THE EFFECT OF CHANNELIZED DRAINAGE SYSTEM ON THE ENVIRONMENT IN MINNA METROPOLIS

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CERTIFICATION

This is to certify that this project work on the effect of the channelized drainage system on Environment in Minna metropolis was presented by **Hanson, Glory Ikpe** of Geography Department, School of Science and Science Education, Federal University of Technology Minna in partial fulfillment of the requirement of the PGD in Environmental Management.

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External Examiner	Date

DEDICATION

This project is dedicated to the most high God.

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I express my gratitude to my supervisor Dr. A. S. Abubakar for his guidance and pains taken to go through my project.

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My thanks also go to everyone that has contributed to my success.

ABSTRACT

This research work attempts to examine the effects of the channelized drainage system in Minna metropolis and to examine the existing drainage channels in the study area.

The work has established that there was flooding and erosion in Minna after a heavy rainfall and many roads, residential and non residential compounds, open spaces are usually flooded and this flood causes damages to farmlands, properties and block roads at times. It is because of this flood and damages that brought about the construction of drainage channels in Minna in order to minimize and control the flood.

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CHAPTER ONE

1.0 DEFINITION OF BASIC CONCEPT

DRAINAGE

The term drainage has been defined by many professionals in accordance with their respective professions. One of such professionals was Arnold who in 1974 defined drainage "as the removal of excess water from the land into natural channel or water body or into other hand".

Gordon et al, (1807) saw channelization as the clearing and straighten of a stream to improve water conveyance. He said this usually increases channel slope and thus water velocity and sediment deposition in flatter section down stream. The higher the peak flows may also occur downstream of the channelized section where the gradient lessens.

Strahler et al (1905) defined drainage "as a conveying mechanism funneling the weaker form of run-off into progressively deeper and more intense paths of activity".

Iloeje defined drainage as a system through which water is carried off the land. This includes floodwater, rivulets, rivers and lakes.

Encyclopedia Americana (1829) defined drainage as the removal of water from soil (surface drainage and sub surface drainage that is top and beneath).

Drainage can also be defined as a channel by which liquid is drained or gradually carried off. It can be an artificial conduct or channel for carrying off water or removal of water by gravity implying either a flow down a slope or percolation. Most land has some drainage, which assists in the removal of a certain amount of the excess water. It is only when large quantities occur for prolonged duration at critical periods, that its removal by artificial means is feasible. Arnold further stated that drainage is required to carry excess water off the land into a natural channel or other land.

The drainage channel often forms a network of ditches which the surplus water seep from the surrounding soil, but must be made progressively deeper to provide a gradient otherwise the water will not flow and drainage will not be effective. However in a low-lying region, the channel from drain into a lake or artificial swamp from which the water has periodically pumped to allow drainage continue. These channels may be open ditches dug to an adequate depth with sloping sides and sufficient gradient to permit the water flow or they may be covered pipes or concretes into which excess water can seep and pass off. The depth, width and gradient in provision of drainage channel for achievement of efficiency depends on size, volume or rainfall intensity, topography and capacity of water. Drainage is divided into surface and sub surface types.

1.1 SURFACE DRAINAGE

This involves the removal of water from the topsoil, that is the removal of water either rain or melting snow that falls directly on the roadbed and interception and removal of water coming to the road from houses and adjacent terrain.

1.2 SUB-SURFACE DRAINAGE

This is the removal of water beneath the soil from the surface. It involves the removal of water from the sub-grade and with the interception of the underground water coming to the sub-grade. This is accomplished by the use of pipe drains through which the water is removed to a safe distance from the area. Excess water need to be drained to prevent water logging which makes the soil deficient in oxygen and is not good for development. It also controlled the salinity of soil particularly areas where salt water is common.

