IMPACT ASSESSMENT OF SOIL EROSION IN PAIKO ENVIRONMENT

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DEDICATION

This project is dedicated to Almighty God. It is also dedicated to my parents Mr. and Mrs. Mishan Shagabe, Barrister Ishaku Ibrahim Kuta and well wishers.

ACKNOWLEDGEMENT

I would like to express my thanks to Almighty God who granted me the grace and strength and guided and sustained me throughout the period on my academic programme.

I am greatly indebted to Dr. P. S. Akinyeye my supervisor for taking time to read through my project work, making correction and offering expert suggestions and criticism.

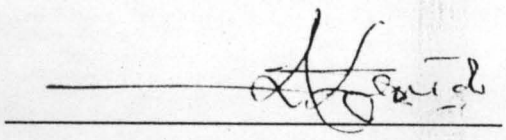
I want to thank all the staff of Geography Department for their unrelenting encouragement and guidance in the course of my study, professor Adefolalu A. A., professor J. M. Baba, Dr. G. N. Nsofor, Dr. A. A. Sadauki, Dr. A. A. Okhimamhe and Dr (mrs) A. E. Odafen.

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

DECLARATION

I hereby declare that this thesis was wholly and solely written by me under the supervision of Dr. P. S. Akinyeye. No part of this work had either been wholly or practically presented before for any degree elsewhere.

Information hereby obtained from published works and unpublished work of other have been referenced and acknowledged accordingly.



Aloysius Mishan Sodah

24/12/04

Date

CERTIFICATION

This is to certify that this project report being submitted by Aloysius Mishan Sodah to the Department of geography, federal University of technology Minna, Niger State is considered adequate and worthy of presentation for the post graduate project.

Dr. P. S. Akinyeye	5/01/05 Date
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ABSTRACT

Soil erosion occurrences have become very common with increasing frequencies both locally and globally and equally increasing losses of lives and properties. Damages include those to crops livestock, buildings and socio economic infrastructure. Today, large segments of the global human family living along low lying coast lines and along river and stream course are under constant threat of erosions. This underscores the need for this study.

Discharge and gauge height for river Chanchaga were collected and analyzed and monthly rainfall records of Paiko 1980 – 1995 aware also collected and analyzed.

The analysis work gives a statically picture of the variation of the rainfall pattern, flow hydrograph flood erosion, occurrence percentage flow hydrograph as well as the magnetic of flood erosion frequency on a climatologically basis over Paiko in Niger State.

The flow hydrograph shows a general patterns of typical rivers, characterized by a gradual rise towards July and reached its summer peak in August, but with a gradual fall in September, indicating rainfall cessation.

The frequency shows no variation in both existence interval and return with little variation in reoccurrence interval of the flood.

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CHAPTER ONE

INTRODUCTION

1.1 BASIC GROUND

Soil Erosion is one of the foremost Nigeria problems, which are inhibitive, inimical or detrimental to agricultural, economic and social growth. This has assumed a national disaster status because of its severity, acuteness extent and magnitude.

Soil Erosion, which is an evil, has a national coverage through out varying intensities. About 80% (percents) of the land in Nigeria is affected by soil erosion (NEST) 1991, sheet, gully, beach and wind erosion affect different parts of the country.

Soil erosion could be defined as an accelerated phenomenon resulting from the movement of the soil by water, wind and deposition of such detached soil elsewhere. In Nigeria soil erosion problem is currently most prominently manifested within the different geological, climatic and soil condition.

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

Splash erosion occur when raindrops strike bare soil causing it to splash as mud, to flow into spaces in the soil and to turn the upper layer of the soil into a structure less compacted mass that dries with a hard impermeable crust. Channeled erosion takes place when a

mixture of water and soil cuts channel, which is then, depends by further scouning. These types of erosion manifest in several different forms namely raindrop, erosion, sheet erosion, rill erosion and gully erosion.

Wind erosion occurs when soil particulars are transported and deposited at various distances forming sand dunes on the seacoast and inland desert comasion, which is the abrasion of rocks, by soil particles, which are defected by wind. Resistance of rock formation, the type and the shape of wind borne soil particles and wind velocity determine the intensity.

* Note — should go aff farmland description in yellow

In Paiko environment the problem of soil erosion manifested by the action of hydraulic force of water causing serious disaster and rendering many people's farm land unproductive and many houses destroyed. This has encouraged the migration of many villagers in Paiko environment to other local government areas in search of agricultural lands for farming.

The foregoing reasons prompted me to study make impact assessments of soil erosion in Paiko is a result of continues destruction of farm plots, buildings and properties by erosion.

1.2 STATEMENT OF PROBLEMS.

It is crucial to educate the citizens about the disastrous environmental impact of erosion in Nigeria of 88.5 million people with a population growth of 33.90 crammed with landmass of 928,768m^2. Because of population explosion, shifting cultivation and

bush fallowing, traditional system that were very suitable for our ecological conditions with minimal risk of erosion, are no longer satisfactory. This is because too much exposure of the land cultivation trigger soil nutrient depletion and erosion as well as deforestation, which in turn cause streams to silt up and eventually disappear.

Erosion has caused a lot of damages to agricultural lands, facilities including services roads, villages and semi-township besides, it also cause damage to main highways, cause of relatively important public utilities, loss of life, properties, serious damage to homes and commercial buildings.

1.3 JUSTIFICATION

Realizing the enormity of the problem created by soil erosion disaster in Niger State especially in Paiko environs in 1986 and 1999 which rendered many people homeless especially those living in Lugogna, Ungwar Yoruba and Papi areas all in Paiko, while settlements and various plot farms destroyed.

It is the light of this that this project intend to look into this problem of soil erosion or surface run-off in Paiko, Niger State and hope that the frame work will provide base line in formation on the following.

i. Cause of soil erosion in Paiko
ii. Its variable frequency and intensity or magnitude.
iii. Preventive Measure to avoid future damage from erosion.

1.4 AIM AND OBJECTIVES

1. To determine the causes of erosion in Paiko
2. To assess the consequences of erosion
3. To provide basic information about the variation in erosion frequency
4. To proffer possible solution to soil erosion

1.5 SCOPE AND LIMITATION

Paiko has no real river except for those tributaries Lygodna river at Meadna, Rafin TAGWAYE at Paiko and Rafin JATAU at Paiko and Chanchaga rivers. The LAPWAI river serves as main sources to the earth Dam at Chachaga and for the fact that data for erosion flow characteristics 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.

CHAPTER TWO

LITERATURE REVIEW

2.1 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. Several world conference on these critical environmental issues have been held in various parts of the world. During the earth summit in 1992 at Rio Janero in Brazil, all countries including Nigeria took an obligation under agenda 21 to reduce the loss of soil, hold back deserts, save arable land, rationally use forest and biological resources and to use their water resource properly.

Erosion by water is particularly prevalent in the humid, high rainfall areas. Heavy rainfall results in rapid water run – off. Gully erosion because of its remarkable visible effert on the landscape. The develop easily in areas of soft bedrock and often rapidly grow into enormous gullies. Areas of spectacular gully erosion in Nigeria are Anambra, Akwa Ibom, Cross River, Imo, Abia, Plateau, Bauchi and sokoto States. In the Angulli Nanka areas of Anambra Sate for instance, over 1000 hectares of land have been lost to gullies estimated to be expanding at 1% per annum for the (Ofomata 1991), other consequences associated with gully erosion are the loss of residential honses, farm crops, changes in topography and hydrology of affected areas, disruption of community lines and loss of sum of money.

The world development report in 1992 indicates that soil erosion may harm productivity by depositing silts in the dam, irrigation system and river transportation in channels, thereby damaging fisheries.

In Africa, according to United Nation Environmental programme UNEP (1984) in salau (1993), 6, 900 millions hectares covering approximately 80% of regions cropland have lost between 25% and 100% of their productive capacity.

Global assessment of soil degradation by united Nation Environmental programme (UNEP) reveals that 1.2 billion hectares, about 11% of earth's vegetation surface, have undergone moderate or severe soil degradation as a result of erosion the problem is significantly greater for developing countries in the tropics than for temperate countries in that rainfall and agricultural practices naturally promote. Soil erosion (world Development Report 1992).

Certain forms of environmental problems, although highly localized are associated with high way construction. This phenomenon has been reported by Petters (1993) and include mostly accelerated gully erosion which often occurs in the course of high way construction wherever drainage is diverted into adjoining lands often with no outlets for water, or where culverts cross the road.

The above forms of land degradation are unbiguitious along Nigeria highways for example the 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 motorway (NEST 1991) and along the Calabar–Itu high way where the millal Nigeria forest have also been wiped out (petters 1993). Petters reported the disappearance of the original swamp vegetation near the Nigeria New spring manufacturing company, now left with vast spectacular expanse of tall dead trees, which are relics of the original tropical moist forest.

