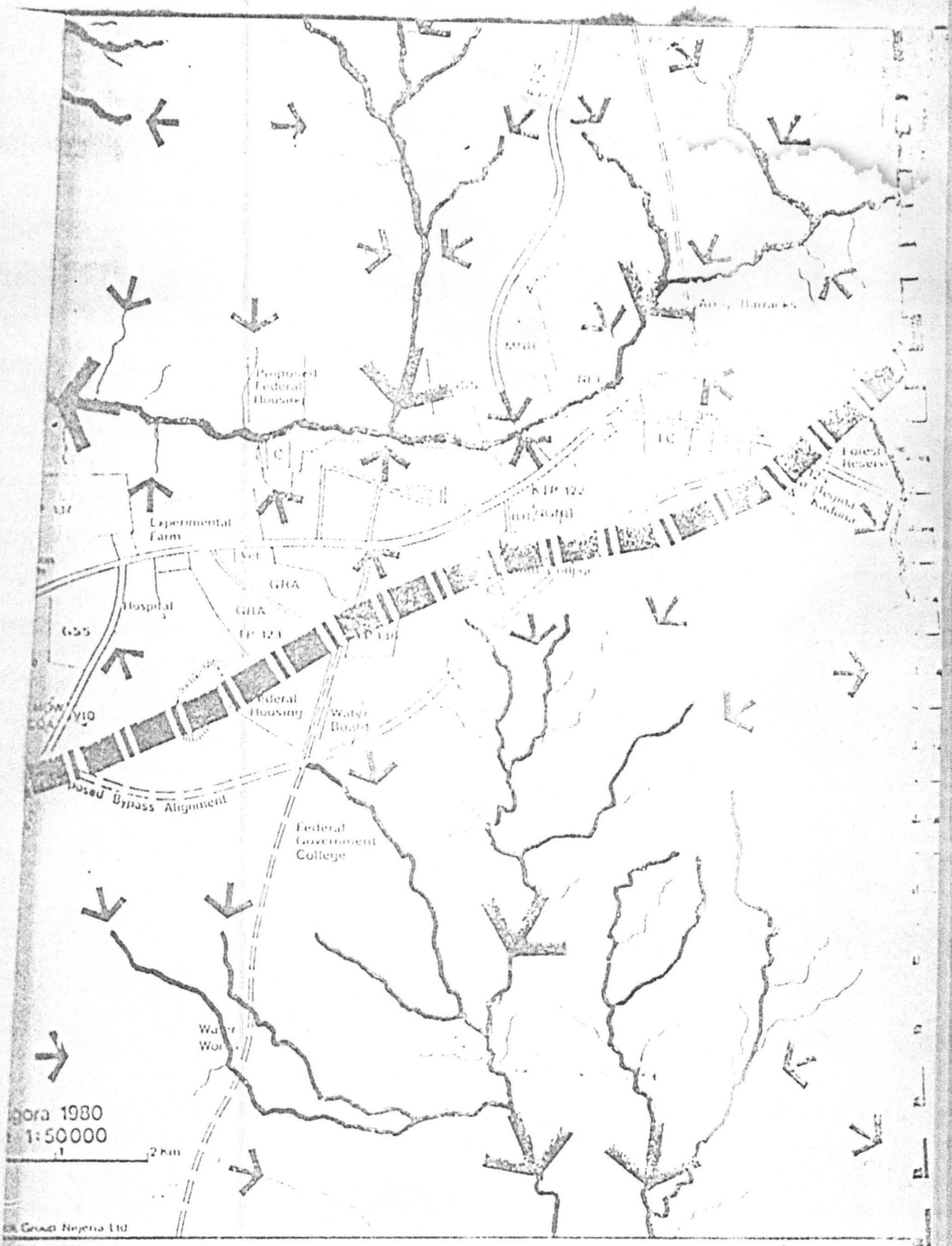
The Town Today

The Beri river which lies to the South and east and drains into River Kaduna at about 15 kilometies South of Wushishi. The Kontagora river which drains to the South-West and empty its content into Kainji Dam. The Malando river which is within a catchment of about 1 kilometres to the north of the town drains into the Niger River near Yauri at the northern end of the Kainji reservoir. As such the town would have been well drained with large developable areas along the watershed, but unfortunately this is not the case. (See fig. Showing Existing drainage or provided).

The city centre of activities is concentrated at the old market which is within reach from the Emirs palace northwards an associated offices for the local government almost infront of the emirs palace. However with the rapid development of business activities, a new market was forced to be established at the western side of the town. Another centre was also at the far western edge of the town around the juction. This is where the main road to Sokoto branches. (Mararaba)

2.3 **LOCAL TOPOGRAPHY**

Local topography of Kontagora town is only what is assessable at the moment, due to lack of updated acrial photography and contour information outside the built-up area.



xisting Drainage

Fig. 2.5

Major Watershed

Surface Water Direction of Flow

As earlier mentioned, the town lies on the watershed of the Kontagora River catchment area to the north and the Beri River catchment area to the South. However, the town has now developed and reach up to the main valley of the town that runs due west wards which is about 3 metres deep and 5 - 6 metres wide. The main valley which flows due South, serves as the main stream headwater of the Beri River that spread out over a wide area.

The Kontagora master plan 2 , contains a large area of land to the south of the town running east-west through the middle of the Muazu commercial Secondary School, paralled to but just south of Rijau road and then south-westwards across the Primary school and Bolobolo hill lies between 34 metres contour which drains in the southern direction.

2.4 CLIMATE OF KONTAGORA AREA.

Kontagora has a mean annual rainfall of about 117mm taken from a good record of 4 years (Max lock group Nig. Ltd Final report 2), the highest mean monthly rainfall is in September. The rain season commences on average between 25th April and 5th of May which last between 17 and 18 days the mean monthly temperature is highest in March and April and the lowest in August.

2.5 PEOPLE AND POPULATION OF KONTAGORA AREA.

People:- The original inhabitants of Kontagora are the Kambari's however the ruling class are the Hausa/Fulani which came into the ruling class after the conquest by their fore-fathers

who were Jihadists, from the renowned Jihadist Usman Danfodio. Apart from the dominant tribe of the Kambaris, there are also the Dukawas, Kamukus, Dakarkaris and other minority Nigerian ethnik group like the Gwaris. There are also settlers from among the other major Nigerian languages that is the Yorubas and the Ibos who came to settle as traders. Even some foreign Nationals such as the Zabarmas from Niger republic.

The main yard stick or data base is the 1952 census followed by the 1963 census, both of which should be reasonably comparable because Kontagora town is a fairly tightly defined area with few nearby outlying settlement such as farin-shinge eastward, Kwangwara and Tungan-wawa South ward, Usubu westward and Masuga northward. These might not have been included in to the town figures. However in 1973 planning consultants to the then Northwestern State Government made an estimate of 250,000 for 1970. But the area is not defined but assumed to be built up Urban area.

In 1980 max lock Group Nigeria Ltd made a detailed field and sample survey and estimated a residential population of 42,180 including the army. As such the economic planning Division have been using the official national standard method of taking the 1963 census as a base and apply a 5% per anum growth rate resulting in an official published population of 34,282 for 1980. The same economic planning division Kontagora have given Kontagora population figure to be about 100,000 approximately by the year 2000.

So to surmarice the existing population figure of Kontagora can be shown in a Table 2.1

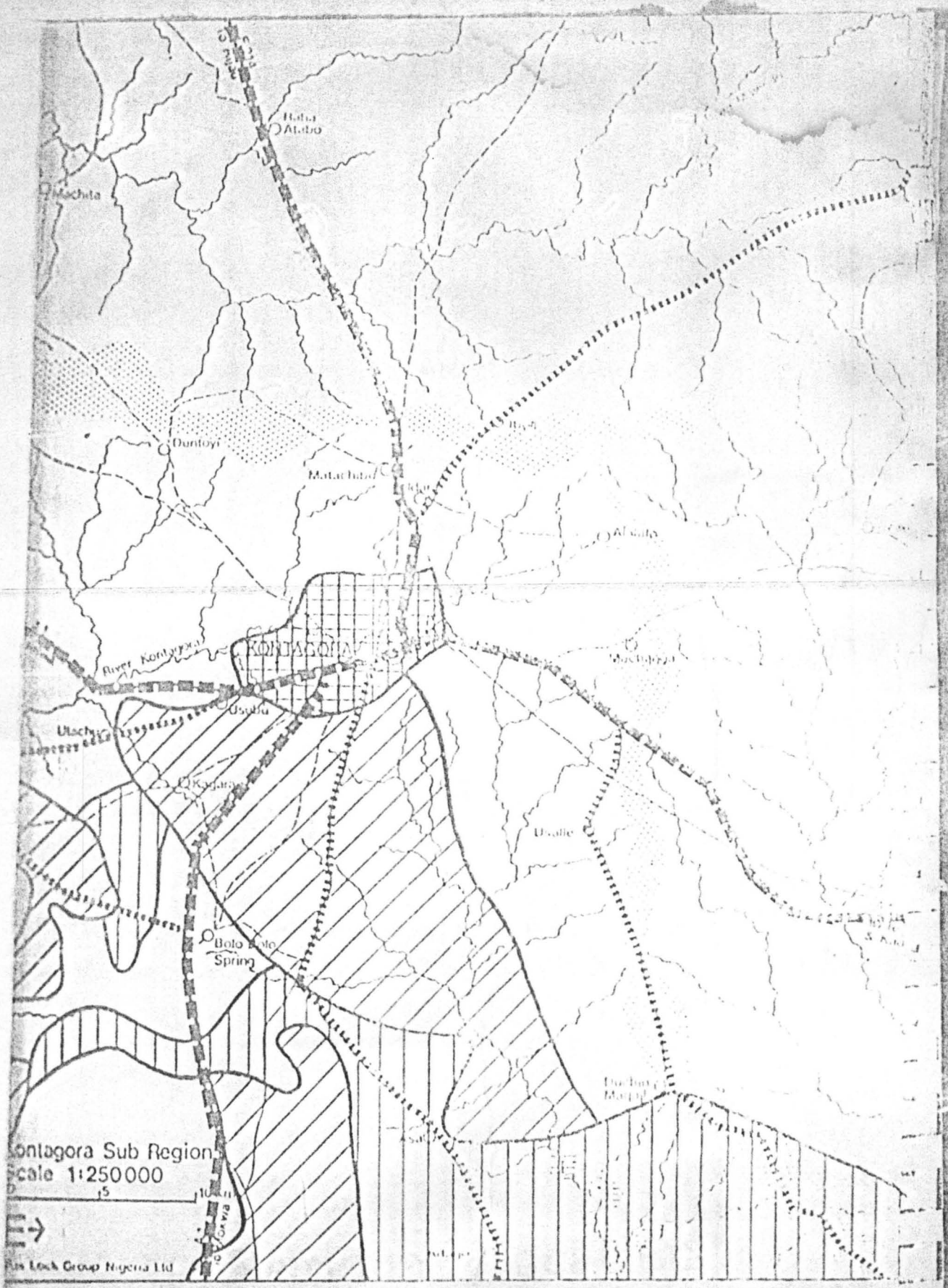
YEAR	***DATA***	***FIGURE***
1952	Census-Kontagora	5,655
1963	Census	14,957
1970	NWS planning consultant K/gora	25,000
1979	Economic planning division K/gora	34,282
1980	MLGN fields surveys K/gora	42,180
1981 - 2000	Economic planning Division K/gora field survey.	100,000

These population data have been converted to annual growth rate for various periods and are shown in table 2.1 below:

Table 2.2 Kontagora town: Annual growth for Existing population Data

YEAR	*DATA*	*ANNUAL RATE %*
1952 - 1963	Census - census	+ 9.24
1952 - 1970	Census-NWS consultants	+ 8.61
1962 - 1970	Census-NWS consultants	+ 7.61
1963 - 1980	Census- Economic planning	+ 6.65
1963 - 1980	Census- Economic planning	+ 5.00

Source:- Kontagora Local Government information and social development department.