1.3 TYPES OF DRAINAGE

There are different types of drainage but the common types according to Gordon et al are:

1.3.1 PIPE DRAINAGE

This involves the use of clay or plastic in very permeable soil following a relatively wide drain surface. The principal point here is:

1.3.1.1 THE DRAIN DEPTH

The drain depth varies between 80m and 1.5m or should be as great as possible. An out fall may be created at an economic level where a tinner cannot be obtained, the drain being in permeable land and the depth being within the capability of available machinery.

1.3.1.2 DRAIN SPACING

This depends on local circumstances and it affects the cost.

1.3.1.3 DRAIN LAYOUT

This is determined by surface topography in designing the layout interception that is the drain should be laid across the fall slope to intercept water moving downward.

1.3.2 MOLE DRAINAGE

Fairly uniform clay subsoil, which is stable water, can be used. The typical mole drainage layout has permanent drains laid across the fall at a spacing of 40-80m and covered around with coarse gravel to surface. It is drained roughly at right angles to permanent drains so as to pass through the gravel. The gravel or permanent black fill will serve to connect the moles to the permanent drains which are circular with about 100m and depth of 55-75cm. The erection of mole channel requires but not too wet.

1.3.3 SURFACE DRAINAGE

This is on-clay soil where subsoil water movement is very slow while the movement in the top soil (cultivated layer is reasonable). To mole the sub soil in such a circumstances requires mole drainage.

1.4 In recent years, great efforts had to be made to improve the qualities of the environment. In most cases, channel drainage performance still leave a lot to be desired. It has not been sufficient enough to preserve the quality of the environment in a desired condition.

Planners have known that water accelerates the deterioration and destruction of road pavement, properties and the entire environment and they have expressed the view that good channel drainage system is one of the basic needs of our pavement for effective and efficient service. History has shown that delay in the provision of drainage where necessary entails not only expensive reconstruction and rehabilitation but also adversely affect and retards development (Arnold, 1974).

Urban drainage channels is an important aspect of urban planning because of its attendant consequences. Flood and erosion are rampant in Nigeria. After having rainfall, many residential and non-residential compounds, roads, open spaces are usually flooded. It does not only block road but also damages household properties. Huge quality of sand are normally deposited on road causing damages to asphalt used in road construction which weakens and disintegrates when subjected to prolonged period of flood water. It is because of this, man have shown creative and innovative mind through his design and construction of drainage in cities which stand as monument to his imagination and this power intellect has enable him evolve solutions to the problems facing the cities today. Flow of storm water through urban drainage receives water course and considerable amount of urban budgets are devoted to the safe conveyance of this water through channels system which lead to the construction of drainage that are of various capacity and discharge.

The uniqueness of each situation requires individual solutions. No one design will work universally. Because of this, an experimental attitude should be taken in approaching each site. Processes can be investigated on a scale with flume studies or field tests.

Channelization is typically carried out to improve drainage or flood carrying capacity, usually leaving a smooth trapezoidal channel with improved conveyance and more predictable hydraulic behaviour. The straightening channels and reduction in roughness leads to greater flowing velocities and thus higher erosive forces as a result, the channel will often erode downward.

In determining the best channels, dimensions can be guided by the natural characteristics of flood in a setting such as width and depth ratio. Channels provides the best hydraulic radius for conducting flood flow, natural cross sections tended to be wider and shallower with a general width to ratio of about 15.1.

In all cases, interaction between biologist and engineers during design construction and monitoring phases can lead to improved designs which are effective from both stand points. For example channels designed for flood conveyance can be modified to

include the biological component by allowing for resistance effect of vegetation. These elements of flood destruction triggered off the study.

1.5 STATEMENT OF PROBLEMS

The presence of flood in some areas due to:

Inadequate channelized drainage system:- The inadequacy of the existing number of channelized drainage in the study area has led to the presence of flood or stagnant water while some places are water logged area.

The poor maintenance of the existing number of the channelized drainage:- despite the inadequate channels, the existing ones are poorly maintained.

1.6 AIM AND OBJECTIVES

The aim of the study is to examine the effects of the channelized drainage system on the environment in Minna metropolis. The specific objectives are:

a. To examine concept and types of channel drainage system.
b. To identify the effects of this channelized drainage system on the study area.

