TITLE

DEVELOPMENT OF A CONCRETE STORAGE RESERVOIR FOR VEGETABLE PRODUCTION (A CASE STUDY OF RIVER KONTAGORA SCHEME)

BY

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PGD/AGRIC/SEET/98/99/35

(SOIL & WATER RESOURCES ENGINEERING OPTION)

BEING A PROJECT REPORT SUBMITTED TO THE SCHOOL OF POST-GRADUATE STUDIES, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POST-GRADUATE DIPLOMA (PGD) IN AGRICULTURAL ENGINEERING, (SOIL & WATER RESOURCES ENGINEERING OPTION).

JULY, 2000.

CERTIFICATION

The dissertation entitled DEVELOPMENT OF A CONCRETE STORAGE RESERVOIR FOR VEGETABLE PRODUCTION by **ABU NDAGUYE** meets the regulations governing the award of Post-Graduate Diploma (PGD) of the Federal University of Technology, Minna and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

With Genuine Humility, I acknowledge Your Aid, O God.

In the true spirit of my religion, I appreciate your grace, O God. With all my heart, I thank you, O God.

Without your Guidance and love, This work would not have been possible. Were It not for your help and cause, this humble contribution would have never become a reality please bless it with your acceptance. This work is dedicated to you, O God, and to my aged Father and Mother, and my Entire Family for the sacrifice and encouragement given to me during the period of this academic programme. May the Almighty Allah reward you abundantly (Amen).

ABU NDAGUYE. ***July, 2000.***

ACKNOWLEDGEMENT

In the name of Allah, most gracious, most merciful.

I am very delighted and grateful to Allah and to so many individuals who contributed immensely in one way or the other to see to the success of this Academic and the project work.

I am particularly grateful to Engr. Babatope .A. Alabadan (My project Supervisor) of the Department of Agricultural Engineering, who despite the pressure of Academic work before him, squeezed time to assist me towards the success of my project work.

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May the Almighty Allah reward you all abundantly (Amen).

ABU NDAGUYE ***July, 2000.***

ABSTRACT

The project area is located between Latitude 10^0 00' N and 10^0 30'N and Longitudes 5^0 30' and 6^0 00'N. It is situated on the outskirts of Kontagora with River Kontagora serving as the source of irrigation water. The objective of the study is to design and develop an On-Stream concrete weir across the river in order to impound run-off water so as to cope with the annual decline of irrigation water in order to boost vegetable cropping in the area. The total area will cover about 45 hectares. Both the soil and water analysis carried out in the project area showed that the water can be used for irrigation without any harm.

Similarly the soil are loamy soils which are best for agricultural purposes. The cost of construction of the structure is estimated to be about #215,325.00.

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CHAPTER ONE

1.0 INTRODUCTION

The fast-growing population of Nigeria estimated at about 120 million (NPC 1991) calls for the need to intensify efforts to provide sufficient foods, employment opportunities and improved standard of living of the small holder farmers.

Consequently, the major goal of the government policies through programme such as Green Revolution, Operation Feed the Nation, River Basin Development Authorities, Back-To-Land Programmes, Agricultural Development Projects, and Strategic Grains Reserves e.t.c. since independence has been on food security, self-sufficiency in food supply and reduction in food importation.

Furthermore, the effective use of the land and water resources for agricultural production involves both development of new lands and water resources, the improvement and better utilization of many irrigation schemes already in existence.

The design and construction of this project will therefore go along way to assisting the smallholder farmers in the project area to produce more food crops all the year round when adequate hydraulic structures are provided for their irrigation activities.

1.1 STATEMENT OF THE PROBLEM

The major constraint to irrigated agriculture in the project area is the growing water scarcity problems and competition for available water use among the irrigation farmers in the project area resulting to insufficient or lack of water for irrigation at the peak of the dry-season which will be able to sustain all the crops to maturity. This has resulted in low agricultural production, despite the abundant potentials available in the project area. The project is being designed principally for dry-season vegetable production.

1.2 OBJECTIVE OF THE STUDY

The objective of the study is to develop an On-Stream concrete Reservoir across River Kontagora for use as the source of irrigation water. This is to impound water in order to cope with the annual decline of irrigation water. The river flows like torrents in the rainy season of between April – October and then remains dry towards the end of the dry-season. During this period, most of the dry-season crops are not ready for harvest, hence, the necessity for the reservoir in order to have abundant irrigation water in the project area.

1.3 JUSTIFICATION OF THE PROJECT

The necessity for increasing agricultural production in this country has long been recognised by the populace, organizations and various governments. This is in order to meet the demand of the fast – growing population estimated at 120million and cut down the importation of grains and other edible food items. It is therefore necessary to utilize both the land and water resources available in the state to their maximum capacity and to the benefit of mankind thereby reducing foreign exchange expended on their importation, improved employment and the living standard of the populace.

CHAPTER TWO

2.0 LITERATURE REVIEW

According to Khushalani (1957), the necessity of a storage reservoir arises from insufficient and ill-timed rainfall with which crops cannot be raised to maturity. He went further to state that irrigation reservoir does not increase the water supply of a catchment, but merely furnishes the means of regulating the flow in a manner to utilise it best for irrigation purposes. A reservoir serve the purpose of a Bank in which water is deposited when it is surplus and withdrawn for irrigation when required.

Also, Varshney (1983) stated that the construction of weirs and storage reservoirs was well known in the early times, but such structures were generally limited in size, scope and designed essentially to store water for use in the periods of droughts.

Similarly, Aisenbrey Jnr (1978), stated that the availability of storage water has determined the course of empires, its use for irrigating crops has been practiced for thousands of years by many peoples of the World. However, only since the late 1800's has man applied scientific knowledge of irrigating dry-lands in order to increase agricultural production.