The world watch institute estimates yearly topsoil loss at 25 billions tons, roughly the amount that cover Australia's wetlands. In the Nigerian punch 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. Miss Umoh therefore charge Nigerians to imbibe the culture of planting trees and beautiful they're against hazards and degradation.

In Niger State around kamji Dam and some parts of river Niger, silting occurs and reduces the efficiency of the hydroelectric power supply system by the reduction in quantity of available water for the turbine engines. Silting raise the level of river beds and beds of water reservoirs resulting in use of ground water level, there by resulting to flooding, cases of this occurrence are in Sokoto Rima

basin and also Victoria Island in Lagos, during the rainy season of 1995 and 1996 respectively.

In Minna, one cannot forget the great flood of 1986, which rendered many people homeless especially those living around Keteren-Gwari, Angwan Kaje and new markets areas of the town while various plots of farmland were destroyed.

On Sunday 18th September 1999, Nigeria Television Authoruty (NTA) Minna featured in its Newscope flood erosion disaster in Niger State with special reference to Minna and its environment. The NTA Stated that the heavy down pour of rain that lasted for five and seven hours on the 11th and 17th of September respectively. Among the areas affected mostly are Kpakungu and its environs, Bosso, Tunga and chanchaga all in Minna. It stated that River suka bridge was over flooded along Minna western bye pass, residential houses were submerged, farm and properties worth of millions o Naira destroyed and lives were lost. It further stated that other area badly flooded was Tunga, where body of a three years old girl was recovered from the flood.

In Nigeria Punch Newspaper of January 2000, the minister of environment, Alhaji Hassa Adamu descrbed Jalingo, the Taraba state capital as a didaster zone because of the area is beyond what the state government could handle. That gullies in the land orient drainage basin and grown in length from about 25, 000 to about 100,000 in lack of urban drainage, uncontrolled urban use and development and other forms of human interferences cause flood

erosion annually of life in most southern Nigeria cities (petter 1993). It can be concluded that most flood erosion disaster in nigeria are man-made. The most notorious causes are the ogunpa urban flood disaster in Ibadan in 1980, which claimed over 300 lives, and the Baganda dam burst in 1988 wich killed 146 people (NEST 1991).

Another headline on this day 6th march, 2000, flood devastated mozambigue. Mozambique fale a new on slaughter of flood water as rain which fell in south African high land over flow its banks and flooded Mozambique making most of them homeless, properties worth of millions of dollars destroyed and many lives were lost, also destructive of economic activities and infrastructure.

2.2 LOCATION

Paiko local government is located about 22 kilometers south of Minna, the Niger State capital city with latitude 9^0 30 East and longitude 6^0 30 North. The local government area is generally situated in the southern guinea zone of the savannah region. The local government shares common bound areas with Kafin-koro local government, Gurara local government, Bosso local government and Agaie local government.

It is situated between Minna and Abuja, the federal capital city. Paiko local government is serviced to Minna and Abuja by a Trunk A road, and the Minna railway station is only a few kilometres from the local government.

2.2.1 **CLIMATE: -**

This is the mean of weather condition observed at a particular place over a long period of time. These elements are made up of temperature, pressure, air masses, winds atmospheric humidity and precipitation. This exerts a dominant influence on soil formation. It determine the intensity of weathering leading and rate of organic decomposition. In fact specific soil forming processes are characteristics of each major climate zone. In the hot or warm humid one in general where there is excess precipitation over evaporation, the predominant movement of water in the profile is down wards.

2.2.2 **TOPOGRAPHY (RELIEF)**

Topography and altitude affect the formation and nature of soil in passive way, the major relief influences are steepness of the slope and position whether high or low. Soil characteristic change from hill to top to valley bottom.

CHAPTER THREE

DATA AND COMPUTATION METHOD

3.1 METHOD OF DATA COLLECTION

Streams, Rivers, Stream discharge and velocity record with meteorology data consisting of rainfall and evaporation were supplied by Niger State Water Board Minna.

The topography map of Paiko was obtained from Federal Government Library in Niger State.

Data collected from Niger State Water Board Minna include the following:-

1. Water guage height of river Chanchaga (1973-1984).
2. Discharge measurement of chanchaga River at Paiko from (1973-1984).
3. Monthly rainfall of Paiko (1980-1995).

3.2.1 ANALYSIS OF DATA

Research procedure and methodology were used in this project to describe the subjects sampled research instruments, sampling procedure, scoring techniques and method of data

(a) Forty five people among whom ten were female while thirty five were males from Paiko and its environs.

(b) Research Instrument:- The data for this project were collected by the use of a questionnaire. Informations were also obtained from library text books and journals, e.t.c. The questionnaire comprises of

some statements on impact assessment of soil erosion in Paiko and its environs.

Draft of the questionnaires were presented to some professionals in the field for modifications and the questionnaires were then given out to obtain some vital information.

(c) Sampling Procedure: - The questionnaires were administered by personal contact with the civil servants through the assistance of the village heads and youth leaders. There was an excellent return by the people.

(d) Scoring techniques:- Scoring of result was based on the following ratings. Strongly agree (20), agree (15 points), Disagree (8 points), strongly disagree (2 points).

	SA	A	D	SD
1				
2				
3				

3.2.2 METHOD OF DATA ANALYSIS

There are several methods of synthesis, but the following have been used in this work.

Histogram: This method have been used for both water guage height and monthly rainfall data collected, histogram is aimed at depicting the mean annual distribution of water guage height for

period of twelve years (1973 – 1984) as well as the means annual distribution of rainfall for the period of fifteen years (1989 – 1995).

3.3 WATER SURFACE RUN –OFF ESTIMATE

The run-off of surface depends on may factors.

1. Duration rainfall and its intensity
2. Storm frequency
3. Amount and type of vegetation cover
4. Probable changes in land use etc.

Having identified the catchments/water shed) area, terrain and land use, the rational formula is well suited for solving problem of surface run-off of drainage and roads.

The formula is expressed as

Q = 0.278 C. I. A ----- Linsley, R. L Koncer, M. A. & Pahubus LLH (1983)

Q = critical rate of run-of from such unguarded catchments in cubic metre per second (m $3^{+}/_{5}$)

C = Run off coefficient (run-off/rainfall)

I Average rainfall intensity mm/hr.

A = Catchments area (sq/cm) contributing to the run-off.

In view of the assumptive deficiency of the rational formula, the time concentration of the water shed (catchments) has been made at least equal to the duration of rainfall. Since the catchments area is considered small this formula can be used directly. The time

combination of over land flow time and conducts flow time which exist any where is the basin.

3.4 RUN – OFF COEFFICIENT

This is the ratio of run-off to that of the rain ad it is dependent on the following factors.

Rainfall Intensity: The area under study is relatively in character regarding terrain, vegetation and land use.

TABLE 3.1 VALUE FOR URBAN AREAS

ITEM	DESCRIPTION	C
1.	Flat, residential with 30% of area impervious	0.40
2.	Moderately steep, residential with about 50% of areas impervious	0.65
3.	Moderately steep, built up with about 705 of area impervious	0.80
Since	The description of the sites goes with item 2, then C value is 0.66	
	Source: Niger State Ministry of work and housing	

3.5 RAINFALL INTENSITY

This is the rate of precipitation and is expressed in M/hr

General, it is given as

$$1 = \frac{kn}{(t + a)^b} \text{ mm/hr} \text{ ------ Linsley R. L. Koncer, M.A. and Pahubus LLH (1983)}$$

Where t = The duration that is time elapsed

S = Slop of the catchments areas

K = 2.54 (A+B log 10n) A & B are constant for stations with similar rainfall regions.

However, autographic rain guage records for Niger State has provided a synthesized pea

k value of Paiko monthly rainfall as 1 = 38 2mm/hr.

3.6 DETERMINATION OF VELOCITY OF FLOW (V).

Some of the known methods of determining the velocity of flow includes-

i. Tracers method

ii. Current meter method

iii. Manning empirical formula.

The tracer (flat) was adopted because if its simplicity and very practical approach. It involves placing a very light unusoakable material called "flat at a marked point A, along the flow of storm water this was done during the rain. The float was observed travel over a distance AB of 10m. There are two observers and a clock man to start, stop and record time lapsed from the top watch. The following readings were taken flow direction.

A____ ____ ____ ____ ____ ____ ____ ____ ____ B

10m

Float travel time A to B is

T_1 = 12 seconds

T_2 = 11.6 seconds

T_3 = 11.70 seconds

$\bar{T}$ means = 11.77 seconds

V = 4t = 10/11 .77 m/n

0.85 m/s

3.7 WATER GAUGE HEIGHT OF CHANCHAGA RIVER (1973–1984)

River Chanchaga guage stage in the elevation above some arbitrary zero datum of the water surface at a station (Kinsley), kohiler, palhus 1982). The datum is some times taken as mean level but more often is slightly behold the point of zero flow in the stream. The simplest way to measure river stage is by means of a staff guage, as calibrated so that a portion of it immersed in the water at all times. The recording or automatic guage include the panch type, guage float type, bubbler gauges crest stage guage, and water or mercury filled manometer.