1.7 SCOPE

The study deals with an examination of the channelized drainage system in Minna metropolis, identify some problems associated with it and proffer solutions to it.

1.8 DESCRIPTION OF STUDY AREA

The study area includes Minna and its environs. Its environs comprises of Bosso, Keteren Gwari, Tudun Wada and Tudun Fulani.

Minna is basically a Gwari town. It got its name from ritual performed yearly by the Gwari founders of the town to observe the beginning of the New Year. The word "Minna" in Gwari means to spread fire. It came into existence because the Gwaris used to put out every bit of fire in the area, even in all the kitchens in the town, on the last day of every year.

However, before the town becomes the modern city that it now is, it went through four metamorphosis. Minna has the largest number of inhabitants. Villages and hamlets are scattered around Minna (the study area), these are inhabited by peasant farmers who cultivate yams, guinea-corn, rice, sugarcane etc. In dry season, some of the farmers become unemployed while others embark on diary farming along river plains, some go for fishing in the major rivers, some take on locally irrigation farming and then turn traders or marketers selling out their farm products etc.

1.9 LOCATION

Minna lies at latitude 9°37' North and longitude 6°33' East on a geological base of undifferentiated basement complex of mainly gnesis and magmatite. To the north east of the town a more or less continuous steep outcrop of granite occurs limiting any urban development in that direction.

1.10 CLIMATE

The town has a mean annual rainfall of 1334mm (52 inches) taken from an exceptionally long record of 54 years. The highest mean monthly rainfall is September with almost 300mm (11.7 inches).

The rainy season starts on average between 190 - 200 days. The mean monthly temperature is highest in March at 30.5°C (87°F) and lowest in August at 25.1°C (77°F).

1.11 VEGETATION

The vegetation of Minna town is made up of different plant species or life forms. These life forms are tree shrubs and herbs.

The vegetation is composed of thick, tall grasses with scattered trees and shrubs forming the assemblages. The greater incidence of the isolated at a ground level results to a thicker and taller growth of grass.

1.12 LAND USE

The proposed land use is depicted in detail on the accompanying 1.25,000 scale master plan map. There are five major categories, namely open space utilities, commercial, institutional and residential.

The efficient and practicable use of land for development, taking into account the cost of engineering involved, has naturally resulted in a considerable proportion of the land area being left as open space. This is all put to positive use to ensure that a control exists on all land so that the entire metropolis area can be administered effectively. The uses are in the first place in areas where a specific control is required.

CHAPTER TWO

2.0 LITERATURE REVIEW

The process of drainage channels implies the ways of draining water in an urban area. This is mostly concerned with the techniques of draining water in an urban area and the types of drainage channels to suit the type of soil in an area especially the study area.

The third national development plan (1978 - 80) noted that storm water drainage system has not changed for decades. Also many of the urban centres lack integrated drainage net work, which consist mainly open earth or concrete trenches and free boal drains along main roads. These trenches are often too narrow to drain water efficiently during heavy rain causing many streets to be flooded and unmotorable. Physical structures such as buildings are affected in one way or the other.

2.1 DRAINAGE IN KADUNA

Like any other centres in Nigeria, Kaduna is also faced with drainage problems. These problems are usually severe during rainy season. The Kaduna master plan (1917 - 2017) prepared by Maxluch and partners highlighted the problems. They recommended that drains provided on all road networks, which other areas are to drain via the existing natural drainage pattern. This is done in order to

avoid concentration of large water bodies. Hence foul and surface water sewers were recommended for certain areas due to the wide variation in flow cost of providing large expensive sewers and the difficulty of maintaining self clearance velocity during low flow condition, the proposals were abandoned. The effect is therefore bad drainage system as most roads in the town became unmotorable.

2.2 DRAINAGE IN SOKOTO

Sokoto is one of the most popular urban centres in the country. Before Kebbi State was created, it has for many decades been facing drainage problem.