Demand pressure on water resources from agriculture, house hold use, and industry has increased dramatically in the past decades. The competition for limited water supplies between individual users, between sectors of water use and even between countries will pose an even greater challenge in the future as population and economic growth increase demands for this vital resource. Meizen-Dick (1998).

Worldwide, the agricultural sector has been and will continue to be the largest consumer of water. (Meizen Dick 1998). During the 1950's to 1980s, irrigation development expanded rapidly and accounted for over 90% of water withdrawals in the low income developing countries including Nigeria.

Although, there is actually enough water for our agricultural needs, it is often not available at the time and place of needs. The development of water resources therefore, involves the storage and conveyance of the water from the time and place of beneficial use. Varshney (1983) many streams and rivers flow, fluctuates widely from season to season and peak demands from many major rivers occur at seasons of minimum flow; this requires that much of the annual flow should be conserved and diverted for irrigation purposes. This situation requires the design and construction of weirs and reservoirs to hold water during seasons of high run-off for subsequent release for irrigation purposes.

According to Varshney (1982), Weirs are located across a river so as to raise the normal water level of the river to divert the required supply into the canal. Storage works in addition to diversion, store surplus water when available in the river in excess of demand and supplement the direct flow of a river during keen demand.

Reservoirs are classified according to the purpose they are to serve for example:-

(a) **Multi-Purpose Reservoirs:-** Serve more than one purpose viz: irrigation, flood control, power generation etc.

(b) **Distribution Reservoirs:-** are used primarily for storing water for domestic and industrial use.

(c) **Flood control Reservoirs:** are those which store water during floods and release it gradually when flood recedes Varshney (1982).

In order that the capacity of a reservoir is not materially affected by sitting, the storage capacity of the reservoir should be only about 10% greater than the average yield of the catchment. It will then be filled in all good years and will be near about filling in bad years Khushalani (1957). He went further to state that if rains are expected just at the close or after the season of replenishment, the storage capacity may only provide for irrigation during the fair weather, neglecting the demand in the monsoon period. Also in order to save cost of supervision and the loss by evaporation, it is preferable to have one reservoir to accommodate the entire demand rather than constructing several reservoirs. As far as possible, reservoirs in series should be avoided, as failure of one will lead to damage to, or destruction of all the lower ones, one after another. But when reservoirs in series are unavoidable, their size should be adjusted so that the capacity of the lower reservoirs goes on increasing.

According to Messiaen (1992), there is a social benefit in the development of vegetable crops. When ever is possible, the profession of a vegetable grower allows competent heads of families, with a small area of land and with limited capital, to achieve a certain level of prosperity, while still being their own masters. An average of 8000m^2 (0.80ha) of intensive vegetable production unit should be sufficient to provide a reasonable standard of living for a family.

CHAPTER THREE

3.0 METHODOLOGY.

3.1 PROJECT AREA DESCRIPTION

3.1.1 GENERAL

The purpose of this section is to present all datas necessary in order to get acquainted with the project area and to evaluate the conditions that have a direct bearing with the project planning and evaluation (Fig.3.1).

3.1.2 THE STUDY AREA

The study area lies on the out-skirts of Kontagora town of Niger State with river Kontagora as the source of irrigation water. The river runs through the project area. Both the banks of the river are over lain by flood plains which are utilised for both wet season cropping and more extensively cultivated for dry season vegetable production. The gross cultivable area after construction is estimated to cover about 45ha.

3.1.3 LOCATION AND GENERAL DESCRIPTION

The selection and location of a development project involves many considerations, the most important being the availability of natural resources which if well harnessed, would be of immense benefit for the public and Niger State in general. Other factors influencing the location of the project is the zeal and enthusiasm shown by the farmers in the project area.

3.1.4 TOPOGRPAPHY

The topography of the land surface is fairly elevated, flat and undulating in some areas with a gentle slope towards the river. The river runs through the middle of the project area.

3.1.5 CLIMATE

The climate of the project area is almost the same as the typical of the Middle Belt of the country with high temperatures ranging between 37.5^{0}C Max and 18^{0}C minimum. The hottest period is from February to April. (Shallow Acquifer Studies 1995).

Temperature has an effect, not only on the growth but also on the development of the plants. It is therefore necessary to check, before introducing any vegetable species into the tropics, that its optimal growth temperature and its photo periodic requirements are compatible with the local climatic conditions. It is also important not to ignore the existing local varieties (cultivated varieties or cultivars) of the species that is to be introduced, even though the quality of their produce is only average. This is because such local varieties may have an important role to play in future plant improvement schemes, since they represent an irreplaceable source of genetic variability. Messiaen (1992).

MONTHLY TEMPERATURES IN ^{0}C Fig. No. 3.1.5a

STATION	PERIOD	TEMP.0C	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC
MINNA	1980	MEAN MAX.	34.8	37.5	37.0	35.7	33.3	32.5	29.5	28.5	29.5	31.8	33.7	34.7
	TO	MONTHLY MEAN	27.8	30.1	30.7	30.4	28.4	27.4	26.0	25.2	25.8	26.7	26.6	26.4
	1990	MEAN MIN.	20.8	22.7	24.4	25.0	23.5	22.2	22.5	21.8	22.0	21.5	19.5	18.0

MEAN MONTHLY RELATIVE HUMIDITY IN % Fig. No. 3.1.5(b).

STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEPT	OCT	NOV	DEC.
MINNA	1980	31	-	83	69	76	84	86	85	80	77	59	44
	1981	22	37	63	64	-	-	87	88	86	79	54	39
	1982	28	-	49	64	72	77	85	70	86	70	32	26
	1983	22	38	62	64	-	80	84	89	84	76	36	32
	1984	24	29	-	63	70	80	84	87	82	73	39	33
	1985	28	30	43	56	69	79	79	87	84	76	42	43
	AVERAGE	25.8	33.5	50.0	63.3	71.8	80.0	84.3	84.3	83.8	75.2	43.7	36.2

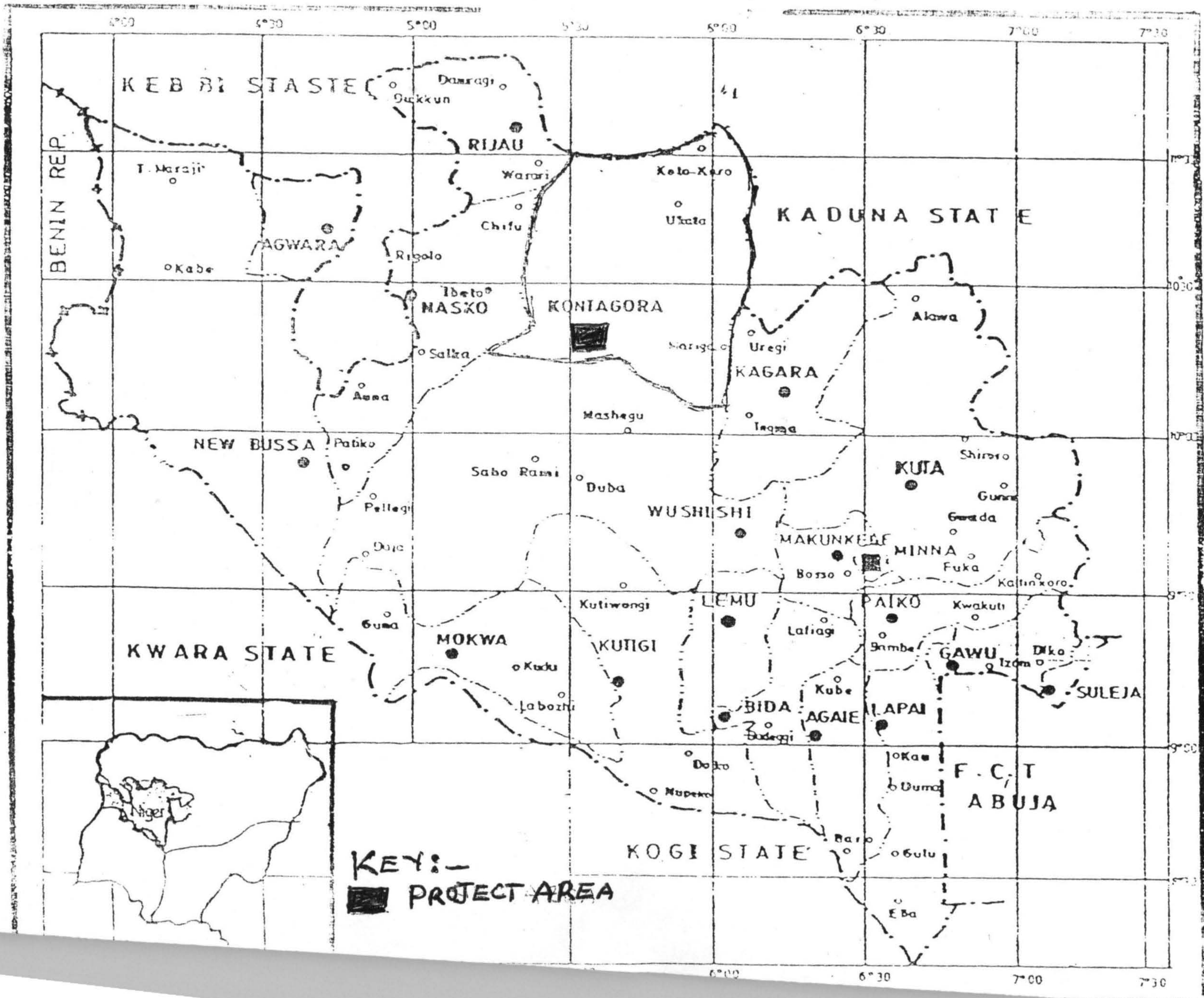
3.1.6. RAINFALL

Water is the most important element for all agricultural activities. Although, the total amount of annual rainfall is used as a determinant in crop zonation, the two most critical parameters for rain fall that gives a realistic projection of crop – yield are the "On-Set" dates of steady rainfall and the "Length in Days" the steady rainfall are to be expected (shallow acquifer studies, Niger ADP). The minimum annul rainfall of the project area is in the range of 900mm and a maximum of about 1300mm. The rains in Niger State and the project area terminates in October (Figs. 3.1.6L and 3.1.6m).