Map 6 Sub-Regional Proposals

Hill areas with poorer soil for anti-erosion forestry

Future urban area

Best soils for standard agricultural practises

Watersheds for anti-erosion afforestation

ap 1 Regional Location

Fig. 2.4

d on 1 located on the National Trunk Road network being at the primary between the A1, Lagos-Jokata, and the A125 to Kaduna and Kano. This Junction together with the development of local access roads will enable ultural potential of Kontagora's hinterland to be fully exploited, and ing long term benefit to the town.

2.6 AGRICULTURE

2.61 ARABLE FARMING

Kontagora and it's environs is an area with a potential fertile agricultural land, and majority of the citizen are arable farmers. As such much investment has been put into agricultural projects around Kontagora by the government. Such as the farm service centres and vetenay of approximately 80 and 20 hectates of land respectively along Lagos road. Tungan wawa, Rafin gora, Babban rain and Koboji are areas within Kontagora along Lagos road, that are active arable farmers. These are areas having one of the Best soils for standard agricultural practices. Large land clearing schemes have taken place on the good agricultural soil of these areas.

These also existed a farm institute in Kontagora town which has now been Shifted to Utachu, a settlement within Kontagora vicinity off Lagos road. Two small irrigation scheme at Lioji and Masuga to the north of the Town along Zuru road are also noticeable. However in view of these, the land within Kontagora area is under considerable pressure from the town's inhabitants for small farming ever on the less productive soils of the town. The existence of Fadama areas along the valley to the south of the town which is being fed by the perenial springs water also aid agricultural activities in Kontagora area.

Map showing sub-Regional (best soils for standard Agric practices).

CHAPTER THREE

3.0 LITERATURE REVIEW.

3.1 EROSION DISASTER.

One of the major environmental problems in the world today is soil erosion. Nigeria too is affected by this problem since soil erosion has become a global issue. On these environmental issues, several world conferences have been held in various parts of the world. In 1992 during the earth summit held in Rode janero in Brazil, participating Countries including Nigeria took an obligation under agenda 27 to reduce the loss of soil, hold back deserts, save arable land. Conservation of forest and biological resources and to use their water resources properly.

However soil erosion by water is particularly prevalent in the humis, high rainfall areas. Heavy rainfall results in rapid water run-off. Gully erosion is the more obvious form of soil erosion because of its remarkable visible effects on the landscape. They appear and develop easily in areas of soft bedrock and often rapidly grow into enormous gullies. Spectacular gully erosion areas in Nigeria are Anamba, Akwa Ibom, Cross River, Imo, Abia, Plateau, Bauchi Sokoto and Niger States.

In the Angulli-Nanka areas of Anambra State for instance, over 1000 hectares of land have been lost to gullies estimated to be expanding at 1% per annum for the least (Ofomata 1991), other consequences associated with gully erosion are the loss of residential houses, farm crops, changes in the topography of an area and

hydrology of affected areas, disruption of communities and sometime lost of lives.

In 1992, the world development report indicates that soil erosion may harm productivity by depositing silts in the dam, thus irrigation systems and river transport in channels may also be affected thereby damaging fisheries.

According to the united Nation Environmental programme UNEP (1984) in Salau (1993), 6,900 million hectares covering approximately 80% of the regions cropland have lost between 25% and 100% of their productive capacity in Africa alone.

Globaly, the United Nation Environmental Programme (UNEP) assessment on soil degradation reveals that 1.2 billions hectares, about 11% of the earth's vegetation surface, have undergone moderate or severe soil degradation. The problem is significantly greater for developing Countries of the tropics than far temperate countries in that rainfall and agricultural practices naturally promote soil erosion (World Development Report 1992).

Although highly localised but is a fact, highway construction are among other factors associated with other forms of environmental problems. It has been reported by Petters (1993) and include accelerated gully erosion which often occurs in the course of highway construction. Wherever drainage is diverted into adjoining lands often with no outlet for water or where culverts cross the road.

The above forms of land degradation are obvious along Nigeria highways, for example the Kaduna - Birnin Gwari highway linking both the North and Southern States, and Calabar - Itu highway linking both the Cross River and Akwa Ibom States.

Fresh water forest communities have been known to be by changes in soil water regime as a result of road construction. Evidence of the destruction of fresh water forest communities arising from the identified processes have been documented for the Epe-Lagos motorways (NEST 1991) and along the Calabar - Itu highway. Where the initial Nigeria forest have also been wiped out (Petters 1993). Petters also reported the disappearance of the original swamp vegetation near the Nigeria Newsprinting manufacturing company, now left with vast spectacular expanse of tall dead trees which are relics of the original tropical moist forest.

About 25 billion tons of top soil is lost yearly according to the world watch institute estimates. Roughly the amount that cover Australia's wet lands. In Nigeria a punch Newspaper Publication of February 2000, a corps member in Minna, Miss Umoh Grace identifies causes of environmental hazards in the Country has been attributed to the negligence and insensitivity of people towards issues that affect their environment. She therefore charge all Nigerians to imbibe the culture of planting trees and beautifying their environment against hazards and degradation.

Around Kainji Dam in Niger State and some parts of River - Niger, silting occurs and thus reduces the efficiency of the hydroelectric power supply system by the reduction in quantity of available water for the turbine engines. As a result of silting the level of the river beds rises and beds of water reservoir which resulted to the use of ground water level, there by resulting to flooding. Cases of such occurrences are in Sokoto Rima basin in 1996, Victoria Island Lagos in 1995 and 1996, and of recent that of Tiga and chalawa Dams of 2001 in Kano and Jigawa State of Nigeria respectively. The

great flood of Minna in 1986 centered may people homeless especially those living around Keteren Gwari, Anguwar Kaje, New market and Limawa wards of the town, while various plots of farm land lives stock were lost.

On the 18th September 1999 the Nigeria Television Authority (NTA) Minna feature in its "Newscope" flood erosion disaster in Niger State with special reference to Minna and its environment. As a result of heavy down pour of rain that lasted for five and seven hours on the 11th and 17th of September respectively. Areas that are mostly affected are Kpakungu, Bosso, Tunga and Chanchaga all within Minna environment. It further stated that streams were over flooded along Minna Western by pass, residential houses were submerged, farm and properties worth millions of Naira destroyed and lives were lost. Other areas that badly affected are Tunga where a body of three years old girl was said to have been recovered from the flood. The body was said to have been recovered at Tunga area of Minna under a bridge wedged by suger case Shrubs several meters away from the family house.

The 1986 Kontagora flood disaster which was as a result of the silting of the major stream river of Kontagora that flows East-West down the northern part of the town. In august 1986 after a heavy rainfall that lasted for about eight hours, the stream over flooded thereby rendering many people homeless, farm land along the river bunk, lives and properties were lost.

The silting of the river is as a result of topographic nature of the town itself and improper city drainage system and water channels that can contained the surface runoff of the water. Thus grill erosion became deep gully erosion as a result of year in year out surface flow.

In Nigeria punch of January 2000, the Minister of Environment, Alhaji Hassan Adamu described Jalingo, the Taraba State capital as a disaster zone, because of the menace of gully erosion in the town. He Stated that the problem of the area is beyond what the State government could handle, that the gullies in the land orient drainage basin had grown in length from about 25,000 to about 100,000m. Lack of Urban drainage, Uncontrolled Urban use of development and other forms of human interference causes flood erosions annually in most southern Nigerian cities (Petters 1093) (as the case may be in Kontagora of Niger State). Thus it can be concluded that most flood erosion disasters in Nigeria are man-made. The most notorious cases are the Ogunpa Urban flood disaster in Ibadan in 1980 which said to have claimed over 300 lives, and the Bagauda Dam burst in 1988 which also killed about 146 people (NEST 1991).

Another headline of this day of 6th March 2000 flood devastated Mazambique. Mozambique face a new on sleight of flood water as rain which fell in south Africa highland over flow its banks and flooded Mozambique making most of them hemocoels, properties worth million of dollars destroyed and many lives were lost and also destructive of economic activities and infrastructures.

CHAPTER FOUR

4.0 METHODOLOGY

For any research to be substantial and valid, it must be more quantitative. By using different mathematical or statistical model to analyses the variables, more meaning can be given to it. Therefore some methods deemed suitable is specifically emphasised on in this chapter for the analysis of the data collected.

4.1 DATA COLLECTION

To discuss the effect of rainfall in the study area, rainfall data spacing a period of twenty years (1981-1999) was used. Also a span of twenty years data was used in the temperature analyses. The data were used to determine the mean annual rainfall, climatic index in terms of degree of dryness (drought) and wetness (floods), deviation from the mean, length of rainy season and cessation and the onset for Kontagora metropolis.

However, the rainfall data of the study period have been properly kept. The only problem being that of inconsistency in records kept in some stations. Only stations with a high degree of consistent records were finally selected to give a high degree of accuracy. Thus the rainfall data collected can be said to be fairly accurate.