1978, master plan report showed that unsatisfactory disposal of sewages and storm water affects and endangers the living of the inhabitants in many ways. This attributed such problems to the inadequacy of storm water disposal system and the activities of refuse dumping in the open ditches and drains, resulting to floods which causes not only damage to physical structure but also health harzard to the residents. This master plan identified two types of floods.

The local floods caused by blockage or drainage to small drains and culverts. The flood in the built up areas is caused by insufficient capacity.

2.3 DRAINAGE IN MINNA

A great deal of work has been carried out on channelization project in Minna. One of such project was the N7 million Minna channelization projects. The project of channelization was started by the then Governor Garba Awaal Moh'd in 1986 due to flood. He started on critical areas.

Such as Angwa Ndaji, Tunga, Keteren Gwari and Tudun Fulani. It was of various sizes in 1989/90 this project was executed by Berger Construction Company and was financed by the National Committee on ecological problems. National drainage was gravely misused as no identified set back was observed from street and refuses used to be disposed into such streams causing urban flood. This was before the project.

Road construction was carried out along with drainage provision. With the channelization project, many houses had to give way for the expansion of natural drainage and for adequate set back. The project has proved to be successful because the intensity of drainage problem was reduced considerably. Drainage project in Minna according to history was constructed on a river course and its all discharged into River Suka in town.

CHAPTER THREE

3.0 DATA RESEARCH METHODOLOGY

The data for this study were obtained from both primary and secondary sources. Secondary source which are textbooks, journal and map. Primary source was largely reconnaissance survey. Field observations and structured differences.

3.1 FIELD OBSERVATION

The researcher personally studied the drainage systems to see things for herself. Such gave the researcher first hand information on the different sizes of channel drainage in Minna. This gives room for comparison in terms of width and breath of the channels.

The research was conducted in Bosso, Keteren Gwari, Tudun Fulani, and Angwandaji.

3.2 PROVISION OF DRAINAGE

Datas were collected and analyzed based on the interview conducted on "why was the drainage provided and who provides the existing drainage channels" then check Appendix for other questions asked.

The researchers gathered that the channel drainage was provided because of flood after heavy rainfall and that this flood destroyed farmland, houses and properties and at times people and motorist will find it difficult to cross or pass.

On who provided the existing drainage channel. The researcher found out that the Federal Government financed the project during Gen. Ibrahim Babangida's regime in 1989/90. Federal Government provisions covered 70% while the 30% was jointly sponsored by the State and Local Governments. (See Appendix). Also the difference in size depends on the:

3.3 CAPACITY

The capacity of the volume of water depends on the environment. Some environment is able to hold a large quantity of water while some cannot.

3.4 TOPOGRAPHY

This depends on the slope. Where there is slope, the channels will be widened to minimize the velocity of water so that it will not flood or cause erosion.

3.5 SIZE

The size of each drainage in some places depends on the space. This is because some areas were built up areas, in order not to destroy houses or properties and farm lands, the government decided to use the existing space.

3.6 VOLUME

Volume of rainfall intensity depends on the intensity of run-off in an area of percolation. This is the ability in which the earth or land can absorb water.

Also the small drainage channels emptied into the big or channelized drainage and more so, that the drainage was constructed on a river course in Minna. It was also noted that before the construction of the drainage channels people dumped refuse on this watercourse, plant rice, banana, mango trees, cashew etc by the bank.

In down stream, steeling basin helps in cushioning the effect, that is energy velocities and discharge in order to make erosion minimal. This method is called Taylor drain discharge and according to the informant, there is threat erosion and that government is trying to widen the drainage system where it stops before.

3.7 PRESENCE OF STAGNANT WATER

In some parts of the study area, the nature of the soil in the study area does not allow water to sink after a heavy down pour. Sometimes throughout a week, after a heavy down pour, inhabitants are no longer at ease as a result of the stagnant waters everywhere.

3.8 LOST LIVES AND PROPERTIES RESULTING FROM FLOOD IN THE AREA.

Many lives and properties were destroyed as a result of these drainage problems precisely in Tunga in 1985/1986. Therefore this calls for the study.

