PROBLEMS OF FLOOD DISASTERS IN HADEJIA:
A PHYSICAL PLANNING PROPOSAL

M.Sc. (U.R.P.) Thesis

BY

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DEDICATION

This work is dedicated to you OH ALLAH! and my beloved mother and father. It is also dedicated to my wife and all the inhabitants of Hadejia who live under the constant fear of being flooded!

DECLARATION

It is with deep sense of responsibility that I hereby submit that this report is made up of my personal contribution to the task of coping with flood disasters in physical planning. It is a pioneering thesis project the same of which was never presented for award of a degree previously. As humanly as possible credit was given to all sources quoted either in the text or in the compiled list of references at the back of the report.

NAME - ALHAJI GARBA ISA

DATE - JULY, 1990

CERTIFICATION

This Thesis entitled:"PROBLEMS OF FLOOD DISASTERS IN HADEJIA: A physical planning proposal", meets the regulations governing the award of the degree of Masters of Science Urban and Regional Planning of Ahmadu Bello University; and is approved for its contribution to knowledge and literary presentation.

---------------------------- Date:--12/11/92--
Chairman, Supervisory Committee
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Zaria
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Alhaji Garba Isa

ABSTRACT

PROBLEMS OF FLOOD DISASTERS IN HADEJIA:
A PHYSICAL PLANNIG PROPOSAL

Plood is perhaps the most disastrous of natural phenomenum. This was amply demonstrated through the various historical records available some of which have been highlited in this report.

Plood prevention and mitigation requires some of the most widest forms of control measures; landuse, engineering, building and the likes combined. Many scholars and researchers have shown keen interest in the area of flood studies. The United Nations through its disaster relief organisation (UNDRO) based in Geneva Switzerland, has been widely involved in International efforts to cope with severe effects of flood menance.

Although engineering control measures were traditionally prefered, recent trends tend to favour a much more physical planning approach of flood plain management which sought to control the use of the flood plain rather than the forces of the floods themselves only.

The study area, Hadejia, in Kano State is located close to Hadejia river at its lower section. Three major flood disasters were documented in the town since the 1940's that is in 1942, 1963 and 1988 which were the main reference points in this study.

Floods in the study area were found to be caused by intense local rainfall, the meandering of Hadejia river as a result of the sandy clay

nature of the soil and as characteristic of river at its lower plain which also makes the river to change course suddenly. Other causes of the flood induce the almost flat nature of the topography and the constant deposition of sediments transported from the upper reaches of the river which makes its bed shallower end thus spills over the banks under high volume of water.

In an attempt to prevent the growth of Hadejia within or towards locations with higher flood risk, a zoning and growth direction proposal was made based on the analysis of past occurrences and the Topographic nature of the area among others. This was augumented with engineering measures as embankment and channel improvement. A hasin-wide long-term flood control proposals were also made to help cope with the flood problems on a regional basis. It is hoped that by the time the comprehensive physical planning proposals for flood control got implemented in reality the constant threat to lives and properties of the people in the study area would have been drastically minimised,

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CHAPTER ONE

1.00 INTRODUCTION

The disasterous impact of natural phenomenum such as Earthquake, Tornadoes, Landslide and flood is as old as civilisation. Despite the rise in the incidences of man-made disasters due to ever rising sophistication of modern technology and denser concentrations of population, majority of the most ~~dens~~ destructive disasters are still caused by natural forces. Flood in particular is the most disastrous natural phenomenum.

It is natural for river to burst its banks from time to time and spill into its flood plain. Thus river-induced flood disasters are of special concern to the emerging field of flood plain planning. Because of the failure of man to realise that flood plain is an integral part of the system, but often only used to discharge peak flows, various disastrous consequences often result from the occupation of such lands. What is quite obvious is that all rivers are liable to flooding. A very peculiar aspect with regards flood disasters is that the amount of losses tend to increase despite increased expenditure on control. This is as a result of increased occupation of the flood prone areas.

There are various professionals engaged in the area of flood control. Most of their attempts aimed at controlling flood disasters are mainly engineering in outlook notably by civil engineers, builders and related professionals. In physical planning the use of the flood plain is regulated rather than concentrating on flood containment alone. Physical planning measures for coping with flood disasters are therefore aimed at achieving among others, the following broad goals; directing people and economic activities away from the most hazardous places and insisting on design and construction techniques that will make buildings and other structures comparatively flood resistant.

There is a lot of inter relationship between man's works and floods. Therefore careful planning of the entire river basin is often necessary if optimum use of the flood plain is to be achieved.

The question which usually arise in physical planning is: what can be done at local level to solve flood problem? Dougal (1969), attempts an explanation; "Either we can attempt to control the flood waters or we can attempt to control use of the flood plain or we can use a combination of the two techniques. Flood plain management encompasses both, combining proper land-use planning and regulation with flood control measures" (figure 1.1). As another attempt at coping with flood disaster in physical planning, this research effort will consider the appropriate combination of the measures so as to achieve a long-term comprehensive panacea to the problem.

1.10 STATEMENT OF RESEARCH PROBLEM

The flood problem in Hadejia is quite visible from the flat nature of the terrain and the very close proximity of the town to the river. Recent rainfall trends which shows decline during the last decade, has led to the fading of memory about previous flood disasters this situation need to be reversed. Also, the construction of Dams in the upper stream notably the Tiga Dam, seems to create a sense of security to the inhabitants and the sense of satisfaction on the part of governmental authorities. Hence, the study is important.