Abubakar (1999) estimated the height value of mean monthly low guage heights at Minna to be between the month of July and October. The value range between 2 to 3.5 m the lowest value between 0.4 – 1.2m occur between the month of December and April. This contrast with values of mean monthly guage height, the highest value occurring between the month of July and September with value ranging between 3.2–5.8. Then lowest value occurs between the months of December to April with records ranging between -1.0–1.2m. The peak occurs between August and September every year. Low flows occur mostly in March and April. This observation equally appreciable to Paiko since the two towns

lay under the same climatic zone, though the observation and conforms with the rainfall patter.

CHAPTER FOUR

METHOD OF DATA ANALYSIS AND DISCUSSION OF RESULT

There are several methods of data synthesis but the following have been used in this work.

4.1 ESTIMATE BY THE USE OF DURATION CURVE:

Discharge measurement value of Chanchaga river at Paiko were used, this is to depict the percentage of occurrence of flood erosion within the year of study (1973 – 1984)

4.2 ESTIMATE OF WATER BALANCING RIVER BASIN USING THE RELATION

$R = P - PET$ – Linsley, R. L., Konler, M. A. and Pahubus L. L. H. (1983)

where R = runoff into rive

P = Precipitation

PET = potential evapotranspiration

In order to determine the amount of water balance in any particular river basin, the amount of run off into the river basin have to be estimated or computed for us to achieve this relation simply give by

$R = P - PET$ as indicated

This mean monthly values of both P and PET as computed by Aremu for Minna for the period of ten years (1980 – 1999) will be used.

Mean monthly rainfall with corresponding mean monthly potential evapotranspiration of Paiko (1980 – 19995)mm.

Fig 4.2

Year Rain fall	J	F	M	A	M	J	J	A	S	O	N	D	Total
1980-90	1.2	0.0	14.5	39.9	109.2	157.1	204.0	266.2	195.9	86.1	27.3	0.0	1104.4
PET 1980-90	153.0	155.1	159.9	153.9	144.5	108.7	101.8	99.93	102.11	117.44	110.88	95.40	1502.75

Source: Niger State water Board

4.3 Estimate of flow index (K) using the relation:

$KM = {}^{QM}/_{QY}$ = monthly flow co-efficient of flow index

Qm = Mean monthly discharge

Qy = Mean annual discharge

The final result have been use to

1. Plot the flow hydrography
2. To determine the like hood

$K = {}^{1}/_{m} = Km$

Where M = 12 (month of the year)

4.4 ESTIMATE ON RIVER STEADINESS

The average flow velocity (V) using the relation

$V = C \sqrt{RS^2}$ M^{sec-1} Linsley, R. K. and Franzini J. B. (1992)

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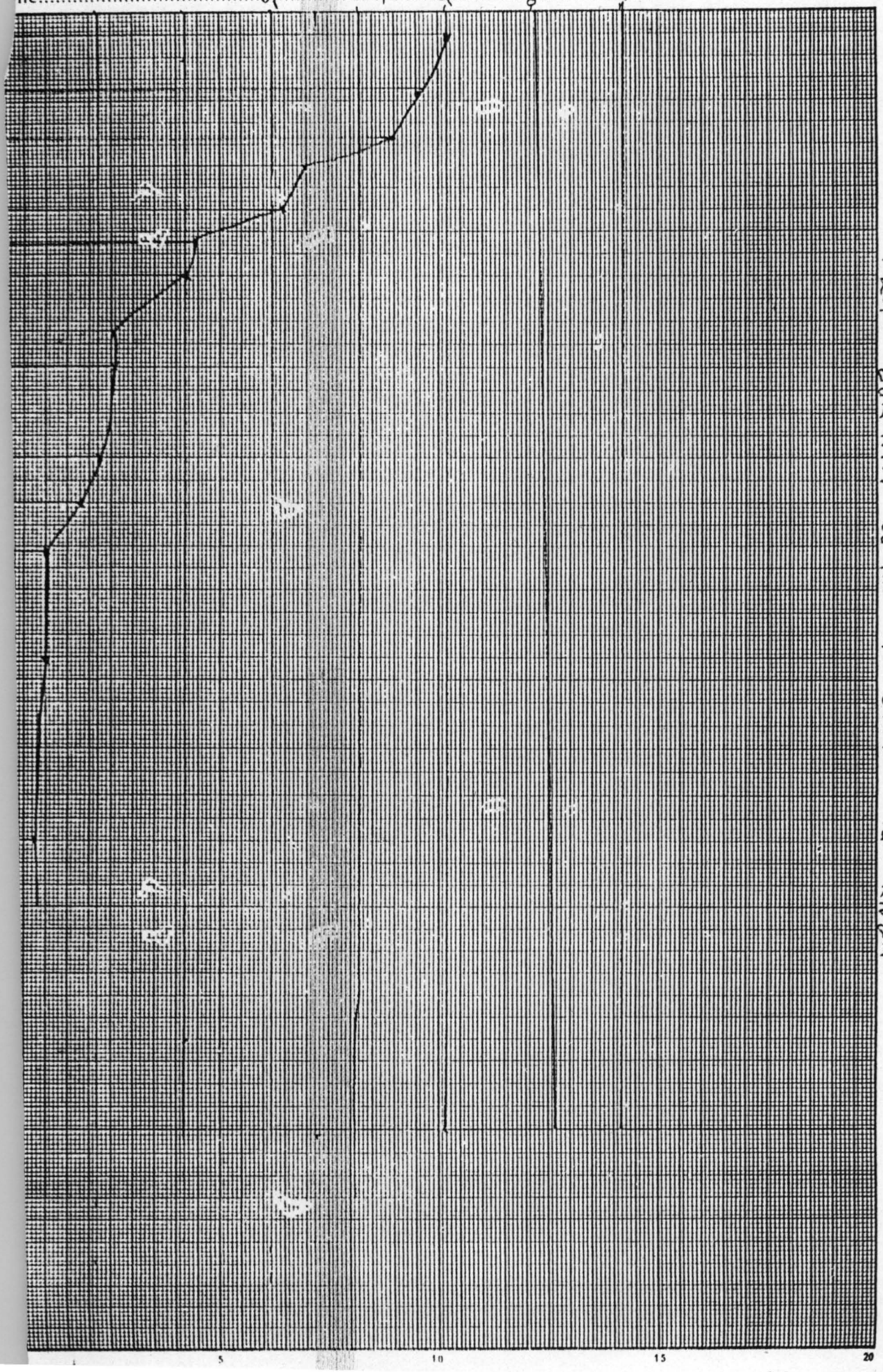

FLOW DURATION CURVE OF CHANCHAGA RIVER.

where V = average velocity flow

R = hydraulic radius

Width and depth = 2

2 2

S = gradient $\frac{(Q_2 - Q_1)}{D_2 - d_1}$ Linsley, R. K. and Franzini J. B. (1992)

$C = {}^{1}/_{n}$, $R = {}^{1}/_{6}$

N = roughness factor (We assumed this to be one (1) for Chanchaga river there is n

catarachs.

In the estimating the river steadiness of Chanchaga river one has to determine the average flow velocity (V) using the relation given.

$V = \sqrt{CRS}\ M^{sec-1}$ Linsley, R. K. and Franzini J. B. (1992)

where R = 2.49m

C = 1.16m

S = 27 computed from the available data

$V = 9.51\ M^{sec-1}$

4.5 MOVING AVERAGE CURVE

Fig 3.1 Shows the moving average curve for Paiko. The monthly rainfall records (mm) in the Appendix (1) were used for the moving average or moving mean curve. In the process the yearly average rainfall of Paiko was plotted in bar graph fashioned as shown in fig.

5.2 such as bar graph does not indicate clearly any trend or cyclic patterns in the rainfall due to abrupt variations in individual years. In order to suppress these and in order to bring forth the general trend of the rainfall, the averages of three consecutive years were found out progressively and then plotted as shown in the figure.

MEAN ANNUAL RAINFALL.