CHAPTER FOUR

4.0 THE EFFECTS AND PROBLEMS OF CHANNELIZED DRAINAGE IN MINNA METROPOLIS

4.1 CAUSES OF POOR DRAINAGE IN MINNA

The factors responsible for poor channelized drainage in Minna especially the study area are divided into two, which is physical and human factors.

The physical factors are subdivided into Climate, Soil, and Topography. Land use, provision of drainage channels and systems of refuse disposal are among the human factors. Others are natural drainage, chemical, infrastructurals, housing densities, roofing pattern etc.

4.2 PHYSICAL FACTORS

4.2.1 CLIMATE

This is the weather condition of a place or a country, this includes heat, cold, rain wind, etc. Among the factors which make the climate of a city destructive are local conditions of large bodies of water, surface cover and construction work.

The weather condition in all area can adversely cause poor drainage on the urban landscape. For instance, as a result of excessive wind, places in Sokoto, Maiduguri are experiencing high degree of drainage problems.

4.2.2 SOIL

This usually depends on the porosity, permeability, texture and structure. Nigeria is located on the coastal plain and belongs to tertiary deposits. Its sedimentary deposit is dominated by coarse and fine sand which are currently bedded. For instance, the eastern part has a soil profile which consists of grey coloured porous, poorly consolidated firm and plastic alluvial layer of dark coloured silty clay with organic matter (soil map of Nigeria project 1982). The significance of these weakly consolidated sedimentary soil in erosion process is that minimum effort is required to disintegrate the soil particles. In the process, very fine sand particles are deposited at some other spots in the form of silt. Where this is accomplished, the silt act as a skin by reducing the rate by which rain water percolates into the soil.

The soil in the study area apart from hilly places, the soil of the town are generally deep, less storming and of finer texture such as sandy, loamy and clay.

4.2.3 SLOPE

Slope accelerates movement of surface water run-off while areas possessing zero percent slope variation are liable to flooding. The low-lying areas experience extensive flooding that may most likely develop into temporary swamp plate. At times, some houses are severely affected that residents are forced to abandon their houses at the peak of the flood.

The slope analysis of the study area has been made using topography map at 1:100000. The slope of the area ranges 0 to slope greater than 20%.

Being steeply sloping, rock outcrops form the principal physical constrain on the east side, a major drainage valley flows with many minor drainage channels feeding into it with storm water run off from the hills to the east. In places, these streams form large area of flood land. There are large but isolated rock out crops in this landscape and also some area of scattered rocks. In other words, land beyond the presently developed strip is suitable for development but needs careful planning to keep engineering cost of culverting bridges, embankments and drainage works as reasonable as possible.

4.2.4 RAINFALL

The topmost climatic factor that affects run off is rainfall. Data on rainfall for most Nigeria cities documented for the period 1970-1990 indicates a mean annual amount of 2846mm. This is mostly received between the months of April and October. During this period, the amount received is five to seven times as huge as that received between November and March. Rainfall increases in amount, intensity and duration of fall to climax in July to August, the Eastern and Southern part of Nigeria has a higher intensity of rainfall while places in the North like Zaria, Kano, Sokoto, Maiduguri experience relatively low rainfall.

4.3 HUMAN FACTOR

Human factor has contributed to poor channelized drainage system in most of our urban centres. Some of these includes:-

Urbanization: This means concentration of people in multi-fractional settlement of relatively large size. This is caused by high concentration and percentage of buildup areas and increases the amount of infiltration of water underground.

4.4 SOLID WASTE DISPOSAL

Solid waste disposal in most Nigerian cities causes a serious threat or problems to efficient drainage in Nigeria, despite the fact that there is an organized system responsible for general disposal of garbage. In this growing urban cities or centres with teaming population, the generation of garbage disposal is high. In the absence of efficient and consistence public body in control, house hold unit simply disposed off their garbage along the roadside especially at night. The heaps of the garbage along such roads and streets continue to smell until it spills over to drainage channels and with time engulfs and blocks such channels.