1.20 JUSTIFICATION OF THE RESEARCH

There is always a big price for inaction in the face of an already envisaged problem. Because of the occurrence of flood disasters in Hadejia notably in 1942, 1963 and 1988, there is great justification for measures to tackle the problem. The research is also justified because the town as a dynamic phonemum will continue to grow whether flood control measures are in place or not. The same applies to the population of Hadejia, which was 31,000 (1978) and projected to 63,000 by 1996 (Hadejia master plan). There is the absence of a

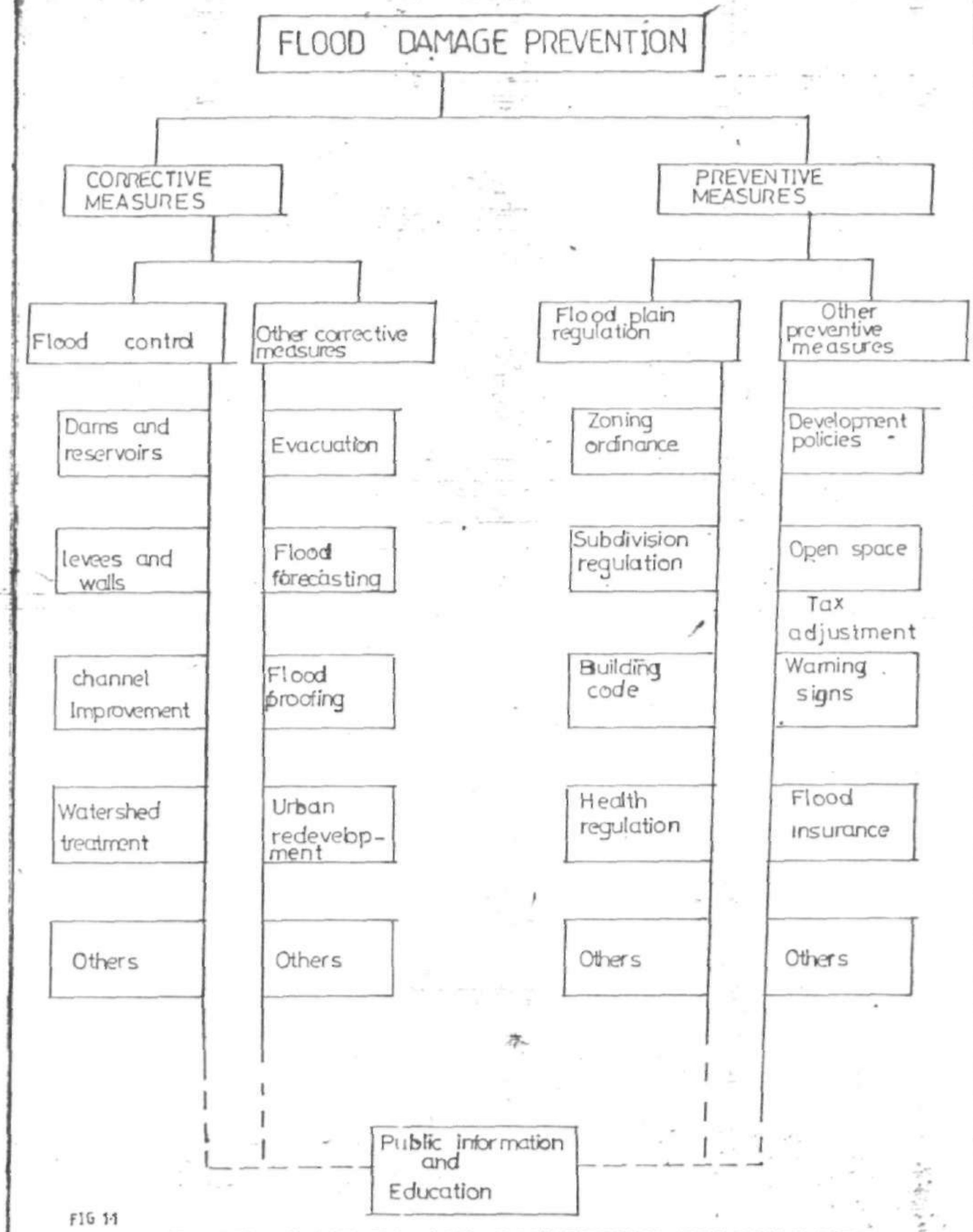

FIG 1.1

ELEMENTS OF FLOOD DAMAGE PREVENTION PROGRAMME A.G. ISA MSc II 88/89

SOURCE: T.V.A. IN DOUGAL (1969).

comprehensive plan to cope with flood disasters in Hadejia. The proposed measures in this research shall focus on the need for efficient land use regulations in the study area.

1.30 AIM AND OBJECTIVES

The aim of the study is to examine the factors responsible for flood disasters in Hadejia with a view to proposing physical planning solution to cope with the situation.

The following limited objectives are meant to achieve the stated aim above.

(i) To examine the geophysical nature of the study area.

(ii) To examine the nature of flood disasters

(iii) To review the impact of flooding in the area

(iv) To review the proposals provided by the consultants in Hadejia master plan.

(v) To examine the local flood control measures in the area.

(vi) To identify the appropriate physical planning proposals to cope with flood disasters in the study area.

1.40 SCOPE AND LIMITATION

The research basically focus attention on flood problems in Hadejia town, Kano State. Most of the proposals are aimed at alleviating the impact of floods within the approximate urban reach of 5km radius covered by the Hadejia 1977 master plan. Regional references are more or less dictated by geo-political realities. Although physical planning measures are the primary concern of the research, they are complimented by appropriate engineering and related measures.

Much as the research is intended to be as thorough as possible, a number of constraints have limited the scope of the work. Most of the relevant hydrological data are either too costly to afford or were not devulged by the relevant authorities. The relative absence of skilled Hydro-meteorological and civil engineering manpower also served as limiting factor to the research in addition to financial, logistical and the lateness in the commencement of some of the field works.