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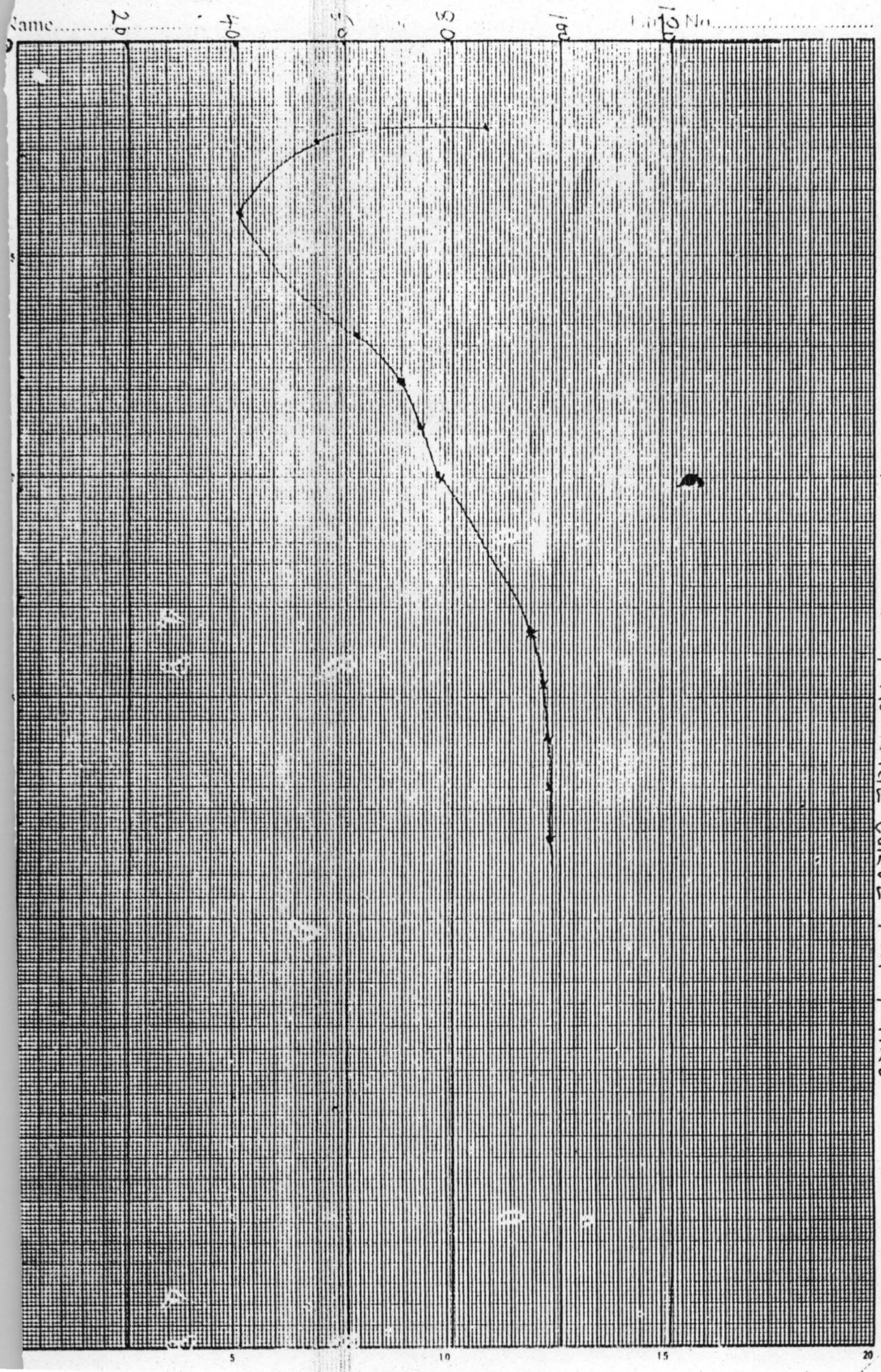

FIG 5.2 MOVING AVERAGE CURVE FOR PANKO.

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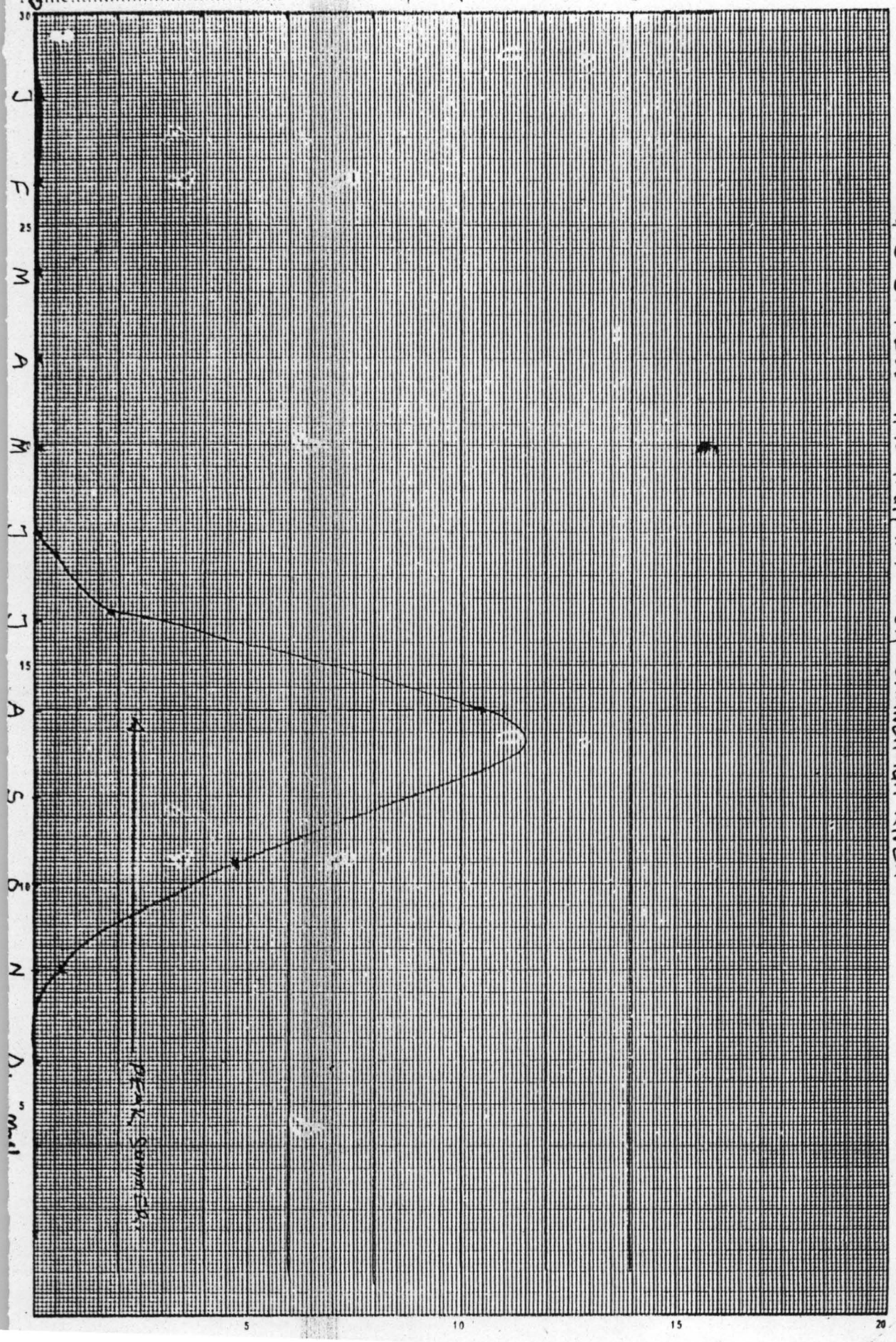


Fig. 5.3 FLOW HYDROGRAPH FOR CHANCHAGA RIVER

4.6 FLOW HYDROGRAPHY

The result which detail computation as shown in Appendix (V) were used in plotting the flow hydrograph (Fig. 5.2). The flow hydrograph has values of low index (K) plotted against months. An inspection of the flow hydrograph shows that it may be considered to consist of three parts, the concentration curve, or rising limb, the crest segment and the recession or falling Limb.

The concentration curve is a function of the time area histogram of the basin and of the duration and uniformity of the rain. The rising limb is seen to be concave upward rising showing in the early stage of the flow event and more rapidly towards the end of the rise. This tendency could be strengthened by the fact that the portion of the rainfall which is taken up by infiltration, interception and surface detention is greater in early stage of a storm, hence uniform rates of rainfall generally means steadily increasing rate of flow.

The peak is the highest instantaneous value of the flow hydrograph but the peak extend from the point on the falling side. The peak summer as observed in the flow hydrography was in the month of August, it occurs when the aggregate contribution is at maximum.

The recession curve of falling side in the figure represent withdrawal of flow, the limb is independent of time variations in rainfall or infiltration and is occasionally dependent on the physical features of the channel alone.

The flow hydrograph, however gives a general pattern of tropical river with peak summer in August. The final result obtained in Appendix (V) was to determine the likelihood of flood erosion occurrence, and from the calculation the value of Km > K which imply that flood is likely say ten or more years.