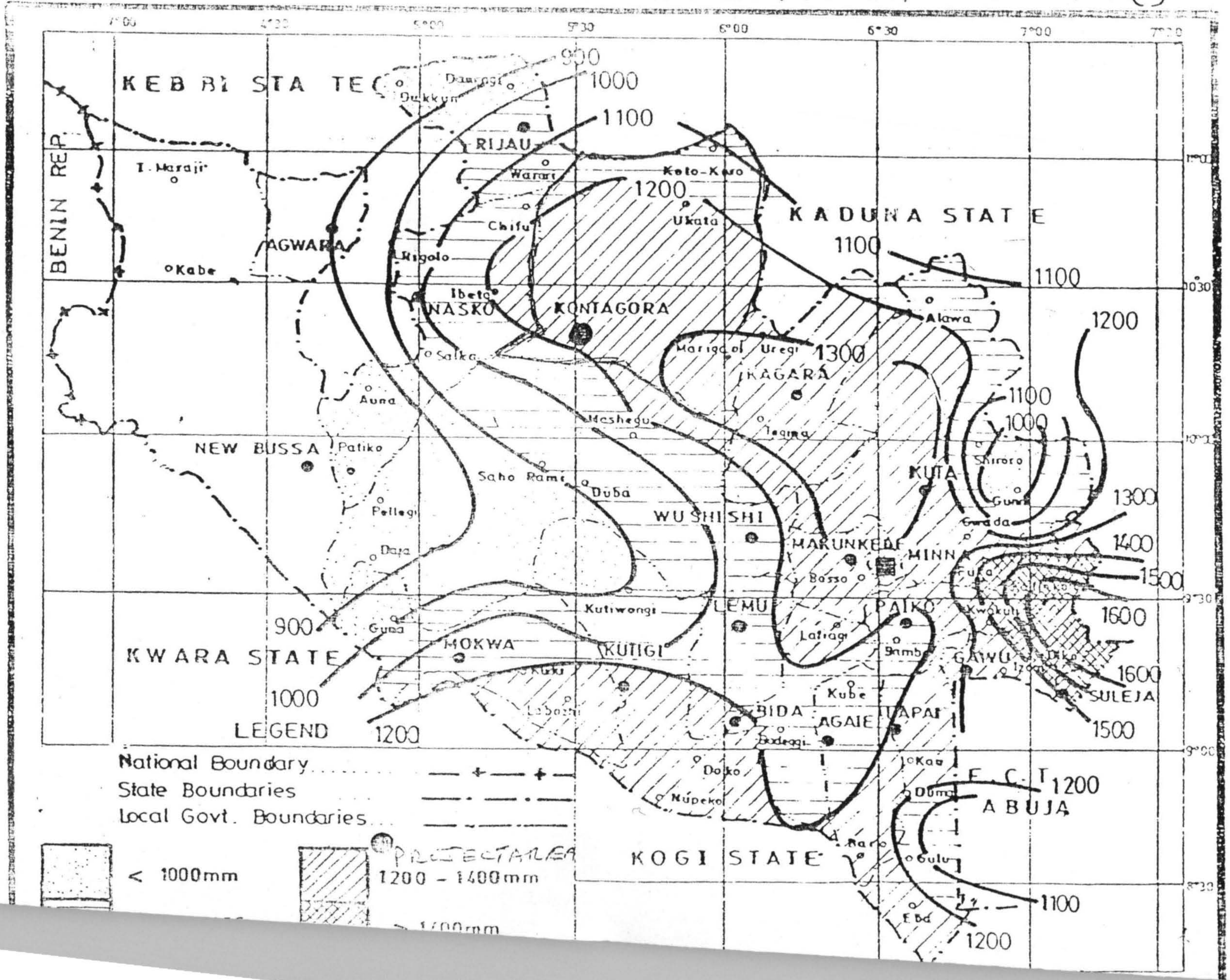
The Hydrological Ratio (λ) or degree of dryness or wetness is the ratio of Mean Annual Rainfall to Potential Evapotran spiration. A value of λ = 1.0 is called the Hydro-neutral condition which under normal situations implies no deficit soil moisture (100% Field Capacity). Any area with λ = 1.0 is called Hydro-neutral zone of potential maximum crop yield. Where λ is below 0.40, additional water will be required to supplement soil moisture to ensure λ = 1.0 at all times. The λ ratio of the project area is shown in Fig.3.1.6n. Also, the mean annual and seasonal distribution pattern of Niger State and the project area are illustrated in Fig. 3.1.6a-n (source: Niger State ADP – Shallow Acquifer Studies) 1995.

From the foregoing therefore, there is need for water-harvests or tapping for periods of needs for example, dry-season, the harnessing of annual and perennial rivers through the construction of weirs and reservoirs cannot be over emphasised.