1.50 RESEARCH METHODOLOGY

The research method employed in this study is the survey method to facilitate the examination of large numbers of selective characteristics of the flood problem and the environment it occurs; it thus involved extensive survey.

The type of methodological purpose is descriptive; seeking to technically establish the size and distribution of the identified flood hazard. Field surveys were carried out to establish the physical extent of the flood and observe other related environmental aspects relevant to the research.

The basic data used are geographical, historical, landuse, technical and administrative.

1.60 SOURCES OF DATA

There are various sources of data used for this research. They are broadly classified into two; primary and secondary sources.

(i) Primary sources

(a) Informal interview with local residents, local officials and related specialists.

(b) Field observations and survey.

(c) Data collected from meteorological and hydrological establishments.

(ii) Secondary Sources

(a) Use of official documents for relevant maps, statistical data and related materials.

(b) Review of related literature.

(c) Use of occassional papers, Newspapers, Journals and magazines.

(d) Use of pictures to show relevant features, events or scenes.

1.70 CONCEPTUAL FRAMEWORK

The thesis is structured in such a way as to allow for smooth flow of materials making up the thesis. It began with the general introductory aspects moving systematically into the field survey and analysis of the physical situation of the study area down to appropriate physical planning proposals.

The conceptual framework of the research visualises the scientific flow of procedures necessary for carrying out a successful and enduring flood alleviation programme. It began from the preliminary aspects, such as the identification of the problem down to goal formulation, implementation and evaluation (Table 1.1).

Table 1.1: <u>CONCEPTUAL FRAMEWORK</u>

INTRODUCTION	GEOGRAPHICAL NATURE OF STUDY AREA AND THEORETICAL BACK-GROUND TO STUDY	STUDY AND ANALYSIS OF EXISTING SITUATION	PHYSICAL PLANNING PROPOSALS	IMPLEMENTATION AND MANAGEMENT
- Statement of problem - Justification of study - Aim and object-ives - Scope and limitations - Research method-ology - Conceptual framework	- Location - Geo-physical features - Theoretical back ground to the study	- Magnitude of flood problem in Hadejia - Impact of floods in the study area - Existing response to floods - Analysis of Findings	- Landuse planning - Flood control measures - Basin wide flood control measures - Emmergency measures	- Landuse Planning and Regulation - Engineering assistance - Emergency relief - Levels of decision making - Phasing and costing

CHAPTER TWO

2000 GEOGRAPHICAL NATURE OF THE STUDY AREA AND THEORETICAL BACKGROUND TO THE STUDY

2.10 LOCATION

Hadejia is located some 209 kms to the north-east of Kano. Hadejia lies approximately between $10^{o}.00'$E and $10^{o}.05'$E longitude and latitude between $12^{o}.25'$N and $12^{o}.30'$N. The town is served by the following Federal trunck roads; to Nguru to the east, to Mallam Madori to the north, to Katagum to south and the state trunk road to Gujungu to the west. The old Hadejia town is walled although developments have now extended beyond the walls. The town is bordered on the immediate South by the Hadejia river as shown in figure 2.1.

2.20 GEO-PHYSICAL FEATURES

(i) Climate

The climate of the area is that of the Sudan savanna type. The area enjoys interior location away from the sea and climate is thus hot and dry for most of the year. Maximum day temperature of about 100^{o}F are common. Minimum temperature is about 55^{o}F. Temperature is adequate for plant growth throughout the year, but for the rain situation which is usually unstable.

The climate is influenced by the equatorial maritime and tropical continental Air-masses. The meeting point or boundary of these is known as the