4.2 METHOD OF DATA COLLECTION

Rainfall form the basic data for the research, Although the whole town is involved in the study, only a few stations in the town had the

required data for the period of study. The department of Meteorological Service Oshodi in Lagos State served as the source of the law climate data required. Material for the write up were extracted from various texts, materials, from articles written and presented by various meteorologist such as professor Adefolalu, Ojo etc. For published or unpublished work, where information were obtained strickly on climatic variation.

4.3 METHOD OF DATA ANALYSIS

Due to the importance of statistical analysis and its growth as part and parcel of geographical methods. And since the rainfall data obtained are mainly statistical. The process used in this research for the analysis of these data are mainly statistical. The process or method also makes it easy for one to arrive at conclusions note objectively and facts easily summarized.

The use of these methods was greatly influenced by the type of data and the purpose of the research which deals with relationship of one or more variables on another variable.

4.4.1 DATA COMPUTATION

Computation of standard deviation mean, mean deviation are adopted from Ebdon (1977). Onset dates and deviation of cessation dates, length of rainy season (LRS) or raindays and Ogives employ the method used by Adefolalu (1981), the method of establishing the correlation is adopted from childress (1976, 77) computation of climatic index (C.I) decaded period were also used in the study.

4.4.2. MEAN AND MEAN DEVIATION

The mean is a measure of average. It's computation is done by summing up all values in a data set and dividing by the number of values.

The mean can be expressed by:

$$x = \frac{\sum x}{N} \text{ for each station}$$

Where x = annual rainfall for a given period

N = Number of case or years in each station

$\sum$ = Sum of all the values of variable x.

Another method of statistics used in the study is the mean deviation which is given as

$$\text{Mean Deviation (M.D)} = \frac{(x-\bar{x})}{N}$$

Where x-x = difference between each value of x and the mean.

= the sum of all the deviation

N = the number of values in the data set.

4.4.3 STANDARD DEVIATION AND CLIMATIC INDEX

Standard deviation is also a measure of dispersion. It is experienced by the following: $\frac{x_1 - x)^2}{N}$

Where N = the amount of observation

x1 = the annual rainfall for a given period

x = the mean for the station

and b = the standard deviation for the station.

Also in the study, climatic index (C.I) is used to analysed the rainfall data. The expressed form of climate index is given by:

$$C.I = \frac{x_i - \bar{x}}{\sigma}$$

Where X = rainfall of a particular year or period

$\bar{X}$ = mean of the station

σ = standard deviation.

The extent of variation of a parameter from an established normal is represented by the index. A climatic index value in the range of 0-0.5 indicates mild drought, when it is between - 0.6 - 1.0 it indicates severe drought and when the C.I. is greater than - 1.0 it indicates extreme drought.

The case is the increase for wetness, i.e. 0 + 0.5 indicates mild wetness, from 0.6 to 1.0 indicates severe wetness and from 1.0 and above indicates extreme wetness.

4.4.4. ONSET CESSATION AND LENGTH OF RAINY SEASON (LRS)

Another method used in the research is the use of Ogive to determines onset and cessation dates, length of rainy season of rain in Kontagora for the period under study. A ten-day decades are used to compute running sum for each year. The Ogive or cumulative frequency curve plotted out by growing the 365 days of the year into 36 ten decade days of rainfall.

For example:

January 1st - 10th $(r_1 + r_2 + r_3 + \ldots\ldots\ldots\ldots\ldots r_{10}) = DN_1 = R_1$

January 11th - 20th $(r_1 + r_2 + r_3 + \ldots\ldots\ldots\ldots\ldots r_{10}) = DN_2 = R_2 + R_1$

January 21st - 31st $(r_1 + r_2 + r_3 + \ldots\ldots\ldots\ldots\ldots r_{10}) = DN_3 = R_3 + R_1$

The plotted Ogive is smoothed to determine the onset and cessation. The onset data of rain is marked by the Lower point of inflexion on the Ogive. This is the point at which a line is just tangential to it. The cessation dates of rainfall at Kontagora is also marked by the upper point of inflexion on the Ogive.

Length of rainy season (LRS) has many definition one of which is the period from seed growing to plants maturity. Another is the methods during which 50mm and more rainfall is received or the number of rainy days based on rainfall amount of 2.5mm in a day. Length of rainy season (LRS) in given by:

LRS (C - O)

Where C = Cessation data of the rainy season

O = Onset of the steady rains.

CHAPTER FIVE

5.0 DISCUSSION OF RESULT

The most important principal element of climate affecting the environment in the tropies is rainfall. It's length, certainty and pattern of fall greatly influence the way of life of the people and their environment. The natural vegetation and types of agricultural system practised in West Africa. This chapter examine properly the distribution of the annual rainfall variation in Kontagora Town. Also the coefficient of rainfall is examined. These are done by analysing in more detail the annual year to year variation, deviation from the mean climatic index and length of raing season. Typical wet and dry years are also discussed.

5.1 ANALYSIS OF CLIMATIC PARAMETER

As has been seen from previous chapters, rainfall is the most important facture affecting various activities in the tropies. It is therefore necessary to assess critically the trend in rainfall and coefficient of rainfall in the study area.

5.2 ANALYSIS OF RAINFALL DATA

The analysis of rainfall data in Kontagora for the period under study (1981-1999) 20 years shows that Kontagora has mean annual rainfall of 1205.54mm.

TABLE 5.1 MEAN ANNUAL RAINFALL OF EACH STATION

STATION	MEAN ANNUAL RAINFALL (MM)	YEAR
Kontagoar Central	1278.8	1981-1999
Kwangwara	1524.2	"
Experimental Farm(Samaru)	1205.5	"
Army Barracks	1087.3	"
Water Works	931.9	"

This shows that the pattern of mean annual rainfall within Kontagora Town changes from place to place. As can be seen in table 5.1 for instance Kwangwara has the highest rainfall mean of 1524.2mm. Water works recorded 931.9mm of rainfall which is the lowest mean annual rainfall in the study area. While Army Barracks recorded a much higher mean annual rainfall of about 1087.3mm for the period under study.

Kontagora central recorded about 1278.8 of rainfall Experimental Farm (Samaru) recorded about 1205.5 of rainfall for the same period of study.

In terms of inter-annual variability of rainfall amount about the means, there were marked deviations during the study period for stations, for example Kwangwara recorded the highest positive deviation of about 960mm of rainfall from the mean in 1984. Kwangwara also recorded the highest negative deviation in 1991 of about - 1474.5mm of rainfall from the mean the highest recorded negative deviation from the mean in Kontagora central, Army Barracks, Water works and Experimental farm were about - 280

(1988), - 300 (1988) - 710 (1999) and - 410 (1994) respectively. For the highest recorded positive deviation from the mean it was about 420 (1984), 370 (1989), 530 (1993) and 750 (1984) respectively.

5.3 TYPICAL WET AND DRY YEARS

The wet periods are years with rainfall above the mean. In the study area during the study period, the typical wet years were 1981, 1982, 1984, 1987, 1989, 1990, 1993 and 1996. On the other hand wet years for Kwangwara, Water Works, Experimental Farm and Army Barracks from year to year varies as shown in Appendix 1-5. Throughout the period under study, 1984 was the year with a general high rainfall amount from the study area.

The dry years of Kontagora central were 1983, 1985, 1986, 1988, 1991, 1992, 1994, 1997, 1998, and 1999. The dry years for the other stations during the study period also varies from year to year (Appendix 1-5). But a common typical dry year to all the station was in 1998. This was the period when there was a general low rainfall throughout the station.

5.4 RAINFALL VARIATIONS

Rainfall variations play a very crucial role in the control of various human activities in general. Such as construction of roads, house building, recreational activities etc. For instance, the onset cessation and duration (length of raing season) of rainfall are very important.

Niger State in general has two main seasons, namely the wet and dry seasons. The wet season is usually between April and October. During this time rainfall is high and the weather is relatively cooler. The length of the wet season also varies from place to place, which shows that rainfall varies in Kontagora during the period under study. In the study area generally, the peak of rainfall occur in late July and into September with a short slightly drier spell called the "August break".

The dry season usually occurs between November to March. During this time the weather is dusty and cold with low vapour prepare. Rainfall early occur between November and February.

5.5 YEAR TO YEAR RAINFALL VARIATION

In Kontagora metropolis, the year to year rainfall variation during the period under study, between 1981 - 19999, shows the lowest recorded rainfall was in 1988 with rainfall amount of 998.7mm. The highest recorded rainfall was in 1984 with 1701.0mm. Both the previous year and proceeding year had relatively low rainfall of 1057.3mm and 1064.1mm respectively. These were below the mean for the station. However there was an increase in 1986 and a further increase in 1987, 1981 and 1982 also had very high rainfall. After the 1988 low rainfall, there was a general fluctuation in the remaining years.

Kwangwara had its highest rainfall in 1984 with a value of 2487.1mm before then there has been a gradual decrease in the previous years of 1981 (1809.23mm) 1982 (1790.2mm) and 1983

(1652.5mm). After the 1984 maximum rainfall, there were also fluctuation in the preceding years. 1994 had 1860.4mm rainfall which was an increase. However there was a decrease in 1995 with an amount of 1485.8mm (Appendix 2). 1991 had the lowest rainfall amount of 49.8, as shown in appendix 2, 1996 which could have been regardal as a dry year had a relatively high rainfall greater than the mean.

In water works area, the highest rainfall of 1457.8mm was recorded in 1993. Generally the year to year rainfall variation for the station indicates fluctuation in the rainfall amount. In 1981 to 1983 there was a gradual decrease of rainfall amount for instance 1381.1mm 1247.2mm and 926.1mm (Appendix 3). 1987 and 1989 also had a period of gradual decrease of rainfall of 1103.8mm, 1006.1mm and 952.9mm respectively. This was after an increase from 1986 which had 948.4mm of rainfall during the year.

The highest rainfall in Army Barracks, from 1981 - 1999 was 1457.5mm (1989). There was marked variation in rainfall between 1981 - 1989. But between the period of 1990 to 1992 there was a steady decrease in rainfall amount. The period of 1993 to 1999 had even distribution of rainfall of 1106.5mm, 928.0mm, 1019.4mm, 929.2mm, 1021.7mm, 932.8mm, 986.1mm and 908.2mm respectively (Appendix 5). The lowest amount of rainfall was recorded in 1988 (786.7mm).