Fig. 3.1

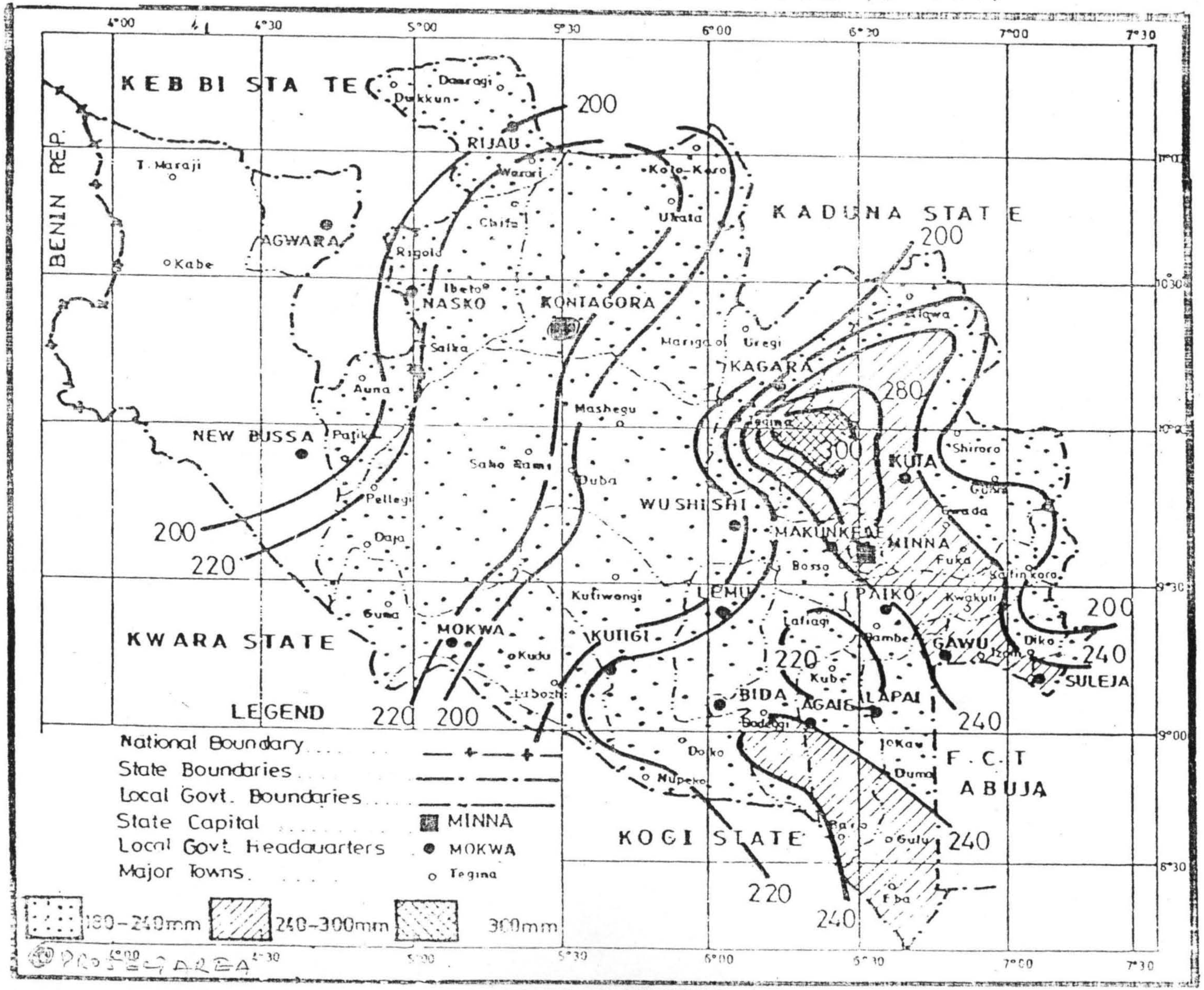

KEBBI STATE
BENIN REP.
KADUNA STATE
KWARA STATE
KOGI STATE
F.C.T ABUJA
RIJAU
AGWARA
NASKO
KONTAGORA
KAGARA
NEW BUSSA
KUTA
WUSHISHI
MAKUNKELE
MINNA
LEMU
PAIKO
MOKWA
KUTIGI
GAWU
SULEJA
BIDA
AGAIE
LAPAI
Niger
KEY:-
PROJECT AREA

NIGER STATE
MEAN ANNUAL RAINFALL (IN MM) FIG. 3.1.6(a)



NIGER STATE

MEAN MONTHLY RAINFALL IN JULY (IN MM) FIG. 3.1.6(b)



SCALE 1 : 2,000,000

NIGER STATE

MEAN MONTHLY RAINFALL IN AUGUST (IN MM) FIG 3.1.6(C)