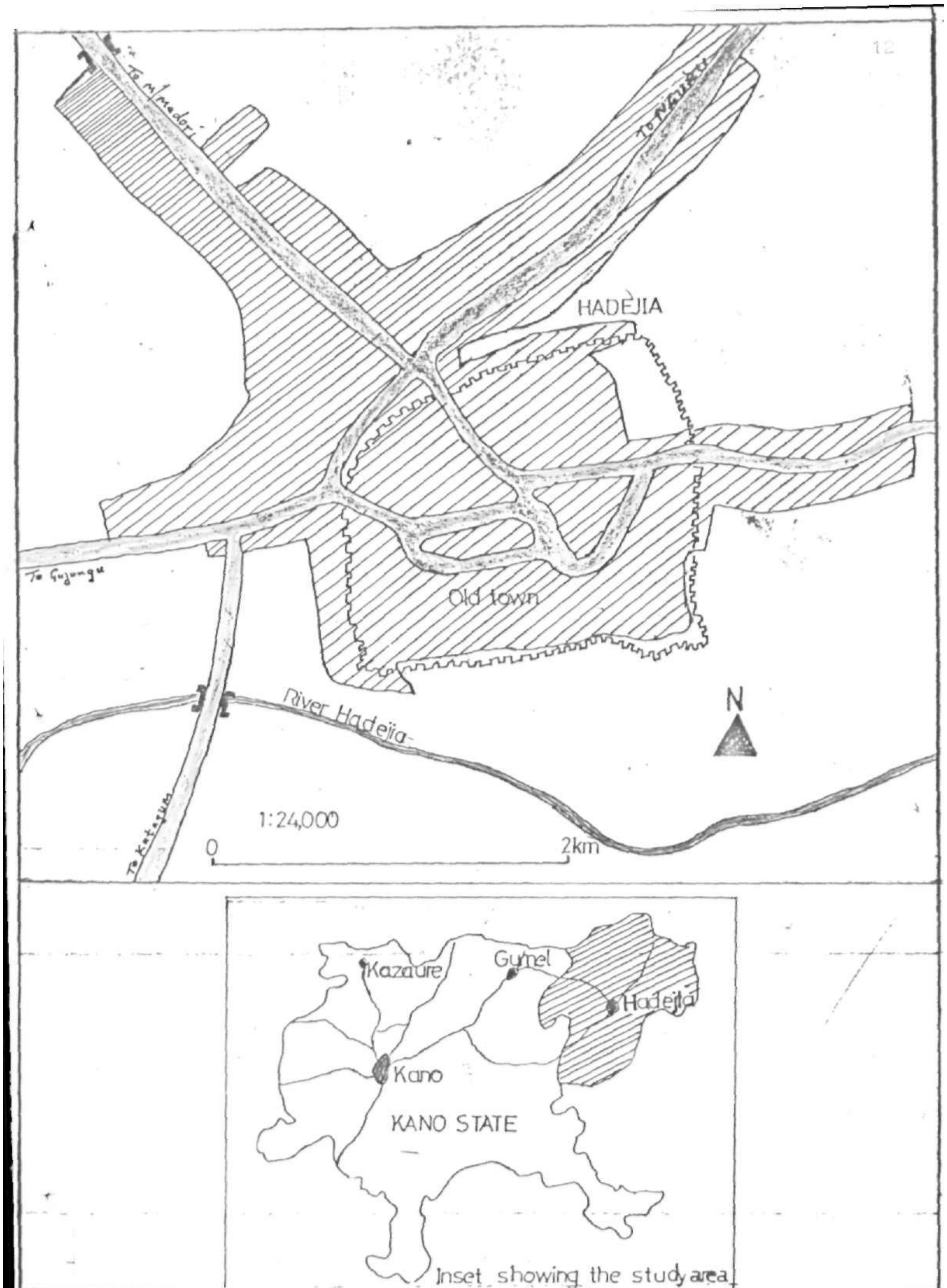

FIG 2.1
THE LOCATION OF HADEJIA

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inter tropical convergence zone (ITCZ). The southerly winds are the main rain-bearing coming on shore from the Gulf of Guinea. The rainy season starts from May or June and ends in September. The tropical Air masses or the Harmattan, are the dusty cold-bearing blowing from the Sahara desert in winter. They are north-easterly and blows from December to February.

(ii) Hydrology and Groundwater

The amount of water available in this area is determined by the amount of rainfall for that year. Regimes of water available is closely related to the climate. Streams and rivers are seasonal. The ground level ranges from 300 - 360m. The depth of aquifers (fed by precipitation and river inflitration) is 25 - 30m for the upper ones, and 90 - 100m for the lower ones. Water is obtained beside from the river, from the upper and lower sub-artesian aquifers. Due to discharge from Tiga reservoir (Dam), the flow of Hadejia river is now perennial.

Artesian reserviors exist in the area with rises of up to 45.72m recorded in water levels in wells in the area. Level of water table is usually independent of the flunctuating in the annual rainfall, but related to extensive deforestation cultivation of vast areas. Deforestation and cultivation reduce transpiration and evaporation and increase surface runoff. The flatness of the land in the area mean run off is not significant as to cause fall in water table. The run off water enter the river system, and this in turn enters or supply more water to the groundwater. According to water loss study of the area 65% of the water is lost through evaporation, 25% through evapotranspiration and 10% lost to the regional groundwater flow (H.J.R.B.D., 1978). Stream discharge and over land flow is seasonal and follows the input of rainfall.

(iii) Hadejia River System

The main river system of the area is made up of Hadejia river which flows from the high plateau of northern Nigeria. The Hadejia river meaders for 828kms (about 300kms within Kano State)(figure 2.2) across the old lake bed with many ox-bow lakes and numerous channels spreak over a wide area. The average annual rainfall within the Hadejia river valley region varies from 762mm along the southern edge to about 318mm in the northern corners, (F.M.E.D.1968).

In its movement within the state, the Hadejia river loses most of its water as it flows from the upper reach to the flood plains running from Tiga dam through Wudil down to Hadejia and beyond. According to WRECA Data for a dry year 1976 - 1977 and a wet year 1980 - 1981, the losses of Hadejia river at its Wudil

Suntulmawa reach, vary from 448.5mm^3 to 2147.2mm^3 annually which is more than the maximum storage capacity of Tiga Dam (WRECA, 1985). Hadejia river is thus contributing immensely to a very vast underground acquifer, out of which very little is retrieved back to surface for utilization. Apart from those losses, others occurs in irrigation areas due to seepage in the canals and incorrect irrigation practices on the farms. The construction of Tiga Dam (1974), has changed the hydrology of Hadejia river which is now controlled during normal rainfall years. The river channel duration is now lengthened; is perennial instead of being seasonal.

There is the annual flooding of some of the areas along the Hadejia river system. The Hadejia river inland Delta formed to the east of Ringin to the east of Kano, is up to 32kms wide. The depth of the annual flooding in the flood plain areas of the river varies widely from season to season. Existing flood control works on valley wide basis by irrigation authorities includes Barrages and polders and pumping stations (Kano State Development Plan 1970 - 1974). The river collects runoff from the Jos Plateau upland area. After the Hadejia river leaves the upstream area, it is a losing stream even though two of its larger tributaries join it in its lower reaches. The average annual runoff of the