In considering the force of the flowing water alone its exerting impact and a dragging action upon the bed, can erode poorly consolidated alluvial materials such as gravels, sand, silt and clay. A river with flow velocity of 9.51m/sec. In 1970 was therefore expected to be turbid with suspended load boulders of great size may be moving over the river bed since the river gradient was steep. The hydraulic water on unconsolidated material in a short time which could result into channel deepening and undermining of the banks causes huge masses of alluvian to slump.

If these process could take place in 1970, then must expect the bed to have been built up by large amount of bed loaded supplied to the river during the first phased of heavy run-off, hence, the hydraulic radius R might have been reduced to less than 2 metres in 1986.

The graph (fig 5.5) shows the average gauge height of Chanchaga river at Minna for each month, the graph reveals the variation in the regime of the river between the summer high level and the winter low level.

CHAPTER FIVE

SUMMARY, FINDINGS , CONCLUSION AND RECOMMENDATION

5.1 SUMMARY and FINDINGS

The analysis of this work gives a statistical picture of the variation of the rainfall pattern flow hydrograph as well as the magnitude of flood erosion frequency, on a climatological basin over Paiko, Niger State. These parameters were calculated from metrorological records of rainfall as well as the discharge measurements and gauge height level supplied by the Niger State Water Board Area Office Paiko. A strong correlation were found between the seasonal variations of rainfall pattern for one year and the next.

The flow hydrography shows a general pattern of tropical rivers charascterized by a gradual rise towards July and reached its peak summary in August but with a gradual fall in September dictating rainfall cessation. The frequency analysis shows no variation in both excedence interval and returns period respectively but with little variation in reoccurrence interval of the flood.

5.2 CONCLUSION

This work was to investigate the possible ways of providing a solution to the destruction to effect of erosion in Paiko Niger State by looking into the causes of erosion, its variable frequency and the preventive measures to be taken as to avoid damages from erosion.

Generally, soil erosion is been caused due to hydralic forces of water and human activities (interference). But one has to be wondered that in spite the fact that Paiko has only a single River (Chanchaga)

that passes through the surrounding of the town yet erosion is pronounced in some part of the town. Actually, the data of erosion flood characteristics are insufficient therefore the work in gathering all the required data and analyzing countless alternative in order to come up with an accurate and satisfactory result of the causes magnitude of the frequency of erosion in Paiko were extremely difficult, hence of the analysis were not hundred percent accurate.

5.3 RECOMMENDATION

The need to arrest the wasteful trend in soil erosion loss has been widely recognized and various soil conservation measures has to be taken at various level to deal with the problems.

In order to reduce the frequency and magnitude of erosion in Paiko, Niger State with particular study of Garage motor park environment with Chanchaga River, erosion control measures would be recommended. However, this is measure strive to reduce the frequency and the magnitude of erosion damages. But cannot eliminate the residual hazard from rare event. The following recommendations become handy to avoid menacing effect of erosion in Paiko.

Two broad measures of controls: Curative and preventive measures. On the curative side the lines of action depends mostly on the type of erosion involved and the attempt has always been to prevent as much as possible from reaching the areas e.g. gullies, wind, sheet and rill erosion.

5.4 CHANNEL IMPROVEMENT

This method improves or increase the capacity of waterway. The erosion of channel improvement is to increase the conveyance capacity so that high discharge are passed without the level of water surface being raised to dangerous height. The increase capacity brought by clearing, snags, trash, accumulated materials, needs from the channel has a relatively low first cost, but high maintenance cost because it must be periodically repeated for a more permanent improvement in replacing the natural channel with large pris-matic channel on straighter alignment.

5.5 CONCRETE STRUCTURES AND DRAINAGES:

These structures can be culverts, bridges, concrete, line drains, dykes. The line drain should be open drain for easy access of water passages and clearing of sediments.

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

The provision of this facilities should be adequately design non-audible roadway drainage channel on the pattern of flow of run off during the raining season and the design should be deep enough to accommodate the velocity flood and culvert, and bridges should be wide enough with head room to allow easy passage.

Provision of the open line drain will be:

i. Prevent erosion flood damage

ii. Provide access to residents at more locating along its lengths.

iii. Improve sanitation and accentuate the aesthetic of the area.

iv. Increase hydralic capacity

5.6 PROVISION OF STONE PITCHING AND EDGE KERBING

5.6.1 STONE PITCHING

As part of the permanent work to support the bridge embankment of high fill. This becomes necessary so as to prevent erosion reoccurrence of the sides.

Stone – pitching proves a hard non-erodible and non-permeable surface for water to be taken right into the drain as well as ensuring that the soil in protected from cracking and tearing under its own weight.

5.6.2 EDGE KERBING:

During the rains, clambered surface of the carriageway ensure that water is drained at any available section of the shoulders. The functions of the kerbs is to properly direct the run-off towards the drain at specific points called the off-shoot drain.

5.7 ENGINEERING METHODS OF LAND USE TREATMENT.

These measures will attempt to decrease run-off by increasing infiltration and could be achieved by contour cultivation or ploughing, land leveling and crops residue use on crops land, bush control, range seeding and farm pond on pasture land and tree management, afforestation and fire control of forest land.

In addition to reduce erosion peak, land treatment will also reduce erosion damage by reducing the sediment content of the water. Land treatment functions by increasing soil moisture storage capacity and delaying over land flow to reduce direct run-off while increasing inter flow and base flow.

5.7.1 **BIOLOGICAL METHOD**

Biological method which is the use of organism primarily rather than tools and mechanical equipment by the manipulation of domesticated plants, only sloping grounds, strip cropping the (alternative of grain in other crop that give little soil protection with strip of close ground leaf or grass sod) is used. This method can be combined with terracing or contour cultivation, shelter belts are useful where wind erosion is serious. This consist of planting of shrubs and trees in wind breaking barriers along wind ward edge of crop lands.

The use of natural vegetation and ground litter to break the force of rain and reduce impact on bare soil in vital, crop litter residue on ground surface 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.

5.7.2 **GRASSING**

Grass, apart from its pleasant appearance, is necessary on verges and embankment to prevent erosion. Thick carpet of grass binds the earth together and its being washed away. It also absolve moisture

from the earth and helps to stablize it to be suitable for their purpose, road side grasses must be deep rooted and must spread rapidly for closely knit carpet most not grow too fall and must resist several month of drought. The ideal types, which can be answerable to this requirement in Nigeria today, are the shrub and bahama grasses. They grow on virtually any type of soil but preferably top soil and are better grown at the beginning of the rain.

5.8 PREVENTIVE MEASURES

Where the incidence of erosion in either not known or not serious a number of measures are taken in addition to the above simple curative measures to check the interception of soil erosion. These 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 end timing of bush burning, adaptation of contour ploughing.

Introduction of inter and multiple cropping and effective use of cover crops, zoning and controlling the use of pasture, other control measures are enlightenment programme and environment education.

The 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 reforestation through the use of solar energy and wind energy, biogas and energy conservation (by way of establishing law on the

exploitation of forest and on the use of woody plants valued of firewood or charcoal.

Generally, all these suggested controls are all very vital and they are in some ways inter-related for instance, the cultivation of and their management would reduce evaporation losses, prevent or minimize soil erosion by wind and water and provide alternative sources of energy e.g. biogas.

The problem created at the river Chanchaga has been traced to human activities and hydraulic forces of water. Hence the problem is not of the engineering alone but of the environment. Furthermore, before4 any such construction is embark upon the environment. impact assessment and monitoring team should be informed for assessment before the project takeoff.

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

MONTHLY RAINFALL RECORD (MM)

Station: Minna

At: 90.37

Tem. 60.32

Cal	Jan	Feb	Mar	Apr	May	June	July	Aus	Sep	Oct	Nov.	Dec	Total	Mcan
1978				4.7	122.6	138.6	212.7	390.3	383.1	94.7			1366.4	113.0
1979			17.4	186.6	212.2	67.3	211.7	367.5	196.6	78.7			1317.0	109.7
1980						111.3		127.8	111.6	78.1			1114.8	34.56
1981				7.8		137.2							145	12.08
1982													108.1	75.67
1983				77.1	21.32	132.03	244.7	152.92	231.2	152.9			1047	84.52
1984					70.4	73.47	140.7	213.9	178.0	37.2			713.61	59.47
1985			3.0	54.6	81.2	114.3	214.8	1135.6	148.1	73.3			874.1	72.9
1986			61.2	17.3	141.7	250.6	233.3	299.7	176.6	61.0			1171.4	99.2
1987			39.6	15.4	86.0	183.3	221.7	243.0	115.8	83.8	17.6		1202.2	100.(
1988			13.50	44.60	104.50	83.90	143.7	238.5	94.60	100.10			873.40	72.7
1989	8.0		38.0	121.0	81.50	132.0	211.3	350.1	103.6	3310			1135.60	119.
1990			5.0	19.5	165.5	316	173.7	248.7	202.0	79.0			1257.9	107.