Experimental farm experiences both marked variation and slight variations in the station for the period under study. From 1981 a marked decrease to 1983 in rainfall and a marked increase between

1983 and 1984. Between 1985 and 1988 the rainfall amount was evenly distributed. 1985 to 1988 had 1422.7mm, 1299.6mm, 1483.6mm and 1654.4mm respectively (Appendix 4). In 1989, 1990, 1991 and 1992 rainfall was 1654.4mm, 1561.9mm, 1534.0mm and 1235.6mm which showed a decrease in amount received. There was also a marked increase between 1992 and 1993, with both having 1235.6mm and 1764.6mm of rainfall data.

5.6 DROUGHT ANALYSIS IN KONTAGORA

Departure from the "normal" climate causes drought in West Africa in general and Nigeria in particular. They have indeed become relatively persistal for the past two decades and were throughout most of the sahel and Sudan regions. The affected areas and land has continuously been under water stress as rainfall failure has become its characteristic (Ojo, 0.1977).

During the drought years of 1996 - 1990, it was established that the 300mm Isolyet is seen to be depressed between 100 - 125km Southwards of the normal position (Than by alpillar 1987). The following year 1000, there was a recovery.

As a base for measurement, climatic index values are used in Kontagora metropolis is characterised by both drought and flood periods. Although the drought periods occur more than the flood periods for the periods under study. Only 1982 and 1984 had a climatic index value of above + 2.0, which indicates extreme wetness during the study periods. Other periods shows a fluctuation of climatic index values between + 0.24 and + 0.36 for 1989, 1987 and 1990

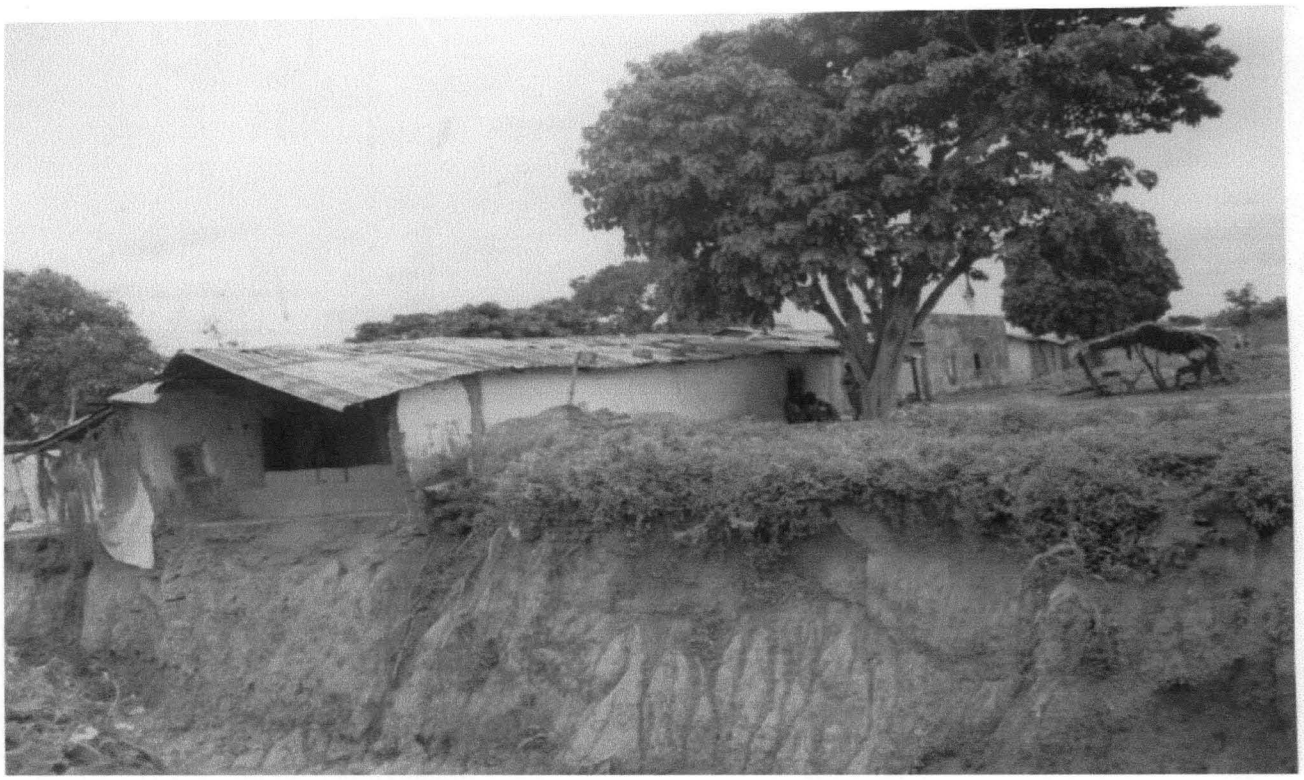


PLATE 5.1: Shows a collapsed house as a result of erosional activities in Kontagora metropolis
SOURCE: Field Survey, 2001

PLATE 5.2: Shows a bridge rendered useless at Unguwar Yamma due to erosion activities
SOURCE: Field Survey, 2001

PLATE 5.3: Shows a burried pipe now exposed to the surface as a result of erosion
SOURCE: Field Survey, 2001

PLATE 5.4: Another house being chopped off by erosion at Unguwar Yamma in Kontagora central
SOURCE: Field Survey, 2001

(Appendix 1). The remaining periods had climatic index values ranging between + 0.54 - + 0.88, which indicates severe wetness or floods.

As a result of these flooding, Erosion in this region is very critical Excess water, through the various erosion processes, cause various bad land to the environment. Most of the building in Kontagora metropolis are under great treat and if care is not taken some of the buildings may collapse. Plate 5.1 - 5.4 shows some of the threathened structures in the study area. Plate 5.1 and 5.3 revenled threatened house and bridge in the study area.

The land surrounding these structures had been badly eroded and part of the structures had collapsed (Plate 5.1). In plate 5.2 the burried pipe can also be seen on the surface due to intensive erosion of the land.

Kwangwara had more flood periods than drought periods during the study period. Although most of the flood periods ranged between mild and severe floods, the station only had one year with extreme flood which was 1984 (+ 2.08).

At Kwangwara area, erosion is also a problem to the environment Erosion has contributed to various formation of the land scape. Various houses are being threatened, such that parts of most of the houses are already being chopped off from the main building. Erosion in this environment are of various degree as can be seen in plate 5.5 - 5.8. The arrows in plate 5.5 reveal that part of the fence and room have been rendered useless. Plate 5.6 shows how a road has been rendered useless due to erosion of the land, thus maloing the road un accessible to motorists.

PLATE 5.5 and 5.6: Reveal a part of a house fence and a loom collapsed due to eroded portion of the land surrounding the house at Kwangwara study area
SOURCE: Field Survey, 2001

PLATE 5.7 and 5.8: Show a minor drainage in Kwangwara environment which erods backwards and downward thus turning into gully erosion
SOURCE: Field Survey, 2001

Plate 5.7 and 5.8 shows a minor drainage in Kwangwara environment. The water channel erods backward and downward, thus producing a gully. The gully as can be seen in plate 5.8 is getting deeper and could be dangerous to the environment.

Water works had up to 60% flood periods during the study period 1981 had a climatic flood index value of + 1.60 indicating extreme flood which gradually decreased with few increase to a minimum flood climatic index value of + 0.08 in 1989. The following year (1990), there was a sharp increase value of up to + 1.0 followed by a decrease and then a final highest value increase of + 1.86 in 1993. The situation of Erosion problem at water works environment is as serious as other study points/station in Kontagora. Plates 5.9 - 5.12 show various erosional activities. The plate reveal water pipes that were burried underground are now exposed on the surface as a result of erosion and wearing away of land.

Army Barracks like Kontagora metropolis had more drought than flood periods. The flood periods shows a pattern in which there was an even distribution between mild, severe and extreme floods 1982, 1984, and 1989 had flood with climatic index values of + 1.50, + 1.58, and + 2.00 respectively for the period under study.

Most of the land surface in Army Barracks had been attack by erosion. Plate 5.13 and 5.14 show how a wing of the building is being attack by erosion. The structure in plates 5.13 and 5.14 are under great threat. Most of the laterite soil have been washed away, thus revealing the foundation blocks. The arrous shows that with time Erosion of the land may cause the development of a gully erosion.

In the case of floods, Experimental farm had about 44.66% of extreme floods of the total floods periods. 17.64% of severe floods and 29.41% of mild flood conditions. Experimental farm had a period of three (3) years in which data were not available.

PLATE 5.9 to 5.11 : Shows water pipes reveal to the surface due to erosional problem, at water works study area
SOURCE: Field Survey, 2001

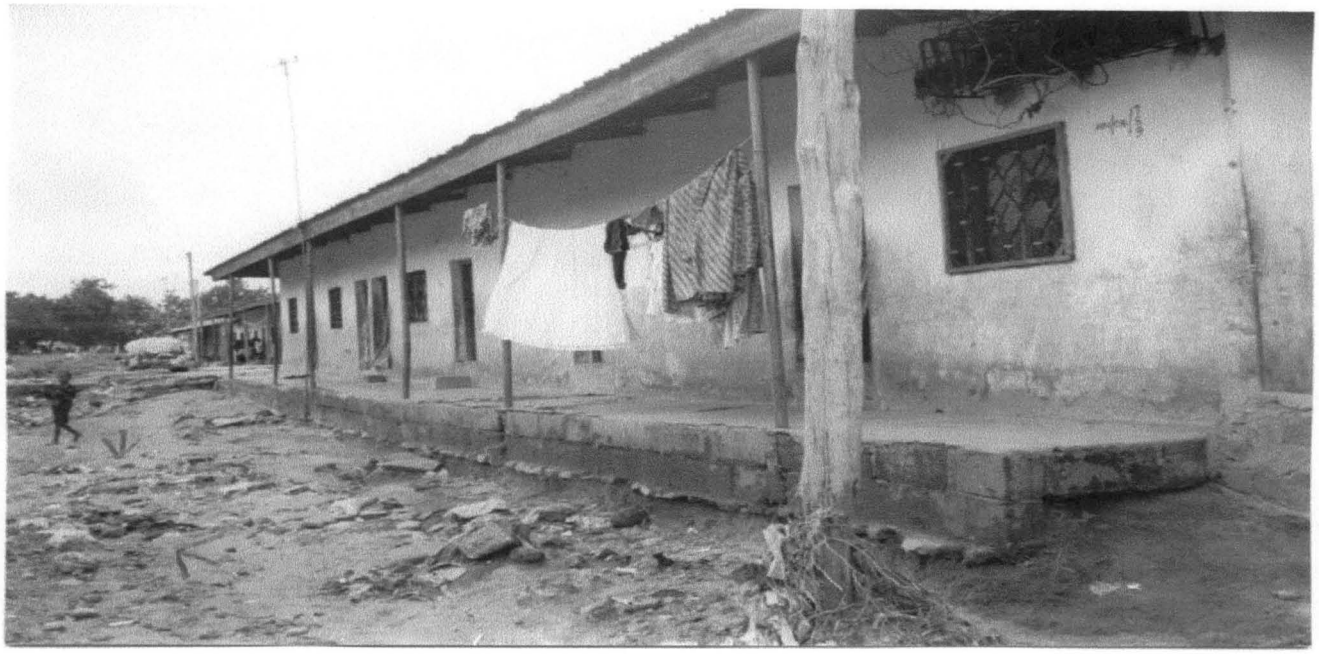


PLATE 5.12 to 5.14: Shows houses under great threat due to erosion activities in Army Barracks
SOURCE: Field Survey, 2001