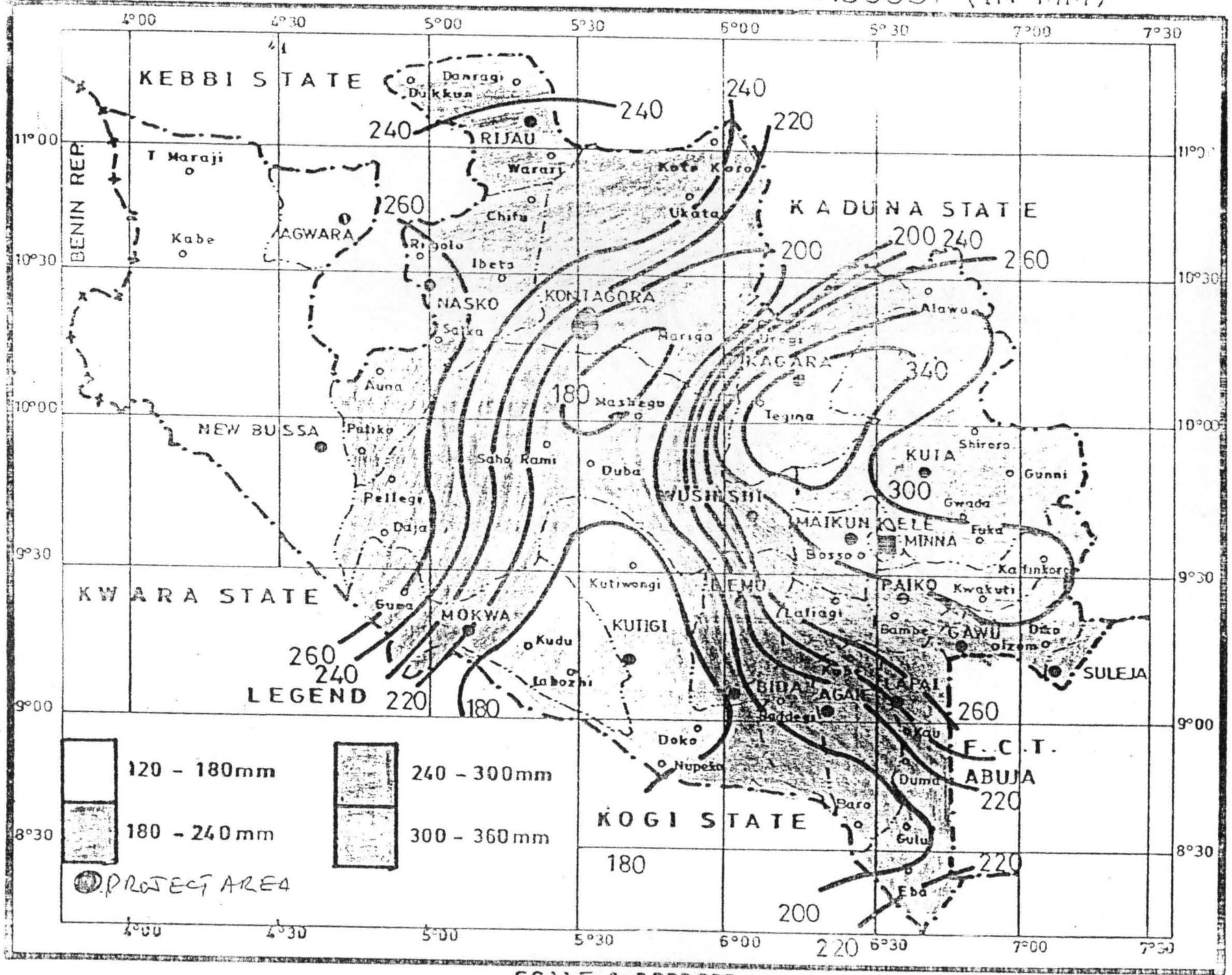


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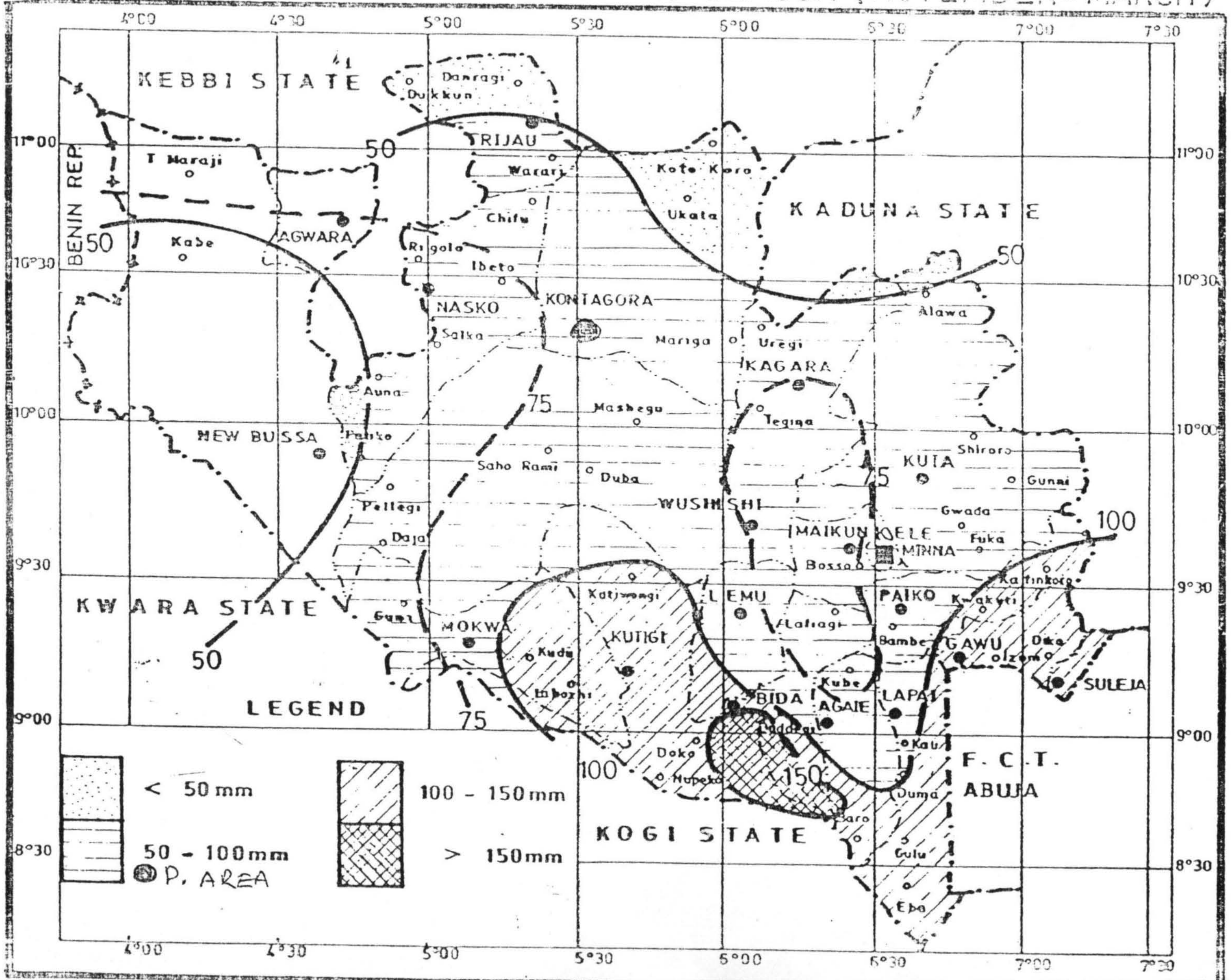
FIG. 3.1.6 (e)