Infrastructure: Infrastructure is one of the causes of poor channelized drainage system. In most of our excessive paving of land surface road construction, high density which leave little open spaces with vegetal cover that can enhance the absorption of rain water. This leads to increased run-off and high incidence of flooding, erosion and sedimentation.

4.5 POOR MAINTENANCE OF EXISTING DRAINAGE

Most of our drainage facilities are inadequately maintained. This leads to blocking of drains, stagnant water, etc. Poorly maintained drainage channels are associated with disease, which is common in areas where culex mosquitoes breed.

According to Dr. Umoh's lecture note 2000 the maintenance of drainage facilities should include the removal and prevention of water logging and control or prevention of soil drainage resulting from high surface run-off.

4.6 INADEQUATE PROVISION OF DRAINAGE FACILITIES

The inadequacy of the existing drainage channel is a common problem in almost all cities and towns today and these are caused by small drainage channels, non availability of drainage channel and flatness to town which is associated with flooding of adjacent areas where heavy rain storm occur.

4.7 PROBLEMS AND EFFECTS OF CHANNELIZED DRAINAGE

These can be categorized under:

4.8 FLOODING

The study area has a problem of flooding due to problem of drainage like most of the urban centres in Nigeria. Flood destroys buildings and properties worth millions of Naira.

Many roads and buildings are damaged due to flooding. Areas that are underdeveloped cannot be developed without the provision of good drainage channels. Flood equally constitutes a problem to urban transportation and planning due to the huge cost of

construction of road involved across the major valley. There is also poor network of roads in the valley as a result, buses and taxes avoid those roads or area and suddenly increased the traffic density on that road thereby increasing the probability of road accidents.

4.9 EROSION

Unlike flood that is seasonal problems erosion produces permanent problem in some locations is Niger State especially in Minna. Erosion at times is so severe that the roadways have been worn away and reduced or made to be impassible areas.

Also there is erosion of pavements of houses and their foundation. This has led to the collapse of fences, houses etc.

To control erosion, regular maintenance or bank stabilization measures must be employed by urban residents including dumping of huge sacks of sand in gullies and making of basket like structures to laid deposition.

4.10 HEALTH RELATED HAZARDS

Environmental degradation may also result from poor storm water management in poor urban centres. It is known that area that is not well-drained serves as a suitable ground for breeding of disease carrying pathogens. Some of the present drainage channels are a menace to public health and welfare. According to Dr. Umoh, apart from polluting the air, contributes in the spread of various water diseases such as typhoid, gastroenteritis, Amebiasis, Arsenic poisoning. This water can gain passage to public tap through broken water pipes in drain where clearing of drainage channels are attempted, no provision is made for disposal of solid waste from clearing. They are removed from gutter and piled up by its sides to eventually end up again in the same channel.

The stagnation of water and the decomposition, purification of debris results in the production of highly undesirable and offensive odour which can be hazardous to the health of the populace.

In conclusion, planning of drainage channel is an important aspect of urban planning because of its attendant consequences. In Nigeria, flooding and erosion are the two major drainage problems that are rampant after heavy rainfall. Many roads, residential and non-residential compounds, open spaces are usually flooded due to lack of channelized drainage system.

Apart from blocking roads, it also damages houses, properties, huge amount or quantities of sound are normally deposited on roads causing damage at asphalt used in road construction which usually weakens and disintegrates when subjected to prolonged period of flood water.

Also, drainage has been one of the problems in urban areas. In urbanizing environments the infiltration capacity is reduced by the placement of ground cover with imprevious surface and also population placement.

According to master plans land use affects the hydrology of an area and urbanization is the most powerful one. This urbanization drainage problem has caught the attention of many environment specialists and government.