PLATE 5.15: Shows Sand bags were used to present erosion activities
SOURCE: Field Survey, 2001

PLATE 5.16: Shows tradtional stone pitching work to present erosion
SOURCE: Field Survey, 2001

APPENDIX 5

FIG 5·2 DEVIATION FROM THE MEAN FOR KONTAGORA CENTRAL

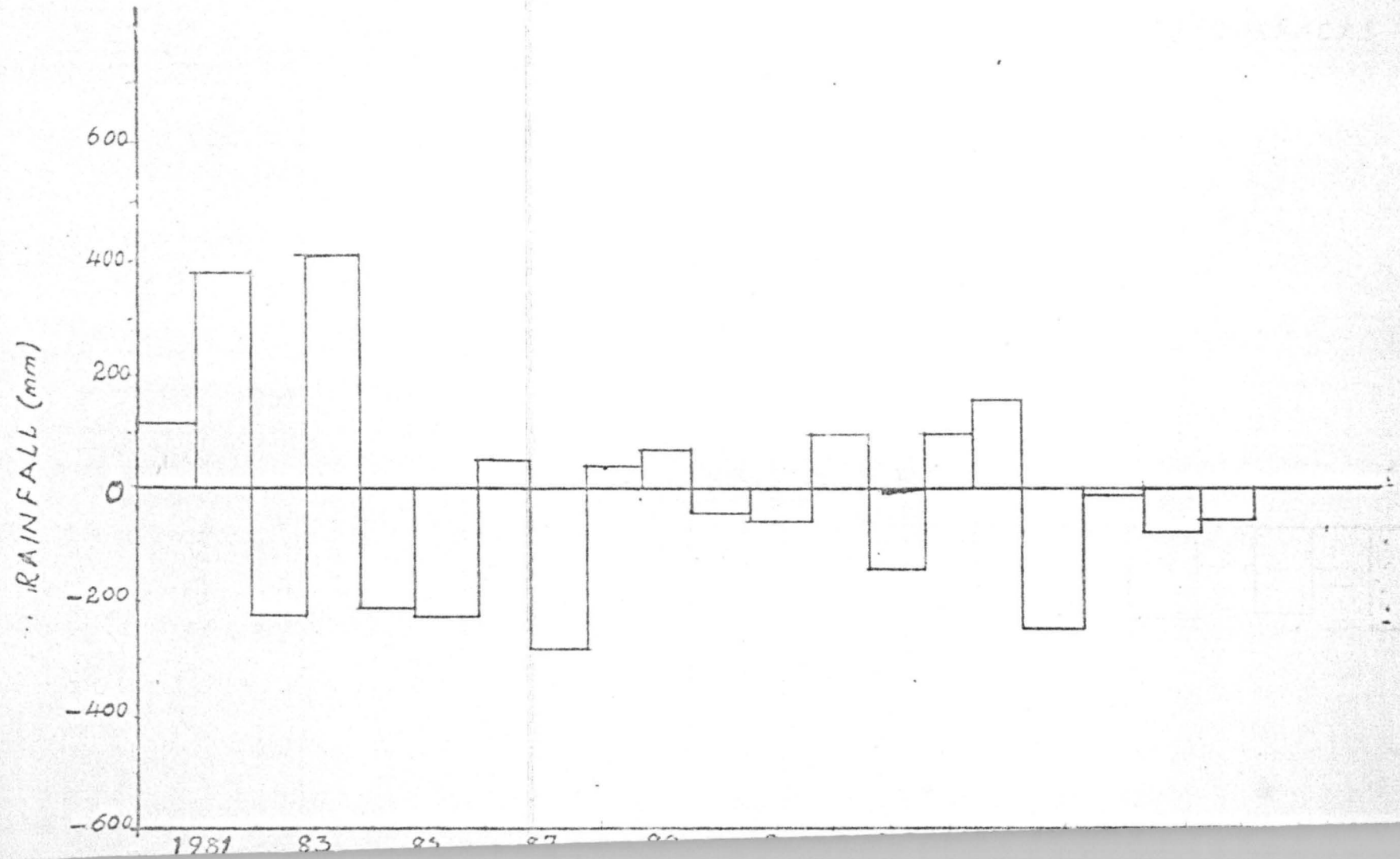