River name: Chanchaga Station: Paiko

Code Number: Catchments area: 58.11

Agency: Niger State Water Board State: Niger

Latitude: 9^0 30 east and Longitude 6^0 30 North

Gauge height level 1996

ate	Jan	Feb	Mar	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	15.61	15.61	15.03	14.53	14.07	13.73	13.92	15.62	16.17	16.39		16.03
2	15.61	15.66	15.03	14.51	14.03	13.73	13.92	15.67	16.24	16.29		16.04
3	15.64	15.60	15.01	14.51	14.01	13.71	13.75	15.75	16.23	16.28		16.05
4	15.65	15.59	15.06	14.50	13.99	13.70	13.75	15.88	16.21	16.28		16.06
5	15.64	15.59	14.98	14.49	13.98	13.71	13.97	15.75	16.27	16.27	16.00	16.06
6	15.64	15.58	14.96	14.43	13.96	13.70	13.99	16.04	16.28	16.26	15.98	16.05
7	15.64	15.59	14.95	14.47	13.94	13.71	13.62	16.08	16.29	16.25	15.95	16.04
8	15.65	15.57	14.93	14.96	13.95	13.72	14.63	16.10	16.29	16.24	15.92	16.03
9	15.65	15.59	14.92	14.45	136.96	13.73	14.64	16.09	15.29	16.23	15.90	16.02
10	15.65	15.55	14.91	14.44	13.97	13.74	14.65	16.08	15.29	16.22	15.97	16.01
11		15.53	14.81	14.43	13.90	13.75	14.58	163.07	16.28	16.21	15.85	16.01
12	15.66	15.52	14.98	14.42	13.91	13.76	14.11	16.08	16.26	16	15.84	16.01
13	15.66	15.51	14.87	14.41	13.90	13.77	14.12	16.07	16.25	16.19	15.81	16.01
14	15.66	15.49	14.86	14.40	13.89	13.78	14.76	16.06	16.24	16.18	15.78	16.01
15	15.65	15.45	14.85	14.39	13.88	13.79	14.77	16.06	16.23	16.15	15.79	16.01
16	15.65	15.48	14.84	14.38	13.87	13.80	14.19	16.05	16.22	16.14	15.76	16.01
17	15.65	15.47	14.83	14.37	13.86	13.81	14.21	16.05	16.21	16.13	15.76	16.01
18	15.65	15.96	14.82	14.36	13.85	13.80	14.23	16.01	16.25	16.12	15.74	16.01
19	15.64	15.45	14.31	14.35	13.84	13.79	14.27	16.06	16.21	16.11	15.73	16.01
20	15.64	15.44	14.80	14.32	13.82	13.79	14.30	16.06	16.20	16.10	15.72	16.01
21	15.64	15.43	14.79	14.31	13.83	13.81	14.33	16.07	16.17	16.09	15.71	16.01
22	15.63	15.40	14.79	14.30	13.83	13.82	14.36	16.06	16.18	16.08	15.80	16.01

23	15.63	15.43	14.77	14.23	13.84	13.84	14.38	16.06	16.17	16.08	15.79	16.01
24	15.64	15.35	14.76	14.23	13.80	13.84	14.40	16.06	16.19	16.07	15.78	16.01
25	15.63	15.35	14.75	14.21	13.79	13.85	14.42	16.07	16.24	16.07	15.72	16.01
26	15.63	15.32	14.74	14.19	13.78	13.84	14.41	16.08	16.24	16.05	15.72	16.01
27	15.62	15.32	14.73	14.15	13.78	13.83	14.46	16.08	16.25	16.04	15.71	15.99
28	15.61	15.30	14.72	14.13	13.78	13.89	14.45	16.09	16.27	16.04	15.70	15.99
29	15.61	15.29	14.70	14.11	13.76	13.90	14.45	16.10	16.27	16.02	15.70	15.92
30	15.61	15	14.69	14.69	13.75	13.91	14.50	16.12	16.30	16.02	15.70	15.97
31	15.60		14.68	14	13.74		14.53	16.12		16.02		16.97
Min	15.19	15.48	14.92	14.36	13.88	13.70	14.76	16.02	17.03	16.15	13.65	
Max	15.67	15.61	15.05	14.53	14.07	13.91	14.53	16.12	16.30	15.29	16.00	16.06
Min	15.69	15.27	14.69	14.09	13.74	13.70	13.72	15.52	16.17	18.02	15.57	15.97

Annual statistic

Mean = 15.05, Max. = 16.19, Min = 13.17

River name: Chanchaga Station: Minna

Code Number: Catchments area: 53.041cm^3

Agency: Niger State Water Board State: Niger

Gauge height level 1997

Date	Jan	Feb	Mar	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	13.62	13.19	12.76	14.67	14.25	14.82	14.52	14.65	15.91	14.18	14.37	14.14
2	13.61	13.17	12.74	14.68	14.24	14.87	14.52	14.67	15.90	14.17	14.37	14.12
3	13.60	18.16	12.71	14.67	14.23	13.98	14.51	14.71	15.83	14.16	14.31	14.10
4	13.61	13.14	12.71	14.61	14.21	13.99	14.51	14.76	15.07	14.16	14.36	14.08
5	13.58	13.12	12.64	14.63	14.20	13.99	14.53	14.79	15.01	14.17	14.34	14.16
6	13.57	13.11	12.65	14.67	14.19	14.64	14.52	14.82	15.04	14.14	14.34	14.04
7	13.56	13.10	12.66	14.69	14.17	14.10	14.54	14.84	15.03	14.15	14.33	14.09
8	13.55	13.09	12.67	14.62	14.16	14.15	14.54	14.87	15.01	14.16	14.33	14.06
9	13.57	13.08	12	14.61	14.17	14.19	14.52	14.91	15.07	14.25	14.32	14.68
10	13.53	13.07	12.59	14.51	14.11	14.25	14.50	14.91	15.00	14.28	14.32	14.99
11	13.51	13.07	12.55	14.55	14.09	14.28	14.48	14.90	15.78	14.32	14.31	14.96
12	13.47	13.06	12.51	14.54	14.07	14.31	14.66	14.90	15.95	14.36	14.31	14.97
13	13.47	13.06	12.47	14.56	14.07	14.35	14.45	14.90	15.92	14.37	14.30	14.91
14	13.45	13.05	12.43	14.55	14.04	14.37	14.45	14.91	14.89	14.37	14.30	13.88
15	13.43	13.05	12.39	14.51	14.04	14.39	14.46	14.91	14.87	14.37	14.29	14.87
16	13.40	13.02	12.37	14.53	14.02	14.40	14.45	14.92	14.84	14.38	14.28	14.86
17	13.38	13.01	12.35	15.52	13.99	14.42	14.43	14.92	14.79	14.38	14.27	13.84
18	13.36	12.78	12.33	15.51	13.98	14.44	14.42	14.96	14.71	14.39	14.26	13.82
19	13.35	12.95	12.32	14.50	13.95	14.47	14.40	14.97	14.70	14.39	14.25	13.81
20	13.34	12.93	12.31	14.49	13.93	14.49	14.40	15.64	14.69	14.40	14.24	13.77
21	13.33	12.92	12.30	14.48	13.89	14.50	14.40	15.15	14.57	14.40	14.23	13.78
22	13.32	12.90	12.28	14.47	13.86	14.51	14.41	15.16	14.47	14.40	14.22	13.76
23	13.31	12.89	12.27	14.46	13.84	14.52	14.42	14.51	14.44	14.40	14.20	13.74

24	13.30	12.89	12.25	14.43	13.82	14.53	14.44	15.47	14.41	14.40	14.19	13.72
25	13.29	12.86	12.22	14.49	13.80	14.54	14.44	15.57	14.31	14.39	14.18	13.70
26	13.28	12.86	12.21	14.31	13.36	14.54	14.50	15.75	14.30	14.39	14.17	13.18
27	13.27	12.83	12.19	14.36	13.79	14.55	14.50	15.92	14.25	14.38	14.17	13.66
28	13.26	12.81	12.13	14.39	13.79	14.54	14.60	15.99	14.25	14.38	14.16	13.66
29	13.25	12.19	12.13	14	13.79	14.53	14.60	15.99	14.70	14.37	14.15	13.14
30	13.24		12.13	14.38	13.78	14.52	14.68	15.10	14.18	14.37	14.15	13.63
31												
Min	13.29	12.21	12.20	14.50	13.57	14.63	14.70	15.15	14.20	14.38	14.15	13.60
Max	13.50	13.48	12.45	15.53	14.02	14.50	14.57	16.22	15.55	13.20	13.22	12.50
Min	13.97	14.30	13.40	14.43	13.05	15.02	15.33	14.30	13.06	13.45	14.30	13.40