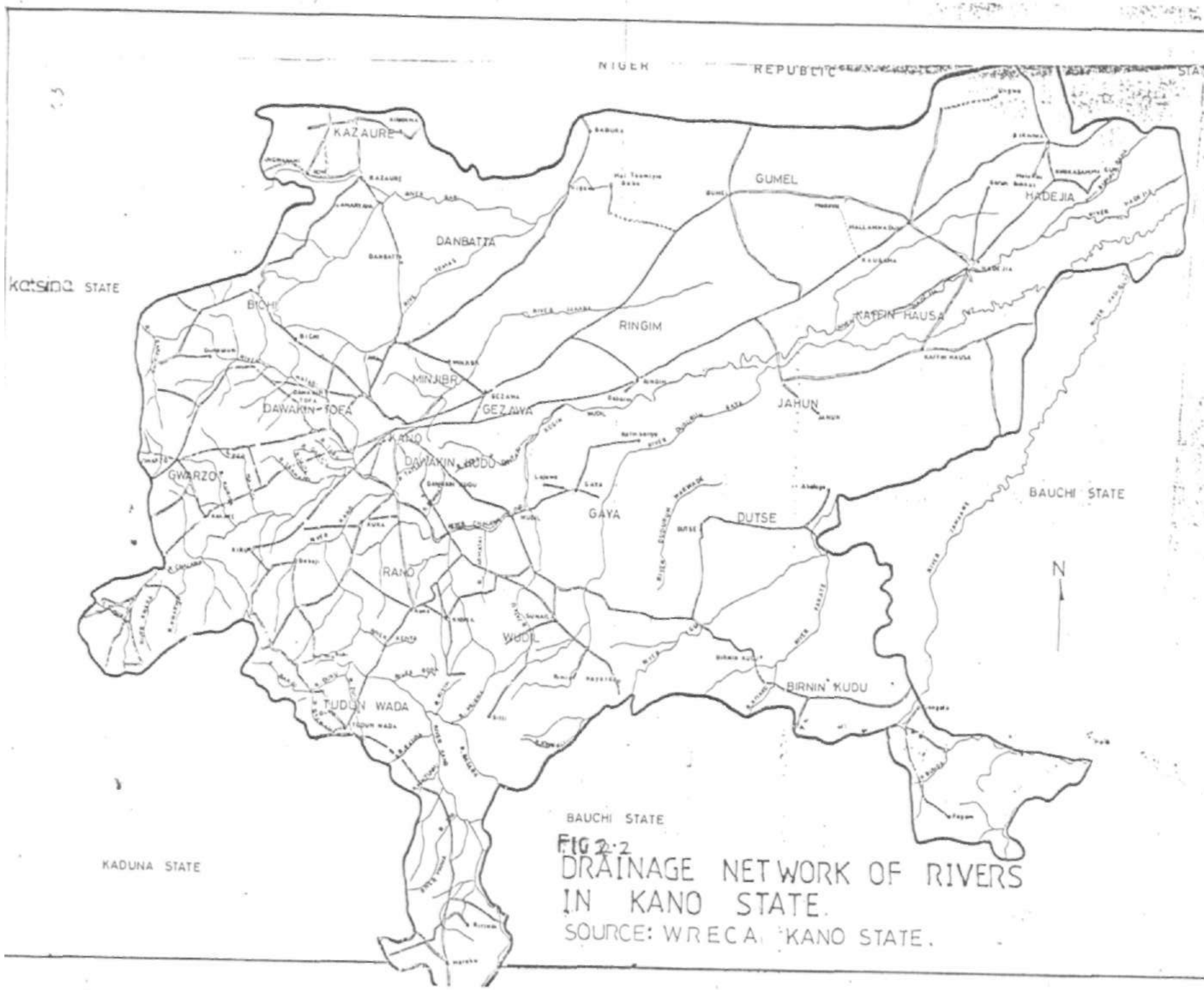

FIG 2·2
DRAINAGE NETWORK OF RIVERS IN KANO STATE.
SOURCE: WRECA, KANO STATE.

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headwater tributaries is about 5,000,000 acre-feet of which probably about 360,000 acre-feet reaches the lake chad at the mouth of the river.

Because of the nature of the Chad formation soil with high inflitration rate and the openness of the semi-Arid vegetation zone, most of the limited runoff from the rainfall is captured in local depressions and Fadamas and lost to evapo-transpiration. Except for rainfall coming from the wetter southern upland areas of the region, any local runoff into the main Hadejia river drainage system does not materially affect the flooding of the areas as it is dissipated before arrival of the flood peaks from the plateau foot hill streams.

Because of the large natural storage capacity along the Hadejia river valley depressions, the flooding problem is not a function of the daily or storm peaks, but rather a function of the total monthly or even seasonal flow. A few feet of additional stage greatly increases the area flooded, but at the same time requires relatively large percentage of increase in run off to occur, (F.M.M.D., 1968). The Hadejia town lies along the lower reach of the river, where the plain is wider, with gradients lower than the plateau streams and have many more ponds and fadama areas.

The Hadejia river flow at Gashuwa (to the east of Hadejia town), with the filling of Tiga Reservoir (Dam) is estimated to be $300m^3 \times 10^6$; therefore the flow losses on Jama'are River to Gashua for 1975 were $1,700m^3 x10^6$ which is 68% of the inflow. For 1975, the inflow from the catchment to the Jama'are River system was two and one-half times the Hadejia River inflow. Hadejia River losses between Wudil and Hadejia (1975) was $330m^3$ 10^6. Annual losses from groundwater storage was $1,440m^3 \times 10^6$ (not through evaporation or surface water inflow), (H.J.R.B.D.A., 1976). Table 2.1 shows the longitudinal distribution of water loss along Hadejia river in March, 1975.