FIG. 5.1 DEVIATION FROM THE MEAN FOR KWANGWARA

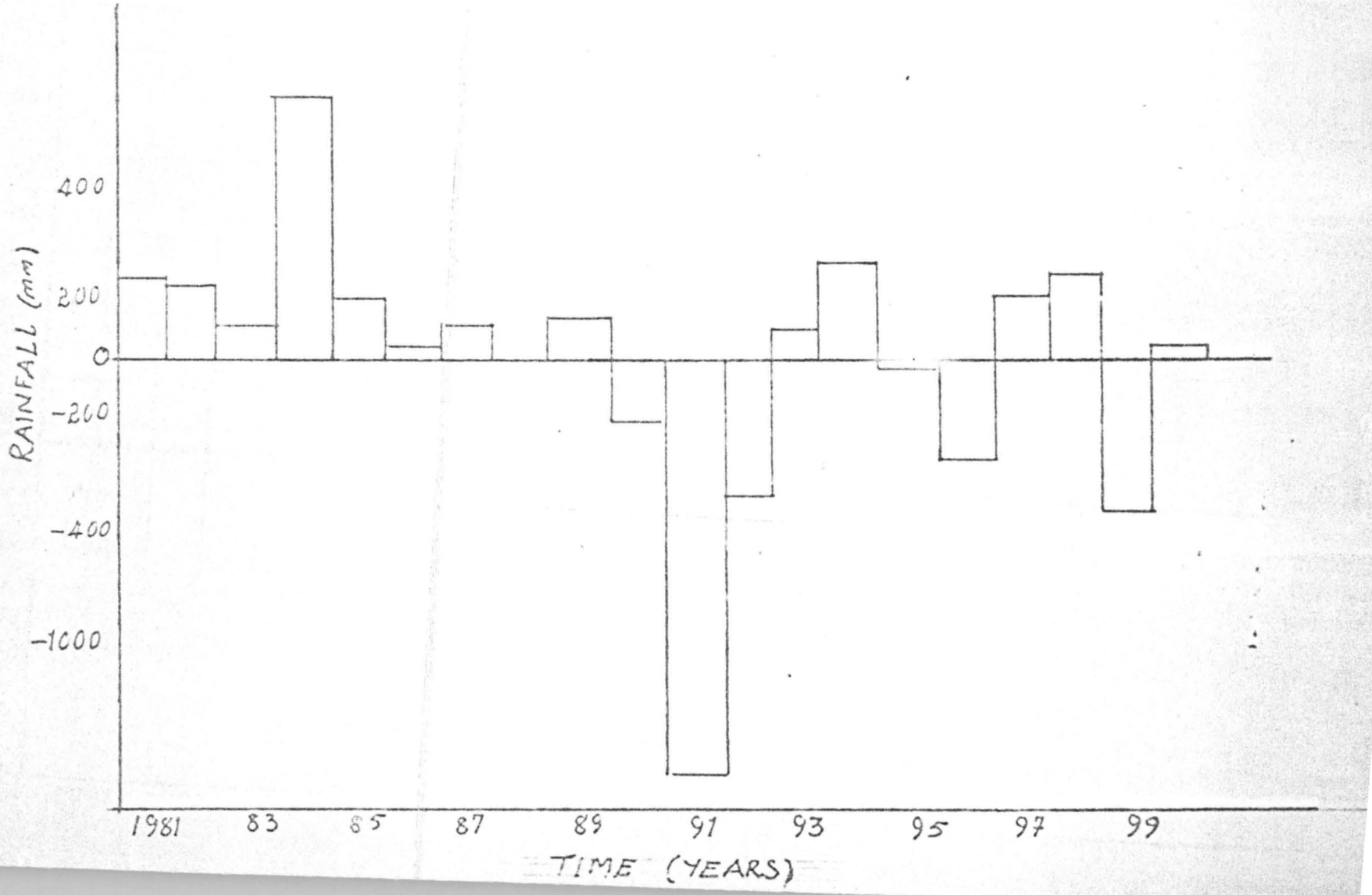
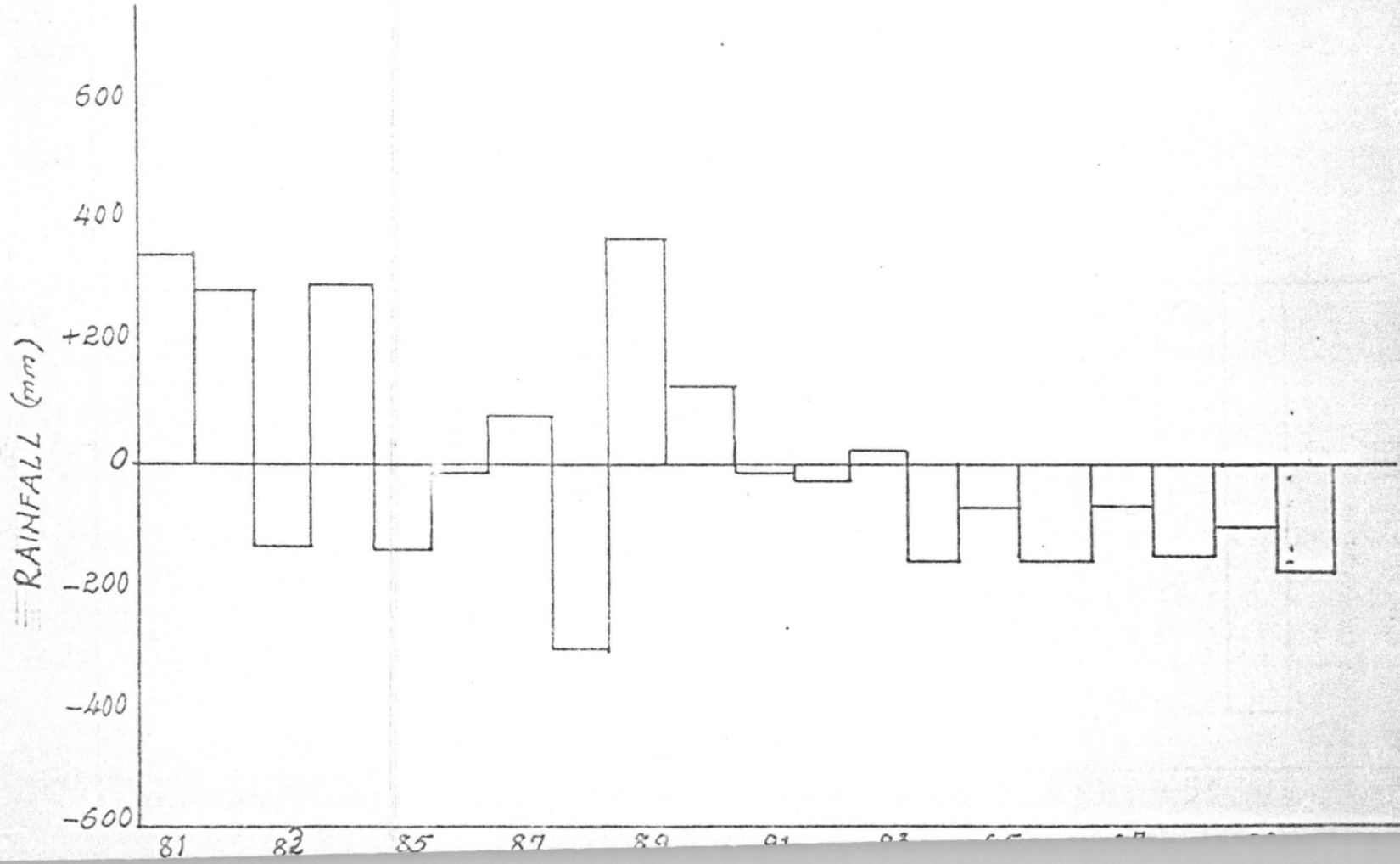
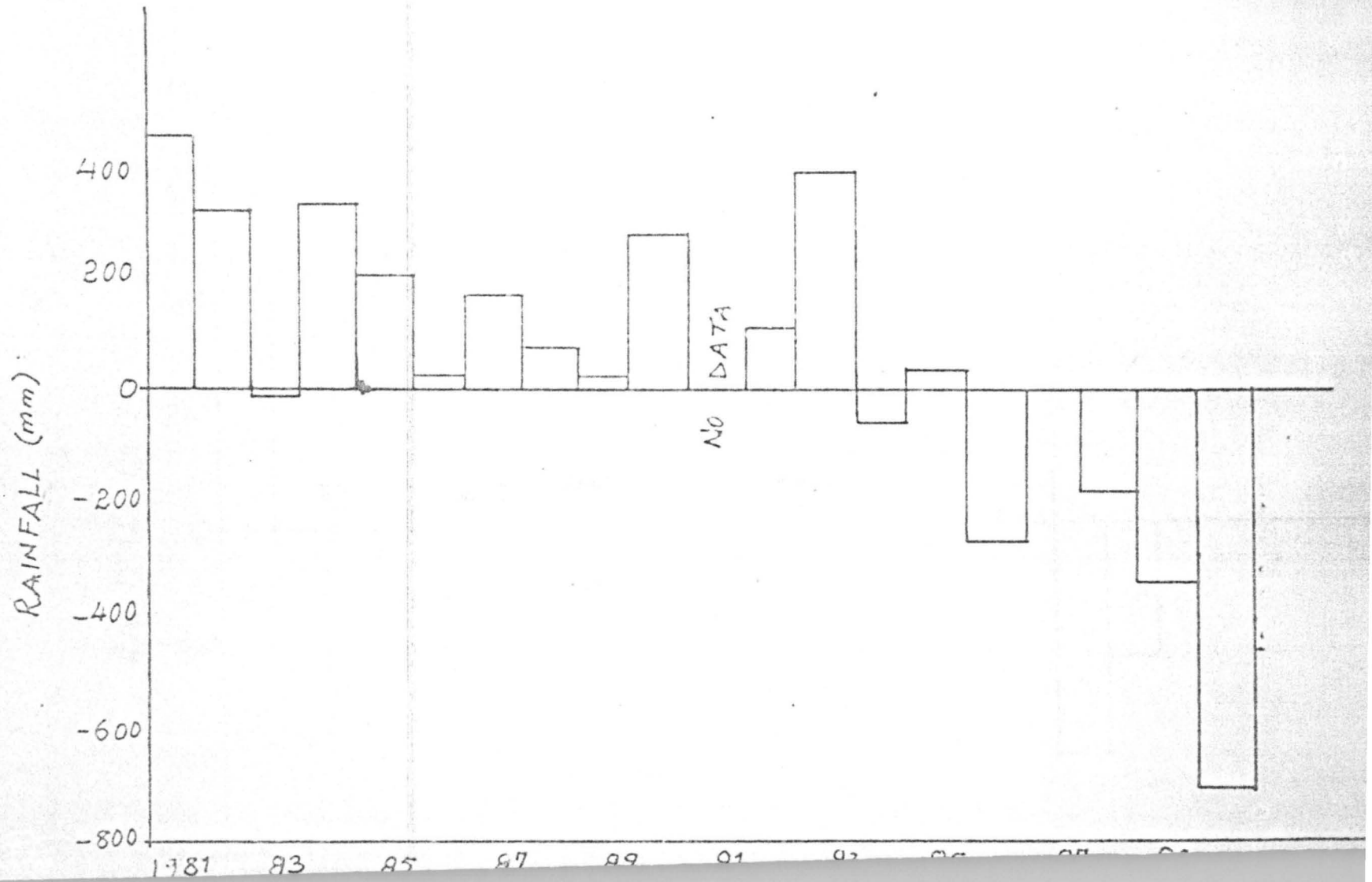


FIG 5.3 DEVIATION FROM THE MEAN FOR ARMY BARRACKS



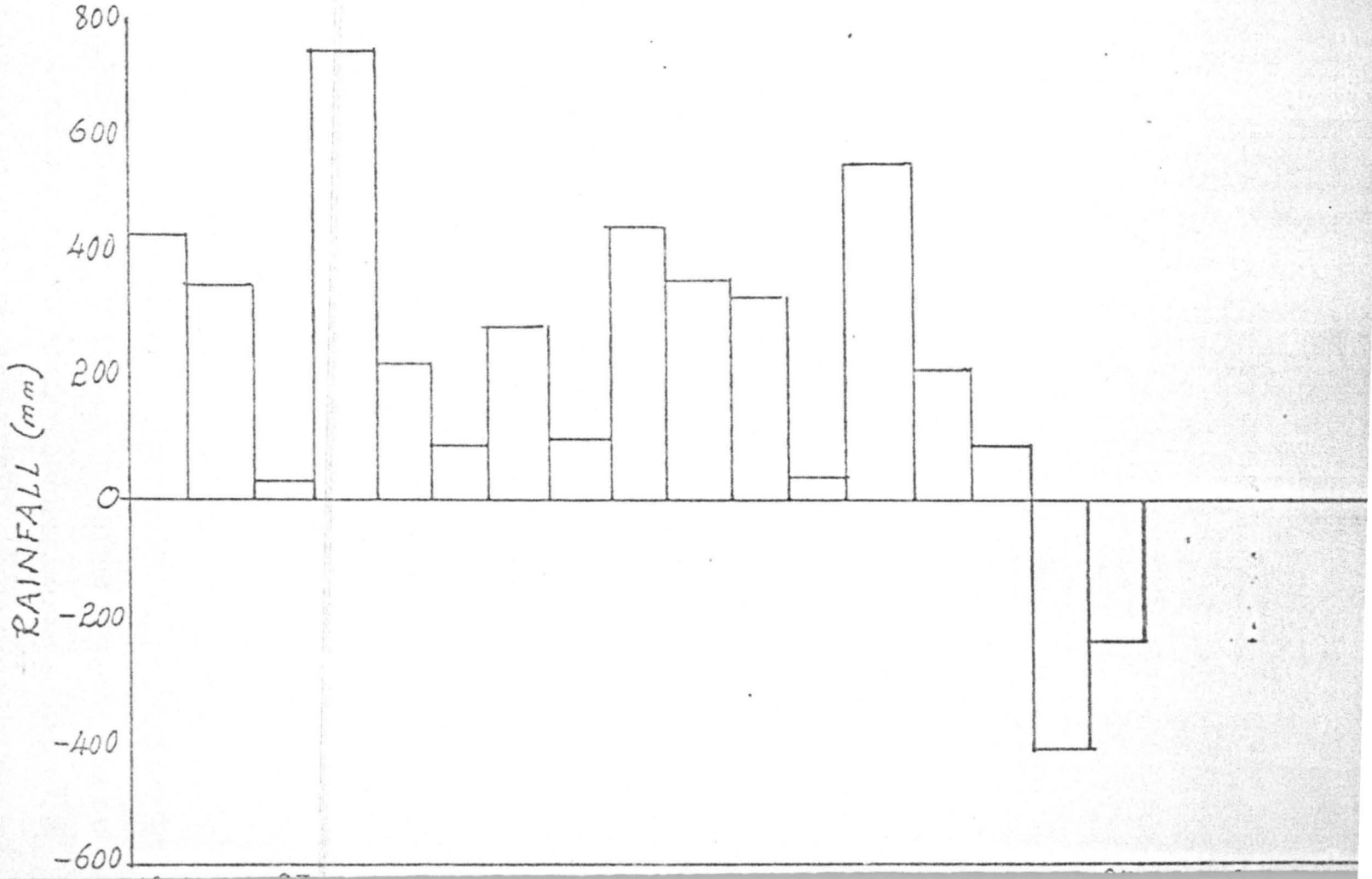
APPENDIX 5

FIG. 5.4 DEVIATION FROM THE MEAN FOR WATER WORKS.