Annual statistics

Mean = 13.97, Max. = 16.10, Min = 13.06

Gauge height level 1998

Date	Jan	Feb	Mar	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	13.35	12.85	14.40	11.93	11.82	11.35	11.99	12.75	15.01	15.15	14.91	14.43
2	13.33	12.83	12.39	11.93	11.99	11.39	11.98	12.75	15.09	15.13	14.91	14.38
3	13.32	12.81	12.39	11.90	11.77	11.66	11.97	12.75	15.10	15.11	14.90	14.31
4	13.31	12.74	12.35	11.88	11.78	11.10	11.96	12.76	15.11	15.09	14.89	14.27
5	13.29	12.75	12.34	11.86	11.70		11.94	12.76	15.11	15.01	14.88	14.21
6	13.28	12.76	12.32	11.83	11.60		11.94	12.75	15.14	15.64	14.88	14.61
7	13.26	12.75	12.31	11.81	11.63	12.12	11.99	12.75	15.16	15.00	14.87	14.11
8	13.25	12.72	12.30	11.79	11.60	12.13	11.93	12.75	15.16	14.97	14.87	14.65
9	13.24	12.72	12.23	11.71	11.56	12.12	11.93	12.01	15.18	14.94	14.87	14.06
10	13.23	12.71	12.28	11.74	11.53	12.12	11.94	13.01	15.20	14.94	14.86	13.94
11	13.22	12.69	12.27	11.72	11.56	12.11	12.01	13.10	15.22	14.96	14.85	13.96
12	13.22	12.60	12.26	11.70	11.48	12.11	12.05	13.18	15.25	15.94	14.84	13.64
13	13.21	12.68	12.25	11.67	11.44	12.10	12.26	13.17	15.25	15.94	14.83	13.81
14	13.21	12.64	12.24	11.66	11.42	12.10	12.27	13.24	15.25	14.94	14.81	13.78
15	13.20	12.62	12.21	11.64	11.37	12.10	12.47	13.71	15.26	14.94	14.79	13.16
16	13.18	12.66	12.26	11.62	11.32	12.08	12.51	13.77	15.24	14.95	14.78	13.73
17	13.16	12.59	12.19	11.61	11.30	12.06	12.66	13.76	15.25	14.95	14.77	13.69
18	13.14	12.57	12.18	11.91	11.33	12.04	12.57	13.76	15.20	14.96	14.75	13.65
19	13.14	12.56	12.17	11.90	11.31	12.04	12.64	13.78	15.20	14.96	14.74	13.63
20	13.06	12.53	12.16	11.95	11.28	12.04	12.64	13.77	15.22	14.96	14.73	13.59
21	12.19	12.51	12.15	11.92	11.26	12.07	12.63	13.76	15.21	14.97	14.77	13.57
22	12.97	12.49	12.15	11.89	11.24	12.01	12.61	13.77	15.19	14.95	14.76	13.54
23	12.95	12.47	12.15	11.87	11.23	12.01	12.61	14.01	15.21	14.96	14.68	13.52
24	12.99	12.45	12.15	11.84	11.21	11.99	12.65	14.08	15.23	14.97	14.61	13.57
25	12.93	12.44	12.14	11.32	11.19	11.93	12.76	14.22	15.25	14.93	14.64	13.48

26	12.92	12.43	12.13	11.90	11.17	11.97	12.76	14.27	15.23	14.93	14.61	13.44
27	12.90	12.42	12.12	11.88	11.15	11.95	12.77	14.42	15.20	14.93	14.57	13.42
28	12.89	12.74	12.11	11.86	11.14	12.00	12.78	14.56	15.18	14.93	14.54	13.41
29	12.88		12.09	11.84	11.15	13.02	12.32	14.56	15.17	14.93	14.51	13.39
30	12.87		12.05	11.84	11.51	12.03	12.86	14.43	15.16	14.93	14.41	13.37
31	12.86		12.01		11.52		12.86	14.75		14.93		13.36
Min	13.11	12.65	12.21	11.85	11.44	11.19	12.37	13.62	15.19	14.94	14.76	13.79
Max	13.36	12.85	12.40	12.03	11.82	12.13	12.86	14.75	15.27	15.15	14.91	14.61
Min	12.86	12.42	12.01	11.62	11.14	11.55	11.93	12.75	15.01	14.92	14.47	13.36

Annual statistics

Mean = 13.09, Max. = 15.29, Min = 11.14

Gauge height level

Date	Jan	Feb	Mar	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	15.67	15.61	15.83	14.07	14.07	13.73	13.92	15.50	16.17	16.29		16.03
2	15.61	15.60	15.03	14.54	14.63	13.73	13.90	15.67	16.24	16.29		16.04
3	15.66	15.60	15.01	14.51	14.01	13.71	13.95	15.75	16.23	16.28		16.05
4	15.65	15.59	15.01	14.50	13.99	13.74	13.95	15.88	16.21	16.28		16.06
5	15.64	15.59	14.98	14.49	13.98	13.71	13.97	15.98	16.27	16.27	16.65	16.06
6	15.64	15.58	14.96	14.48	13.96	13.70	13.99	16.04	16.28	16.26	15.95	16.05
7	15.64	15.58	15.95	14.47	13.97	13.71	13.02	16.08	16.29	16.25	15.95	16.04
8	15.65	15.57	14.93	14.46	13.95	13.72	14.03	16.10	16.29	16.24	15.77	16.03
9	15.65	15.56	14.92	14.45	13.94	13.73	14.04	16.09	16.29	16.23	15.70	16.02
10	15.65	15.55	14.91	14.44	13.97	13.70	14.05	16.08	16.29	16.22	15.87	16.01
11	15	15.53	14.89	14.43	13.94	13.75	14.08	16.07	16.29	16.21	15.88	16.01
12	15.66	15.52	14.88	14.42	13.91	13.76	14.10	16.06	16.28	16	15.89	16.01
13	15.66	15.51	14.87	14.41	13.90	13.71	14.12	16.07	15.25	16.19	15.81	16.01
14	15.66	15.49	14.86	14.40	13.89	13.78	14.15	16.06	15.24	16.18	15.81	16.01
15	15.66	15.45	14.85	14.39	13.88	13.79	14.17	16.06	16.23	16.15	15.78	16.01
16	15.65	15.48	14.84	14.38	13.87	13.80	14.19	16.05	16.22	16.14	15.79	16.01
17	15.65	15.47	14.83	14.37	13.26	13.81	14.21	16.05	16.21	16.13	15.76	16.01
18	15.66	15.46	14.82	14.36	13.85	13.80	14.23	16.04	16.25	16.12	15.76	16.01
19	15.64	15.45	14.81	14.35	13.84	13.79	14.27	16.06	16.21	16.11	15.79	16.01
20	15.64	15.44	14.88	14.32	13.82	13.79	14.30	16.06	16.20	16.10	15.93	16.01
21	15.64	15.43	14.79	14.31	13.83	13.81	14.33	16.07	16.19	16.09	15.92	16.01
22	15.63	15.40	14.78	14.30	13.82	13.82	14.34	16.06	16.18	16.08	15.71	16.01
23	15.63	15.38	14.77	14.23	13.81	13.84	14.33	16.06	16.17	16.08	15.80	16.01
24	15.64	15.37	14.76	14.23	13.80	13.84	14.46	16.06	16.19	16.07	15.74	16.01
25	15.63	15.35	14.75	14.21	13.79	13.85	14.42	16.07	16.24	16.07	15.72	16.01
26	15.63	15.39	14.74	14.19	13.78	13.84	14.41	16.08	16.24	16.65	15.72	16.01

27	15.62	15.37	14.73	14.15	13.77	13.83	14.44	16.08	16.25	16.64	15.71	15.99
28	15.62	15.30	14.72	14.13	13.78	13.89	14.45	16.09	16.27	16.64	15.70	15.99
29	15.61	15.29	14.71	14.11	13.74	13.90	14.40	16.10	15.29	16.62	15.70	15.98
30	15.61		14.70	14.09	13.75	13.91	14.50	16.12	16.30	16.62	15.70	15.98
31	15.60		14.69		13.74		14.53	16.12		16.62		15.99
Min	15.19	15.45	14.92	14.30	13.88	13.76	14.16	16.03	17.03	16.15	13.74	16.06
Max	15.67	15.61	15.03	15.53	14.07	13.01	14.53	16.12	16.30	15.29	16.00	16.06
Min	15.68	15.29	15.79	14.07	13.74	13.70	13.92	15.52	16.17	16.02	15.57	15.76

Annual statistics

Mean = 15.05, Max. = 16.39, Min = 13.70

REFERENCE

Aboot M. B. (1966): An introduction to the method and characteristics. Thames & Gudson, London, & Elsevier N. Y.