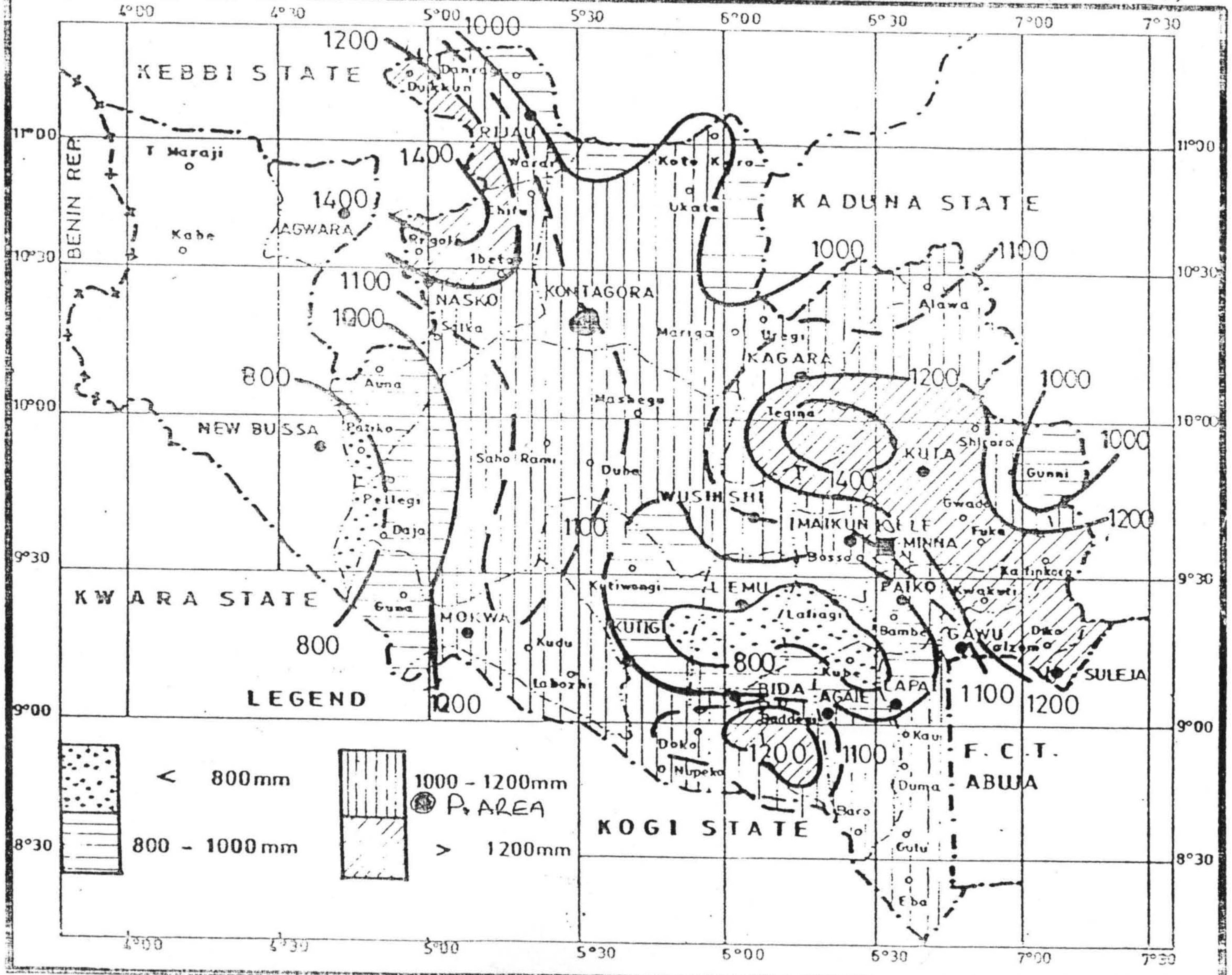
NIGER STATE

MEAN RAINFALL DURING DRY SEASON (NOVEMBER-MARCH)



NIGER STATE

Fig 3.1.6(f) MEAN RAINFALL DURING WET SEASON (APRIL - OCTOBER)



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3.1.10. FARM SIZE

At the moment the average farm size farmed by one family ranges between 1.5 – 2.0 ha per farming family, but this varies annually and subject to the availability of in puts and economic base of the farmer. On completion of the project, this farm size will increase.

3.1.11 FUTURE AGRICULTURAL AND LAND USE

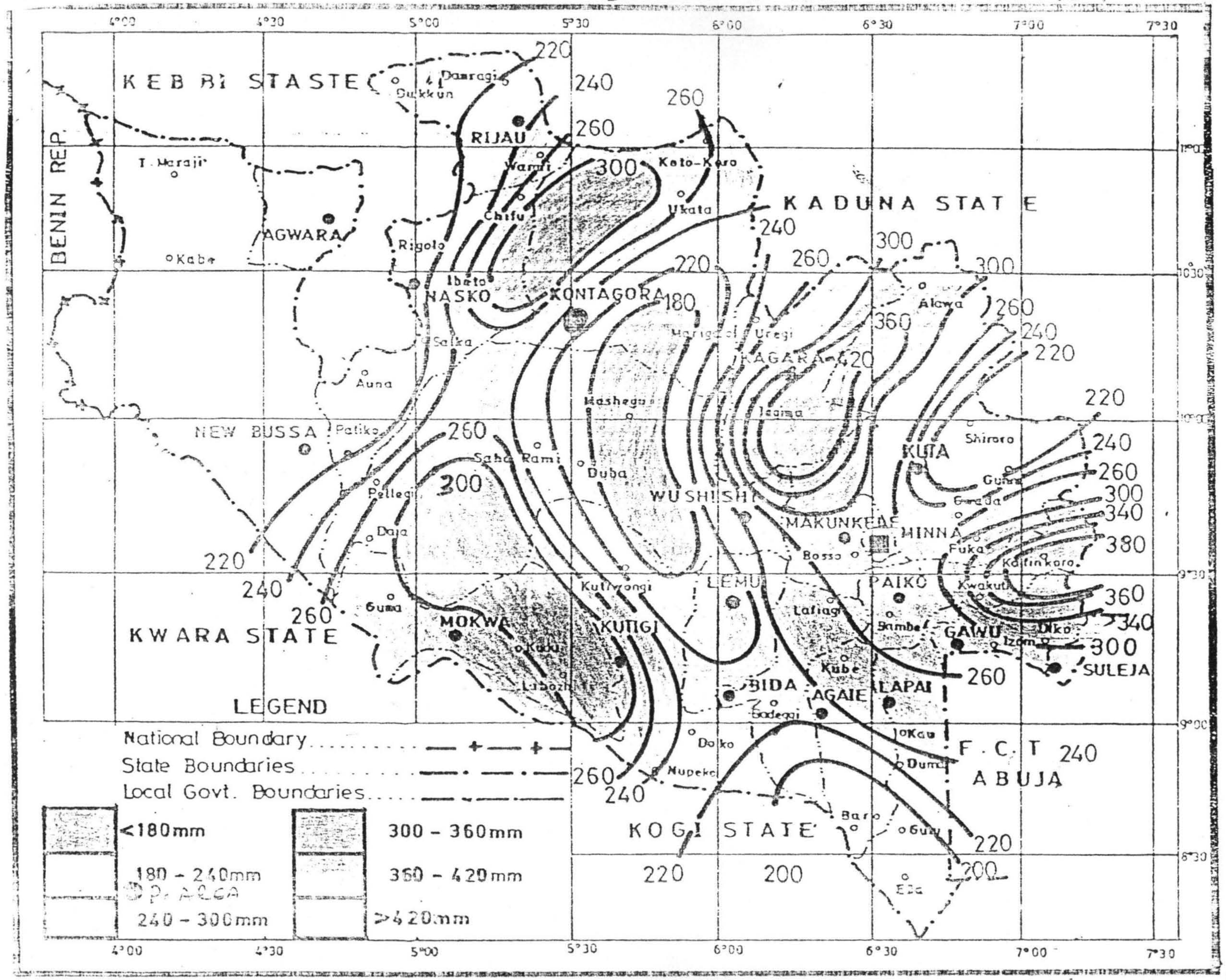
The net project area after the completion of the project is estimated to be about 45 ha. Most of this area will be used for rice and other crops in the wet season, while about three – quarters of these area will be used in the dry season for vegetable production.