APPENDIX 5

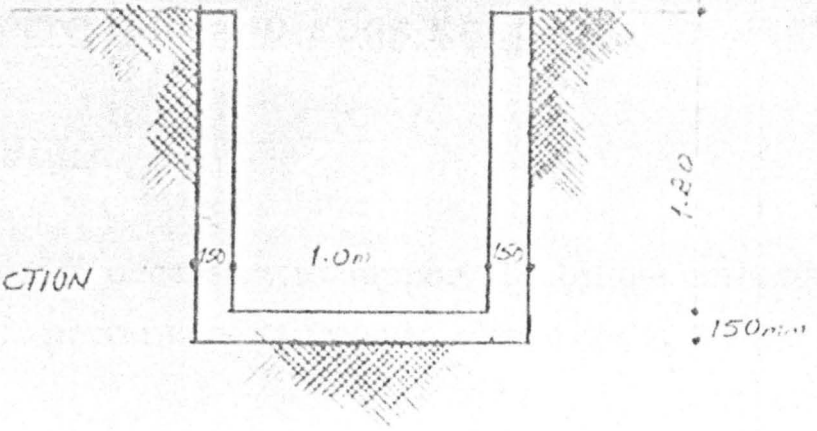
FIG. 5:5 DEVIATION FROM THE MEAN FOR EXPERIMENTAL FARM



A TYPICAL R.C WATER CHANNEL

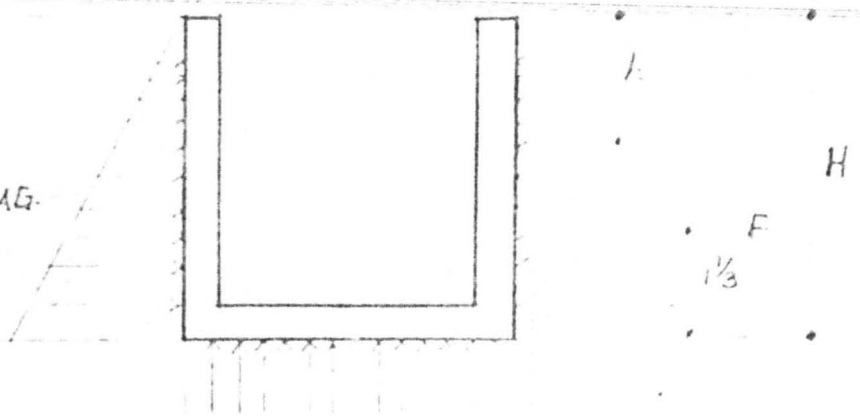
A

A CROSS SECTION



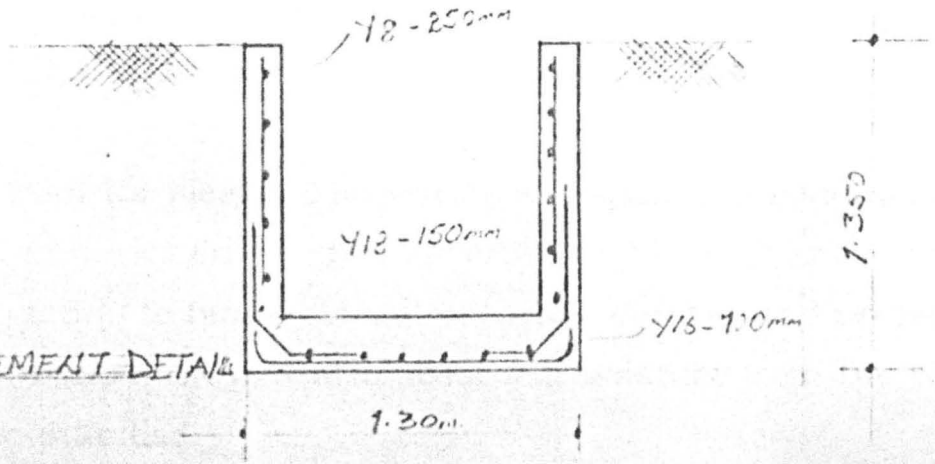
B

PRESSURE DIAG.



C

REINFORCEMENT DETAIL



SUMMARY

Efforts were made by various people to combat further erosional menance. Plate 5.15 and 5.16 show some attempts made by people to use traditional methods to reduce further damage to their environment. Plate 5.15 shows how sand bags were used to prevent further Erosional activities. Plate 5.16 also reveal the construction of stone pitching embankment to prevent further erosion.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

This work is to investigate and recommend the possible ways of providing a solution to the destructive effects of soil erosion in Kontagora Niger State by looking into the causes of the erosion menace in the area, its variable frequency and possible ways of taking preventive measures so as to avoid future occurrences and its likely consequences affiliated to soil erosion.

In general knowledge, it has been known that the major causes of soil erosion is due to hydraulic forces of water and human activities in an environment. This is because one wondered that inspite of the fact that Kontagora has no real rivers but only tributaries, but why then the erosion problem that is facing the town as of now.

In reality, the data of erosion flow characteristics are insufficient, therefore the work in gathering all the required data and analysing countless alternative in order to come up with an accurate and satisfactory results of the cause, magnitude and its assuring frequencies of erosion in Kontagora were extremely difficult. Henceforth, the results of the analysis were not hundred percent accurate but provide the following informations.

i) From datas it could be concluded that erosion can take place as a result of heavy down pour of rain that could last for several hours.

i) The hydraulic radius of most of the town's tributaries were shallow, but with greater average flow velocity.

(iii) Human interference due to his activities on land such as destruction of forests, improper drainages, construction activities, Dams Construction, Ploughing of major land areas for cultivation, growing Urbanisation to mention just a few. All these activities serves to break up the natural environment in general and in particular reduce the infiltration properties of soil which in turn promotes erosion and other land degradation.

2. The work provide a base line information on the magnitude of flood erosion occurrences in the State.

3. The work also provide a base line information that flood erosion is likely for say Ten or more years because km>k.

RECOMMENDATION

In todays modern world, the need to arrest the menace of soil erosion is widely recognised, and various soil conservation measures have to be taken at various levels to levels to deal with the problems.

In order to reduce the frequency and magnitude of soil erosion in Niger State with particular study of Kontagora environs certain control measures would be recommended. Although this measures may stave to reduce the frequency and the magnitude of erosion damages; however it cannot eliminate the residual hazard in some

race events. The following recommendations may be found suitable to avoid soil erosion menance in Kontagora.

There are two distinctive measures of erosion control:

(a) Curative Measures
(b) Preventive Measures.

On the curative sides, line of action depends mostly on the type of erosion that is involved and the attempt always taken to prevent as much damage as possible from reaching other areas e.g. gullies, sheet, rill and wind erosions.

6.1 IMPROVEMENT OF WATER CHANNELS

This involve the increasing of water way capacity. Its essence is to improve or increase the carrying capacity of channelised water way so that high discharges are accommodated without the level of water surface being raised to dangerous heights.

This can be achieved by clearing, snags, trash, accumulated materials, to be removed from the channels. However, this is a high maintenance cost because it must be periodically repeated for a more permanent improvement in replacing the natural channel with larger prismatic channel on straighter alignment.

Typical example can be see in plate 6.2 showing how the refuse heap causing meandering of the channel flow intimately overflowing of banks and a threat to the structures near the channel flow. Such work could be done manually or through the use of an earth moving machine.

6.2 CONSTRUCTING OF CONCRETE STRUCTURES AND DRAINAGES

Constructing of concrete structures as culverts, bridges, concrete line drains, to be open and wide enough for easy access of water passage and clearing of sediments to make them sustainable.

The purpose of the structures is to collect discharge and control the movement of storm water during raining seasons to the basin of the study area.

The construction of these facilities should be properly design. Non-audible roadway drainage channel on the pattern of flow of run off during the rainy season and the design should be deep enough to accommodate the velocity flow. Culvert and bridges should be wide enough with head room to allow easy passage.

Provision of open line drainages will:

(a) Prevent erosion - flood damage
(b) Provide access to residents at more location along its lengths.
(c) Improve sanitation and the aesthetic of the town
(d) Increase hydraulic capacity.

Plate 6.2 are example of concrete side line drainages to be adopted for sustainable drainage system.

6.3 STONE PITCHING AND EDGE KERBING

STONE PITCHING

This becomes necessary to support the bridge embankment of high fillv so as to pre ent erosion re-occurrence of the sides of bridges.

This result in pro iding a hard non-erodible and non-permeable surface for water to be taken right into the drain. This ensures that the soil is protected from cracking and the shearing under its own weight. This is a more sustainable way than the local way in which bags of sand were place by the sides of the channel with a iew of protecting the soil from washing awayv cracking and shearing under its own weight.

EDGE KERBING

Cambered surface of the carriageway ensures that water is drained from the pa ement to the shoulders. Because if not confined the water would drain at any a ailable section of the shoulders. The function of the Kerbs to propertly direct the run-off towards the drain at specific points called the off-shot drains.

6.4 GRASSING

Apart from its pleasant appearancev grassing is necessary on erges and embarkment to pre ent erosion. Thick grass such as carpet grass tends to binds the soil particles together and pre ent it from being washed away. It also absorbed moisture from the earth and helps to stabilise.

To attain a sustainable purposev road side grasses must be deep-rooted and must be spread rapidly and for a closely knit carpet must not grow too tall and must be capable of resisting se eral months of drought.

The ideal types of games which can be answerable to this requirement in Nigeria today are the daub and bahama grasses. There tends to grow on irtually any type of soil but preferably top soil and they are better grown at the beginning of the rain.

6.5 ENGINEERING METHOD LAND USE TREATMENT

These measures will attempt to decrease run-off by increasing infiltration and could be achie ed by contour culti ation or ploughing. Land le eling and crop residue use on crop landv bush controlv range seeding and farm pond on pastural land and tree managementv afforestation and fire control of forest land.

In addition to reduce erosion peakv land treatment will also reduce erosion damage by reducing the sediment content of the water. Land treatment function by increasing soil moisture content/

storage capacity and delaying o er land flow to reduce direct run-off while increasing inter flow and base flow.

BIOLOGICAL METHOD: This in ol e the use of organism primarily rather than tools and mechanical equipment by the manipulation of domesticated plants. Only on sloping groundsv strip cropping is used (alternati e to grain or rather crops that gi e little soil protection

with strip of close ground leaf or grain). This method can be combined with terracing or contour cultivation. Shelter belts are also useful where wind erosion is serious. This consist of planting of shrubs and trees in wind breaking barriers along windward edges of crop lands.