CHAPTER FIVE

5.0 PROPOSAL AND IMPLEMENTATION

The following proposals made are policy and designed. This is aimed at improving and enhancing the effectiveness of drainage in Minna metropolis thus providing for safe and efficient movement of waste water or unwanted water. It is the main aim of every environment planner or Engineer. It is essential for them to design an effective and efficient drainage network for the purpose of achieving the aim.

In laying and construction of channels, it is proposed that there should be a minimum set back of 5m from the centre of the road where drain will be laid. This will help in reducing the encroachment of road width by drainage, which collapse and break. Other proposal to go along with this policy and design are:

Need for local government to pass the bye laws, which will take care of these dumping of refuse in and on drainage path, such law should provide for fines and court action against the defaulters.

Another bye laws is the law which make the inhabitants to take care of the existing channels around their house or where they live, that is, channels in front of their houses. If not the local government should refuse to renew their certificates of occupancy and also no

building plan should be approved without government or local government going to survey the area. This will also help in achieving the desired aim.

The Local Government should employ the services of qualified sanitary inspectors for the purpose of drainage maintenance and the maintenance should be made on regular basis at least once every two weeks.

5.1 IMPLEMENTATION

To achieve the objective of this project, the work is to be implemented by the local government and the owner of individual houses. This will reduce the amount of money to be used or spent by the local government if they were the only body to implement the work.

5.2 CONCLUSION

To be able to preserve the quality of the environment and life of the human population, drainage system must be cared for.

There is no doubt that urban drainage problem is a disastrous form of urban environmental degration and as such should form a vital component of broad objectives of urban planning in Nigeria.

With the above approach, the problem of drainage channels as well as health related hazards in Minna and Nigeria would be a very happy place to live in.

REFERENCES

Audfey N. Clark, (1992): Longman dictionary of geography, Human and Physical term explained.

Encyclopedia Americana Vol 9 and 10.

Gordon et al (1807): Stream hydrology. An introduction to ecologist John Wiley and Sons, New York.

Gregory K. J. and Madew J. R. (1982): Land use change, flood and frequency and channel adjustment in gravel bed rivers (ed)s R. D. Hey T. C. Bathurs and C. R. Thorne (Pp.757-81) John Wiley Chichester.

Iloge N. P. (1980): New Geography for West Africa Longman Group Limited.

Keith Beven and Paul Carling: Flood hydrological sedimentological and geomorphylogical implications. John Willey and Sons Chichester, N. Y. Brisbane, Toronto and Singapore

Lambert T. K. Smedema (1983): Land drainage planning and design of agricultural drainage system. Batsford.

Maxluch and Partners (1917-2017): Kaduna master plan.

Maxlock Group Nigeria Ltd (1979-2000) Minna: Master Plan Final Report February 1980. Plot 60 GRA Minna.

Niger State: New World of investment guide to successful investment industry and Agric.

Strajhler, A. N. (1964): Quantitative Geomorphology of drainage basin and channels network in chow. U. T. (ed) hand book of applied hydrology Mc, Graw Hill. New York.

Stahler et al (1905): Element of Physical Geography, 2nd edition John Wiley and Sons, New York.