DATE	SITE OF MEASUREMENT OF DISCHARGE	DISCHARGE C.M/SEC	LOSS BETWEEN	CUMULATIVE LOSSES FROM TIGA/WUDIL
18/3/85	Tiga	6.96	-	From Tiga
	Chiromawa	6.75	3%	3%
	Tamburawa	4.02	40.4%	39%
19/3/85	Wudil (with Shimar) flow of 2.05	5.12	23.6%	From Wudil
20/3/85	Joda	2.85	44%	44%
20/3/85	Dabi	2.60	8.7	49%
	Suntalmawa (2 Sections 1.51x0.32)	1.83	29.6%	64%
20/3/85	Sarawuya	1.04	43.2%	80%
	Hadin	0.81	22%	84%
	Hadejia	0.21	74%	96.0%
	Marna	Impounded gauge height 0.74	-	-

Table 2.1

Longitudinal distribution of water loss along Hadejia River (March, 1985).

Source: Adapted from WRECA, Kano State.

(iv) Geology and Soil

The area is underlain by rocks of the Chad formation which are quarternary in age. Much of the ground is covered by superficial deposits of fine sand which have been swept into series of low-dunes by the wind from the Sahara desert (figure 2.3). The soils are comparatively recent in origin. The dunes are mainly composed of fine grained single sized sands derieved from the more recent sediments of the Chad formation. Heavier textured silty clay soils occupy the inter dune depressions and have poor drainge characteristics, (Soil Report, M.O.W., Kano, 1969).

The area is made up of vast open plain developed on young sedimentary rocks of the Chad formation which mainly consist of clays with some sand horizon and gravels. Clay is the dorminant soil which is very dark in most of the area as a result of accumulation of organic matter - the clays become plastic where exposed to surface and saturated with water during rainy season. The dark clay of the area dries up in dry season giving rise to hard and brittle surface with numerous cracks. In the usually flooded floors of the river valley, heavier soils with high clay content occur. This heavy soils become water logged when it rain heavily; in some places cultivation can be difficult. The soil mechanical properties are such that it mainly consist of sandy and silty soil in the upland areas and loamy-sands to clay-loams in the depressions.

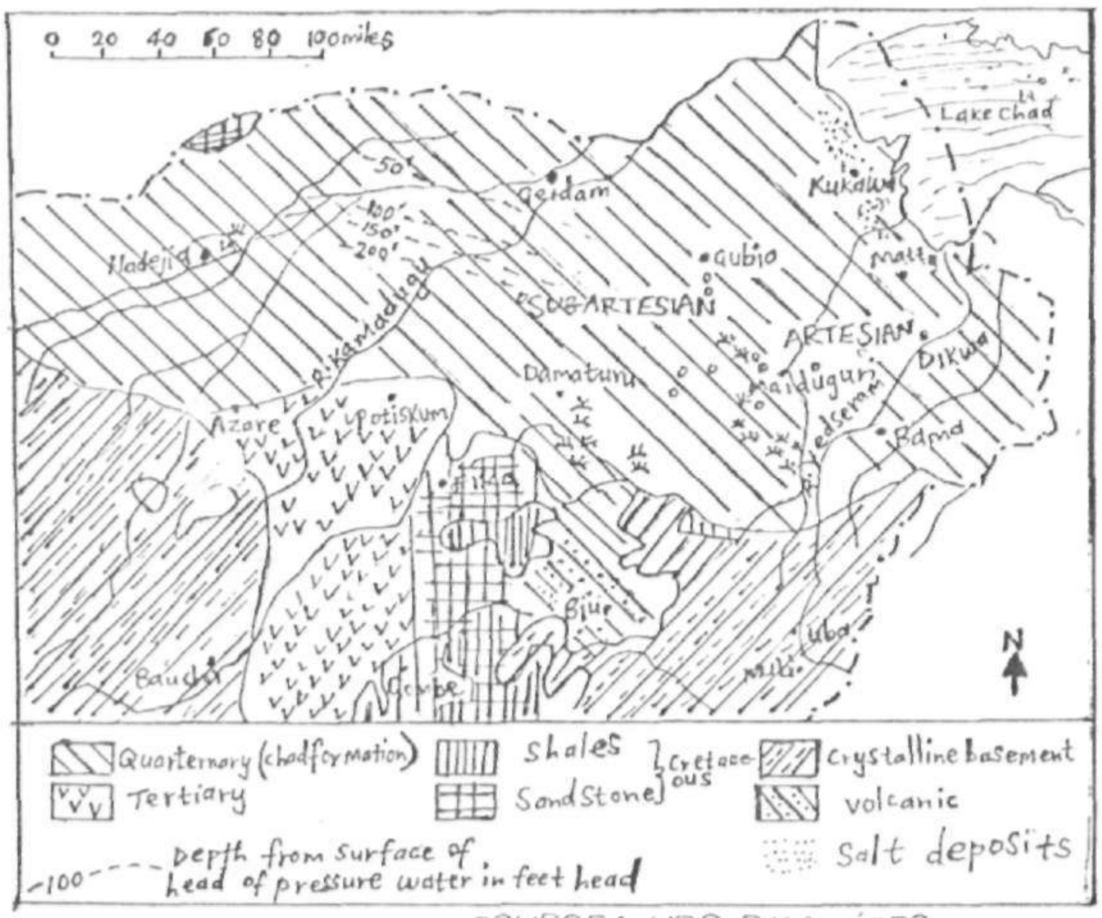
(V) Topography

The area is largely made up of strikingly uniform open land scape often flooded during the rainy season (figure 2.4) the clay plains alternate in places with patches of slighly higher grounds of Dunes of sand nature. The average elevation of the plain is 300m above sea level.