The use of natural vegetation and ground litter to break the force of rain and reduce its impact on bare soil in vital. Crop litter and residue on ground surfaces can be kept instead of turning under ploughing. Mulching can be done to cover soil and manure and other organic waste can be used to reduce soil erosion by improving the structure of the soil.

6.6 PREVENTIVE MEASURES

In place where soil erosion either not known or has not yet taken place a number of measures are taken in addition to the above simple curative measures to check the inception soil erosion. Among other measures include limitation of the extent of forest degradation by evolving system of cultivation which will always ensure that the ground is under effective cover of vegetation. Controlling the extent and timing of bush burning, adaptation of contour ploughing.

Introduction of inter and multiple cropping. Effective use of cover crops, Zoning and controlling the use of pastures. Other control measures are enlightenment programme and environmental education.

Provision of grazing reserves for animals as well as water supply and control is also important for soil conservation. The use of available energy source can be controlled by reforestations through

the use of solar energy and wind energy, biogas and energy conservation.

In general speaking all these suggested preventive control measures are very vital and are in some ways inter-related. For instance, the cultivation of plants and vegetation as well as their management would reduce evaporation losses, prevent or minimized soil erosion by wind and water and provide alternative sources of energy e.g. biogas.

However, the problem created by soil erosion along the stream of the study area has been traced to be partly that of human activities, hydraulic - forces of the run-off surface water and misuse of land. Hence the problem is not that of the engineering alone but to the environment.

6.7 LEGISLATIVE MEASURES

Generally, all these preventive measures can contribute only if there should be a legislative law backing them. By establishing law on the exploitation of forest and on the use of woody plants as fire wood or charcoal, by strictly sticking to the land use law (land development regulations) and establishing stick punishment on offenders. This will in no small measure will help in the conservation of our available soil.

It is hoped that the recommendation or suggestion would be enforced to make a better environment for our generation and for generation to come.

REFERENCES

Abbott M. B. (1966): An introduction to the method and characteristics. Thames & Hudion, London, & Elsevier, New York.

Agabi, J. A. Abang, S. O. and Animashun A. J. (1994) Nigeria Environment.

Arthur N. S. (1975) Physical Geography: John Wiley and Son London.

Arved J. R. (1997) Hydrology: An Advanced introduction to hydrological processes and modelling: Pengannon press Ltd. New York.

Baba J. M. (1992) sustainable development and Nigeria Environment.

Collins W. T. (1939): Run off distribution graphic from prediction occurring in more than unit Civil Engineering MC graw Hill Inc. New York.

Dansmann R. F. (1983): Environmental Conservation 5th Edition.

Daudu, H., (1999): A guide to Conservation Education.

Dunnes T & B (1978): Water in Environmental Planning Freenan and Company San-Fransisco.

Hassan R. & Hiertizer G. (1988) Deforestation from over Exploration of Natural Resources.

Kakonge J. O. (1994): Monitoring of Environment impact assessment Rev. Vol. 14 PP 295 - 304.

Linsley R. K. and Franzini J. B. (1992): Water Resources Engineering 14th edition PP 312 - 316.

Linsley R. K. Konler M. A. and Pahubus J. L. H. (1983): Applied hydrology TATA MC Graw Hill Company Ltd. New York.

Myers. N. (1989): Deforestation rate in tropical forest on their climate implication.

NEST (1991): Nigeria's Threatened Environment, A profile Ibadan A NEST Publication.

Nigerian Coaservation Foundation (1994): Environmental Education.

Ofomata G. E. K. (1991) Soil Erosion: An impediment to better life for Nigerians: Fellowship lecture.

Ojo, o. (1977) The climate of West Africa Heinamann London.

Orto Land (1984) Environmental Planning Decision Making, New York.

Petters. S. W. (1993) Environmental Problems and the challenges of Environmental Education in Nigeria. 1st Environmental Education Conference.

Salau A. T. (1993) Environmental Crisis and Development of Nigeria: University of Port-Harcout: Inaugural lecture 1993.

Statistics Office (1990): Kontagora Local Government Statistics Office.

Tomlinson M. J. (1984): Foundation Design and Construction Pitman.

World Development Report (1992) Development and the Environment World Bank; Oxford University Press.

APPENDIX 1

STATION: KONTAGORA CENTRAL

YEAR	TOTAL R/F (MM)	ANNUAL MEAN	STD DEVIATION	$\frac{X - X}{CI}$	DEVIATION FROM THE MEAN X - X
1981	1389.6	115.8	182.94	0.60	110.8
1982	1662.6	138.6		2.09	383.8
1983	1057.3	88.1		-1.21	-221.5
1984	1701.0	141.8		2.30	422.2
1985	1064.1	88.7		-1.17	-214.7
1986	1157.0	96.4		-0.66	-121.8
1987	1326.8	110.6		0.26	48.0
1988	998.7	83.2		-1.53	-280.1
1989	1321.7	110.1		0.23	42.9
1990	1346.2	112.2		0.36	67.4
1991	1235.8	103.0		-0.23	-43.0
1992	1224.9	102.1		-0.29	-353.9
1993	1379.3	114.9		2.54	100.5
1994	1411.6	95.1		-0.75	-137.2
1995	1377.5	114.8		0.53	98.7
1996	1439.0	119.9		0.87	160.2
1997	1037.6	86.5		-1.31	-241.2
1998	1275.3	106.3		-0.01	-3.5
1999	1213.0	101.1		-0.35	-65.8
2000	1226.2	102.2		-0.28	-52.6
TOTAL	25575.2				
MEAN	1278.8				

APPENDIX 2

STATION: KWANGWARA

YEAR	TOTAL R/F (MM)	ANNUAL MEAN	STD DEVIATION	X - X CI	DEVIATION FROM THE MEAN X - X
1981	1809.23	150.8	464.40	0.61	285.0
1982	1990.2	149.2		0.57	266.0
1983	1652.5	137.7		0.27	128.3
1984	2487.1	-		2.07	962.9
1985	1744.5	145.2		0.47	220.3
1986	1554.8	129.6		0.06	30.6
1987	1639.3	136.9		0.24	115.1
1988	1505.5	125.5		-0.04	-18.7
1989	1662.7	138.6		0.29	138.5
1990	1297.6	108.1		-0.48	-226.6
1991	49.8	4.2		-3.17	-1474.4
1992	1049.7	87.5		-1.02	-474.5
1993	1627.8	135.7		0.22	103.6
1994	1860.4	155.1		0.72	336.2
1995	1485.8	123.8		-0.08	-38.4
1996	1156.5	96.4		-0.29	-367.7
1997	1734.2	144.5		-0.45	210.0
1998	1820.7	151.7		0.68	296.5
1999	985.0	82.1		-1.16	-539.2
2000	1569.8	130.8		0.09	45.6
TOTAL	30483.1				
MEAN	1524.2				

APPENDIX 3

STATION: WATER WORKS

YEAR	TOTAL R/F (MM)	ANNUAL MEAN	STD DEVIATION	$\frac{X - X}{CI}$	DEVIATION FROM THE MEAN X - X
1981	1381.1	115.1	282.4	1.59	449.2
1982	1247.2	103.9		1.12	315.3
1983	926.1	77.2		-0.02	-5.8
1984	1264.5	105.4		1.18	332.6
1985	1127.0	93.9		0.69	195.1
1986	948.4	79.0		0.06	16.5
1987	1103.8	92.0		0.61	171.9
1988	1006.1	83.8		0.26	74.2
1989	952.9	79.4		0.07	21.0
1990	1211.6	101.0		0.99	279.7
1991	-	-		-	
1992	1041.1	86.8		0.39	109.2
1993	1457.8	121.5		1.86	525.9
1994	875.0	72.9		-0.20	-56.9
1995	961.0	80.1		0.10	29.1
1996	662.0	55.2		-0.76	-269.9
1997	977.4	77.3		-0.02	-4.5
1998	740.5	61.7		-0.68	-191.4
1999	584.9	48.7		-1.23	-347.0
2000	220.0	18.3		-2.52	-711.0
TOTAL	18638.4				
MEAN	931.9				

APPENDIX 4

STATION: EXPERIMENTAL FARM

YEAR	*TOTAL R/F (MM)*	*ANNUAL MEAN*	*STD DEVIATION*	*X - X / CI*	*DEVIATION FROM THE MEAN X - X*
1981	1634.0	136.2	318.96	1.34	428.5
1982	1560.3	130.0		1.11	354.8
1983	1231.3	102.6		0.08	25.8
1984	1953.8	163.7		2.35	748.3
1985	1422.7	118.6		0.68	217.2
1986	1299.6	108.3		0.30	94.1
1987	1483.6	123.6		0.87	278.1
1988	1307.8	109.0		0.32	102.3
1989	1654.4	137.9		1.41	44.9
1990	1561.9	130.2		1.21	356.4
1991	1534.0	127.8		1.03	328.5
1992	1235.6	103.0		0.09	30.1
1993	1764.6	147.1		1.75	559.1
1994	1414.7	117.9		0.66	209.2
1995	1283.5	107.0		0.24	78.0
1996	798.5	66.5		-01.28	-407.0
1997	970.1	80.8		-0.74	-235.4
1998	-	-		-	-
1999	-	-		-	-
2000	-	-		-	-
TOTAL	24110.4				
MEAN	1205.5				

APPENDIX 5

STATION: ARMY BARRACKS

YEAR	TOTAL R/F (MM)	ANNUAL MEAN	STD DEVIATION	$\frac{X - X}{CI}$	DEVIATION FROM THE MEAN X - X
1981	1423.4	118.6	185.98	1.80	336.2
1982	1368.5	114.0		1.81	281.3
1983	953.7	79.5		-0.71	-133.5
1984	1381.6	115.1		1.58	294.4
1985	950.4	79.2		0.73	-136.8
1986	1076.6	89.7	-0.05	-0.005	-10.6
1987	1163.0	96.9		0.40	75.8
1988	786.7	65.6		-1.62	-300.6
1989	1467.5	121.5		1.99	370.3
1990	1215.5	101.3		0.68	128.3
1991	1078.5	89.9		-0.04	-8.7
1992	1058.5	88.2		-0.15	-28.7
1993	1106.5	92.2		0.10	19.3
1994	928.0	77.3		-0.85	-89.2
1995	1019.4	85.0		-0.35	-67.8
1996	929.2	77.4		-0.84	-58.0
1997	1021.7	85.1		-0.35	-65.5
1998	932.8	77.7		-0.82	-154.4
1999	986.1	82.2		-0.54	-101.1
2000	908.2	75.7		-0.96	-179.0
TOTAL	21745.8				
MEAN	1087.3				