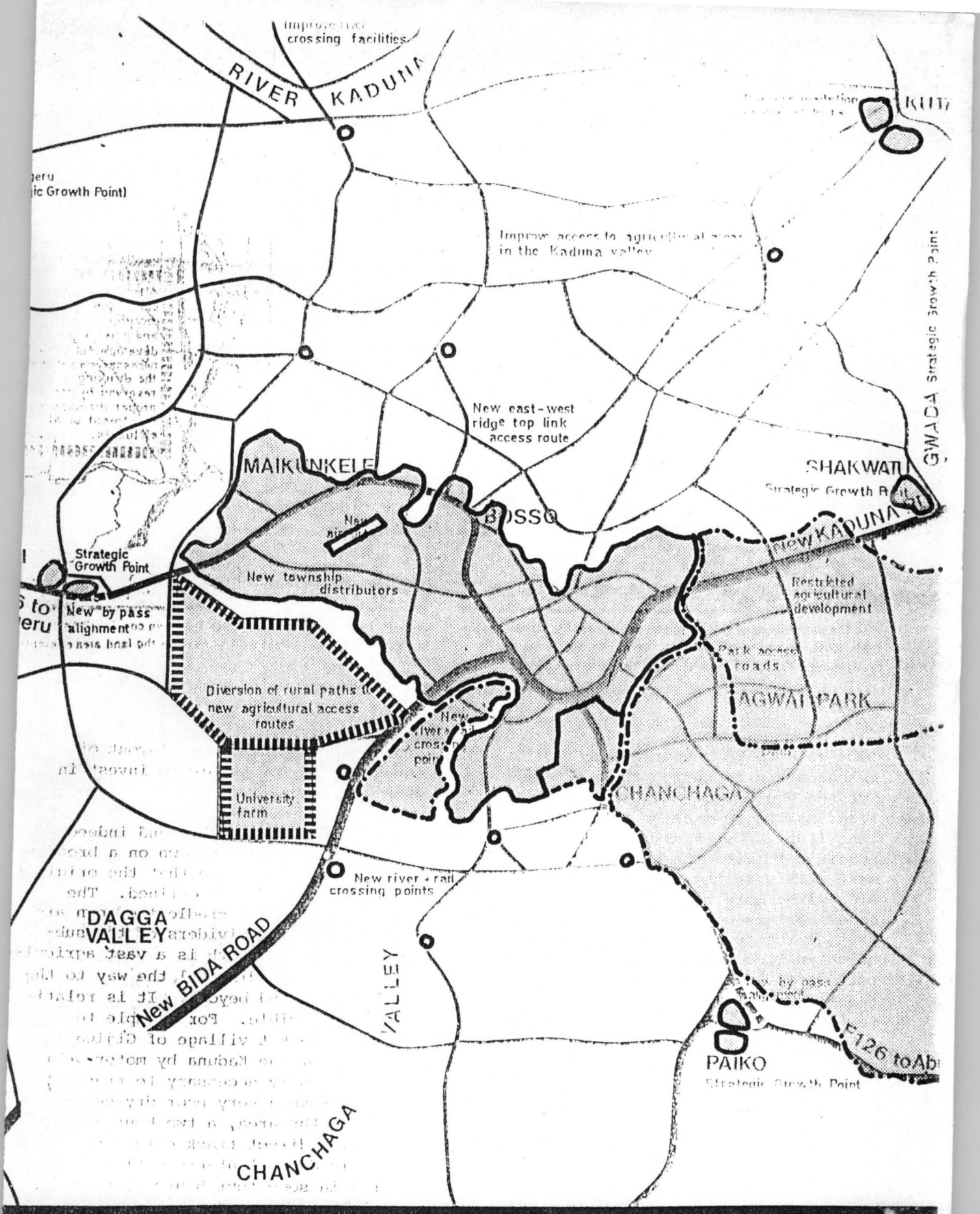
Schields F. D. Jr. (1982): Environmental features for flood control channels, water reservoir bulland.

Thomas Dunnes and Luna B. Leopold (1978): Water in Environmental Planning W. H. Freman and Company.

Maxluci 1978: Sokoto master plan.

APPENDIX

1. What is your name?
2. What is your level of education?
3. Are you an indigene of Minna?
4. How long have you been residing here why was drainage constructed?
5. Who started the construction?
6. What has been there before the construction?
7. Do you think that drainage has disturbed people in the area?
8. What is your occupation?



City Shape

TRUNK ROADS
PRIMARY
DISTRICT

LAND TO BE DEVELOPED:

FOR CONTROLLED RECREATION
FOR CONTROLLED AGRICULTURE
FOR URBAN EXPANSION
FOR UNIVERSITY DEVELOPMENT


Newairport
Nakado
Suka
TUDUN WADA
Gora
Bako
Sauke
CHANCHAGA
Minna 1979
SCALE 1 : 100 000
3 miles
Chanchaga
To Suleja
Abuja
Topography & Town