The low sand dunes are generally between 5-10m high providing about the only relief in the area. The inter-dunes areas consists of flat plains in which inter-mittent river channels can be recognised. Flooding by rain water and more rarely by the Hadejia river system occurs in the wet season (M.O.W & Survey, 1969). Hadejia river remains the most important feature of the terrain of Hadejia town - it is to the immediate southern part of the town.

2.30 RELATIONSHIP BETWEEN GEOGRAPHY AND FLOODING IN HADEJIA

As a geomorphological phenomenon flood is highly related to the geography of the study area. It is obvious from the brief outline of the geography of the area that conditions exist for the regular occurrence of flooding in Hadejia. Although the climate is for most parts of the year dry, regular incidences of flood threats are likely to occur due



SOURCE: UDO R.K. 1970

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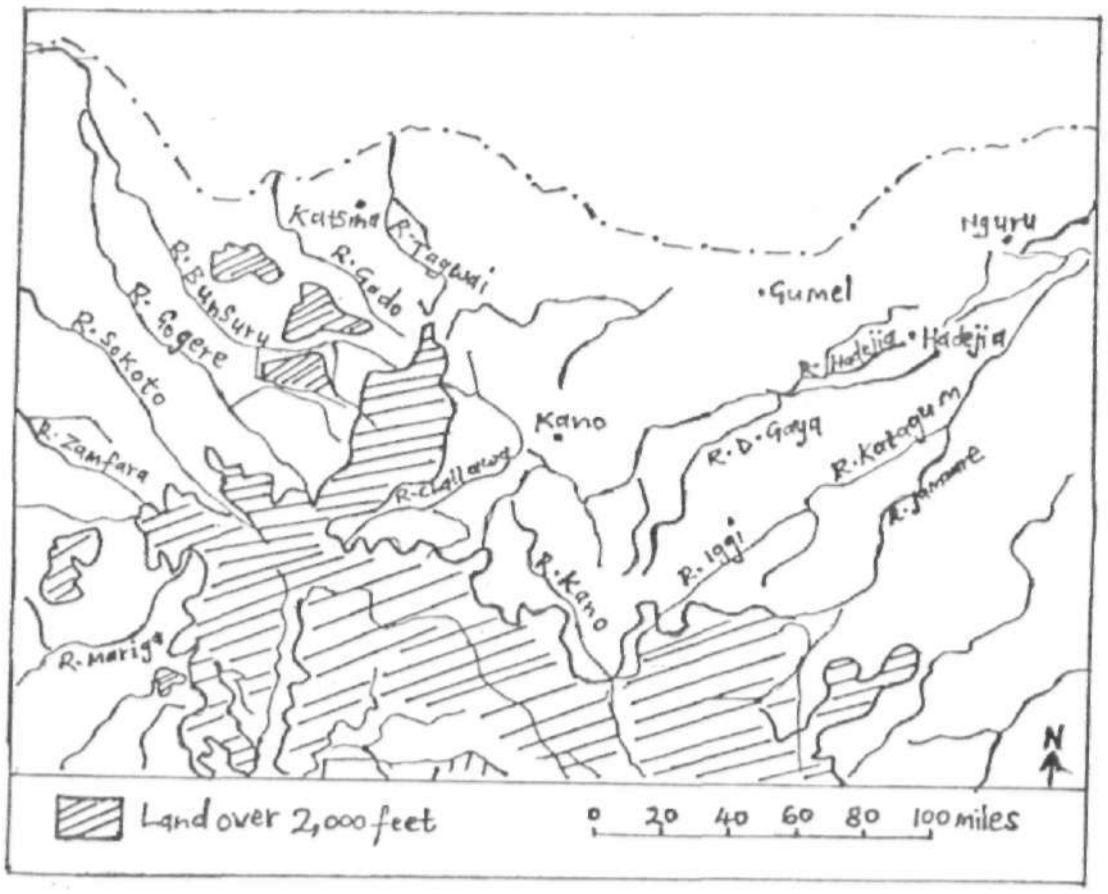
FIG 2.3
GEOLOGY AND DRAINAGE OF CHAD FORMATION

to spells of intense rainfall, the low-land characteristics of Hadejia river, scanty vegetation, the uniformly open landscape and the close proximity of Hadejia town to the river among other geographical factors.

Attempt will be made to carefully study and analyse the major geographical aspects of the area in relation to the flood problem. In addition to the geography of the area a theoretical background to the study is provided in the concluding section of this chapter to highlight the concern of various scholars to the problem of flood disasters and their heavy toils in terms of lives and property. This will enable us draw some lessons from the experience of others as we attempt measures to cope with flood disaster in Hadejia based on the understanding of the existing situation in the study area and research findings.

2.40 THEORETICAL BACKGROUND TO THE STUDY

Many scholars and international agencies notably the United Nation (UN) through its disaster relief organisation (UNDRO) have shown keen interest on the subject of flood induced disaster. The UNDRO for instance published in 1976 a series of books on the "Guidelines for disaster prevention" covering such aspects as the pre-disaster physical planning of human settlements, building measures for minimising



SOURCE: UDO R.K. 1970

FIG 2·4
RELIEF AND DRAINAGE OF KANO REGION

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the impact of disaster and management of settlements. The United Nations also organises seminars and relief efforts in case of flood and other related disasters.

Among the scholars with great interest in the issue of flood disaster was Kates (1962) who catelogued a wide range of elements needed in the future as loss-bearing, flood fighting in energency situation, structural change in land elevation, changing landuse and controlling floods. His suggestions for possible individual actions as detailed components of the choices includes stand by plan for evacuation of people, possible adandonment of high risk areas, to construction of levees.