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

Aothur, N. S. (1975) Physical geography: John Niley and Son London

Arved, J. R. (1997) Hydrology: An Advanced Introduction hydrological processes and modeling; Pergannan press Ltd New York.

Baba, J. M. (1992) Sustainable development and Nig. Environment

Collins, W. T. (1939) Run off distribution graphic from prediction occurring in more than unit civil engineering Mc grow Hill Inc. New York.

Dansmann, R. F. (1983) Environmental conservation 5th Edition

Dauda, H (1999) A guide to conservation education

Dunnes, T & B (1978) Water in Environmental Polanning freeman and Company sen-Dransisce.

Hassan R & Hertizer, G (1988) Deforestation from over exploitation of natural resources.

Kakonge, J. O. (1994) Monitoring of Environment Impact Assessment Rev. Vol. 14pp 295 – 304.

Linsley, R. K. & Franzini, J. B. (1992) Water resources Engineering 14th Edition pp312 – 316.

Linsley, R. L, Konler, M. A. and Pahubus, L. L. H. (1983) Applied hydrology TATAMC grow Hill company Ltd New York.

M Yers, N. (1989) Deforestation rak in tropical forest on their climate implication

NEST (1991) Nigeria's threatened Environment. A profile Ibadan. A NEST pablication.

Nigerian Conservation Foundation (1994) Environmental Education

Ofomata G. E. K. (1991) Soil Erosion: An impediment to better life for Nigerians: fellowship lecturer 34th Annual Conference of the Nigerian geographical Association, Alvan Ikoku College of Education, Owerri, April 7/11/1991

Orto Land (1984) Environmental planning Decision making, New York.

Patifriro, M. P. (1996) Strategic environmental from recent practice: Environmental Assessment Rev. Vol. 16, No 1, pp 31 – 55.

Petters, S. W. (1993) Environmental problems and the challenges of Environmental Education in Nigeria first National Conference on Environmental Education Conference proceeding: The Nigerian Conservation Foundation.

Salau, A. T. (1993) Environmental Crisi and development Nigerian University of Port-Harcourt. Inaugural lecture Series No 13, 1993.

Statistics Office (1990) Niger State Statistical year Book pp 3

Tomlinson, M. J. (1984) Foundation Design and Construction Pitman Pp 304 – 306.

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

IMPACT ASSESSMENT OF SOIL EROSION IN PAIKO AND IT ENVIROUNS

Instruction: Please tick (✓) in any option that agrees with your choice

A. Identification of respondent.

1. State:.....
2. Local Government Area:.....
3. Village:.....
4. Age of Respondent:.....

i. Up to 25 years		ii. 26 years	
iii. 36 – 45 years		iv. 56 – 65 years	
v. None			

5. Level of Literacy.

i. Primary School		ii. Secondary School	
iii. Post Secondary School		iv. Advance Education	
v. Arabic/Christian		vi. None	

6. What is your major Occupations

i. Crops Faming		ii. Livestock Farming	
iii. Fish farming		iv. Hunting	
v. Civil Servant		vi. None	

B. ***The Advancement of Soil Erosion in Paiko Area.***

1. Type of Soil

a. Sandy Soil ☐ b. Loam Soil ☐

c. Sandy Loam ☐ d. Clay Soil ☐

2. Type of Soil Erosion

a. Water Erosion ☐ b. Rill Erosion ☐

c. Wind Erosion ☐ d. Gully Erosion ☐

e. Sheet Erosion ☐

3. Action

	SA	A	D	SD
a. Emerges Rapidly				
b. Water Erosion is much Prominent				
c. Wind Erosion is less Pronounce				
d. Rill Erosion more Pronounce				
e. Sheet Erosion less Prominent				

4. Method of Farm Operation

a. Manual ☐ b. Mechanical ☐

c. Animal Traction ☐

5. Type of Crop Grown

a. Yam ☐ b. Sorghum ☐ c. Rice ☐

d. Yam/rice ☐ e. Yam/Sorghum ☐

6. Drainage System

a. Individual Effort ☐ b. Community Effect ☐

c. Government ☐

7. The Causes of Soil Erosion

a. Frequent Felling of Trees ☐

b. Continuous Cropping ☐

c. Type of Ridging ☐

d. Overgrazing ☐

e. All of the above ☐

8. Measures Taken to Arrest the Problem of Soil Erosion

a. Reforestation ☐

b. A Forestation ☐

c. Contour Ridging ☐

d. The Use of Natural Manure ☐

e. All of the above ☐

f. None of the above ☐

9. Whether the Problem/Case has been Reported to the Government:.....

Yes ☐ No ☐

10. Step taken by the Government.....

.....

KEY

SA = Strongly Agree

A. = Agree

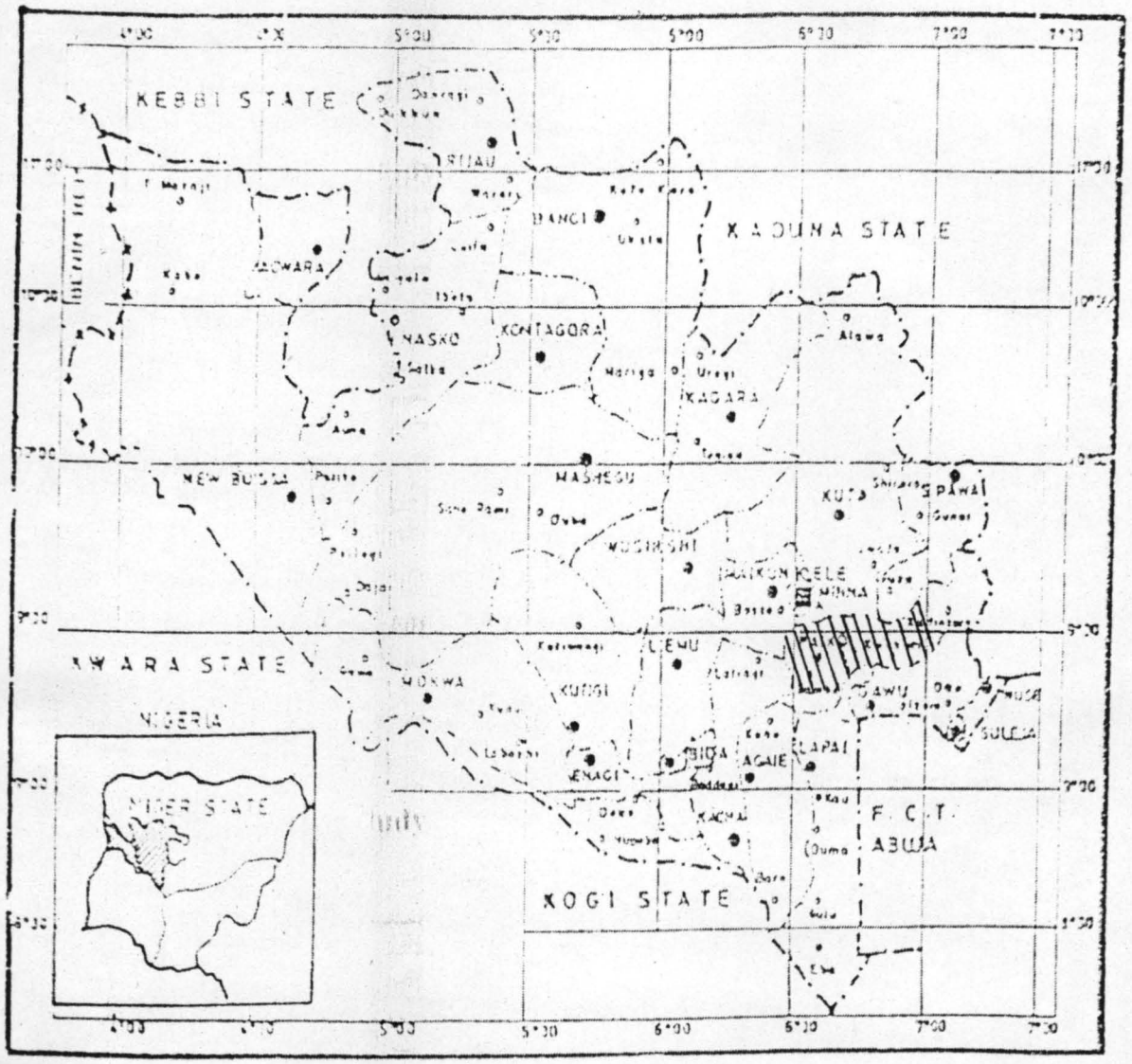
D = Disagree

SD = Strongly Disagree

Y = Yes = Agreeing with the Statement

N = No = Disagreeing with the Statement

FIGURE 4: **Showing the Study Area shaded**



SOURCE: Department of Geography, 2004