As a result of the Ogunpa flood disaster in Ibadan in 1980, the federal government of Nigeria embarked on a channelisation programme of the Ogunpa river. The programme was meant to remove large deposits of materials which have made the river shallow as Urban residents of Ibadan continued to deposit both solid and liquid wastes into the river. This is in addition to the constant encroachment of the river's flood way which had been taken over by urban developments. The federal government is also engaged in efforts to control ecological disasters nation-wide in particular following the wide spread floods of 1988, which also affected other African countries (figure 2.5).

Among the scholars who analysed the subject of flood within the over all context of flood plain management was Dougal (1969). According to him, instead of relying on structural protections to contain flood waters, flood plain residents should rather acknowledge the "right of way" of a particular river, i.e. lands within the immediate reach of the river be reserved for the conveyance of flood waters. Where those lands must of necessity be used, they should be used for such developments with low disaster potentials as golf, plantation and other essential water front activities. Another scholar who discussed the destructive impact of flood disaster was Royward (1978). He went so far as to catalogue some devastating floods such as the Hwang Ho flood of 1887 or the 'China's sorrow' in which 900,000 people died, the 1973 flood in Mexico in which 1,500 people died and 200,000 rendered homeless.

The recurring flood disasters in Bangladesh have received substantial coverage in recent years. A common feature of flood in Bangladesh is its permanancy. The flood which hit the country in 1988 for instance, affected about 25million people and three quarter of the entire country was under water (BBC London, 1989). The flood in Bangladesh is compounded by the opening of the gates of Farrakha

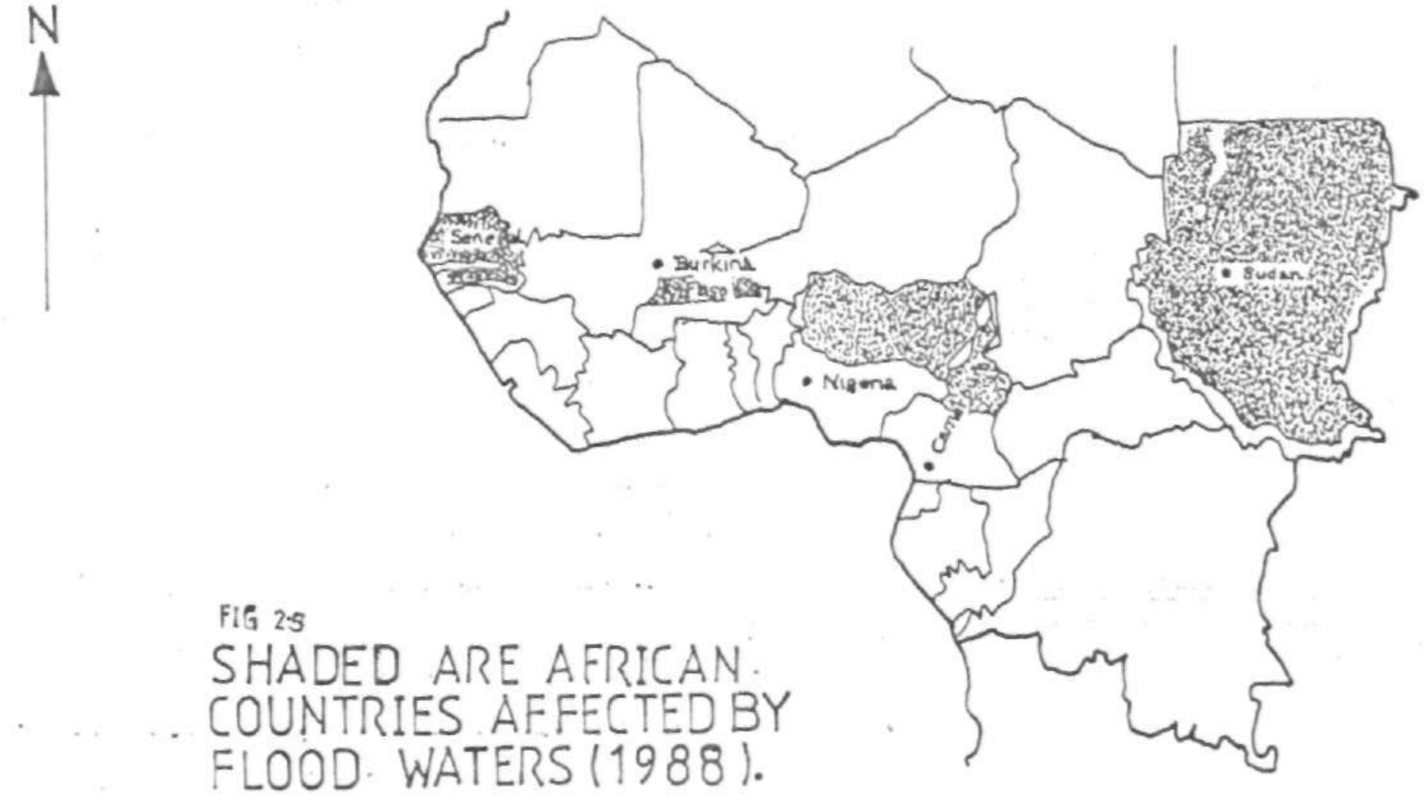

FIG 2·5
SHADED ARE AFRICAN COUNTRIES AFFECTED BY FLOOD WATERS (1988).
SOURCE: THE DEMOCRAT August,19,1988.

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urban settlements particularly following the nation-wide flood disasters of 1988. The review of some of the existing works on the subject of flood disaster brought into focus the disastrous impact of floods in various parts of the world and hence the need for prompt action to cope with the menance. It is better to act now than watch floods wreck havoc on lives and properties with rising intensity - this is the greatest motivation for this research work "problems of flood disasters in Hadejia: a physical planning proposal".