The farmers in the project area have been practicing a Border Strip System of irrigation in which the farm plots are divided into a number of borders separated by low leevees or borders. Irrigation water will be supplied using small water pumps of say 3HP direct from the reservoir channel and unto the field canals.

3.1.12 CULTURAL PRACTICES

Although the farmers are at the moment conversant with the proper lay-out of irrigation systems, it is still very necessary to enlighten them on the good water management practices so as to improve their crop yields as this will have a significant effect on the economy of the project.

Mean Rainfall (in mm) During Month of Maximum Rainfall (September). Fig. 3.1.6(d)



SCALE 1 : 2,000,000

Similarly, water so wasted may have an adverse effect in reducing the cultivable area that can be irrigated with a given amount of water. A limited irrigation water may require a more careful irrigation scheduling of land preparation and planting dates. Also chemical and organic fertilizers will be required to maintain satisfactory fields in the project area.

3.1.13 YIELDS AND PRODUCTION

After the completion of the project, the average yield per unit area, will be greatly increased. The adverse effects of flood damage and drought which results in low yields will be reduced. Under present conditions these two limitations are dominant in the project area resulting in low yields.

3.2 METHODS OF INVESTIGATIONS

Consequent upon the identification and selection of the project area, several field reconnaissance survey trips were made to the project area in order to acquaint myself with the area, assess the requirements of all the field information as well as the other relevant data that will assist in carrying out the project work. References were also made to many text books, agricultural journals and consultations with many farmers and agricultural experts.

3.3(a) SOIL – TEST ANALYSIS

The soil analysis was carried out using standard soil analysis as documented in the I.I.T.A. soil manual. PH determination was carried out in duplicate using water and 0.01m $cacl_2$ in the ratio 1:2:5.

Organic carbon/matter was determined using Walkley and Blackwet oxidation method. Total Nitrogen was determined by Kjeldahl method.

3.3(b) WATER QUALITY ANALYSIS

The water Quality analysis was carried out to determine:-

(i) The Electrical conductivity of water

(ii) Sodium Adsorption Ratio (SAR)

(iii) Biocarbonates in water

(iv) Boron in water

(v) Sodium percentage

(vi) Salt content (ppm)

3.4 CONTOUR MAP ANALYSIS

A topographical sheet of scale 1.25,000 was studied and analysed to look into the most viable site for the construction of weir and the storage reservoir. A copy of the relevant portion of the sheet is presented in Fig.3.4(a).

This site is chosen because storage water can be obtained at a moderate cost without much loss of water by way of evaporation and absorption.

The storage site is classified as follows:-

(i) Natural lake basins

(ii) Favourable positions of natural valleys, or the drainage lines whose flow is to be stored.

(iii) Natural depressions away from natural drainage lines in which water can be led from the catchment under tribute and out of which water can be taken for irrigation and other purpose. However, site of class (ii) is the most common throughout the world, classes (I) and (III) rarely exist – Khushalni (1957).

CHAPTER FOUR

4.0 PRELIMNARY DESIGN AND LAY-OUT

4.1 GENERAL

The most fundamental consideration for this project is to design a water control structure that will impound and raise the level of water to be used for dry-season vegetable production. This is in view of the immense agricultural potentials abundantly available in the project area. An attempt is being made to avoid very expensive structures and the lay-out has been kept as simple as possible. The design consists of a concrete weir to be built across river Kontagora and an on-stream storage reservoir.

4.2 DESIGN OF A CONCRETE WEIR

A concrete weir is to be located in a favourable position of the natural valleys along the river. The location is a confluence of smaller tributaries that will contribute flow to the reservoir, other factors put into consideration in the siting of the weir and the reservoir include:-

(a) It has a narrow, well defined channels of supply.

(b) Availability of construction materials such as sand, gravel, lump stone etc.

(c) Possibility of diverting the river during construction.

The component parts of the weir are:-

(a) The crest

(b) The stilling basin that will dissipate the energy of the falling water.

(c) The retaining walls and

(d) The down – stream rip-rap.

Typical design of the weir with its dimensions and cross-sections is shown in Fig. No.4.2.(a) and (b).

In the design of the weir, considerations will be made of the hydraulic forces that will act on the structure and the determination of the configuration for the best economy and functional efficiency, while the structural design of the Weir will consist of the dimensions of the various components of the structure, so as to enable the structure to resist safely all the forces that would act on it.

4.3 FAILURE OF WEIRS ON PERMEABLE SOILS

In order to avert the failure of the weir structure after the construction has been completed, the following were put into consideration during the design:-

(a) Seepage or subsurface flow

(b) Surface flow.

The subsurface flow will endanger the stability of the weir by:-

(i) PIPING OR FLOATATION:- This will be caused when seepage water has sufficient residual force at the end of the work to lift up soil particles.

Fig. 4.2(a)

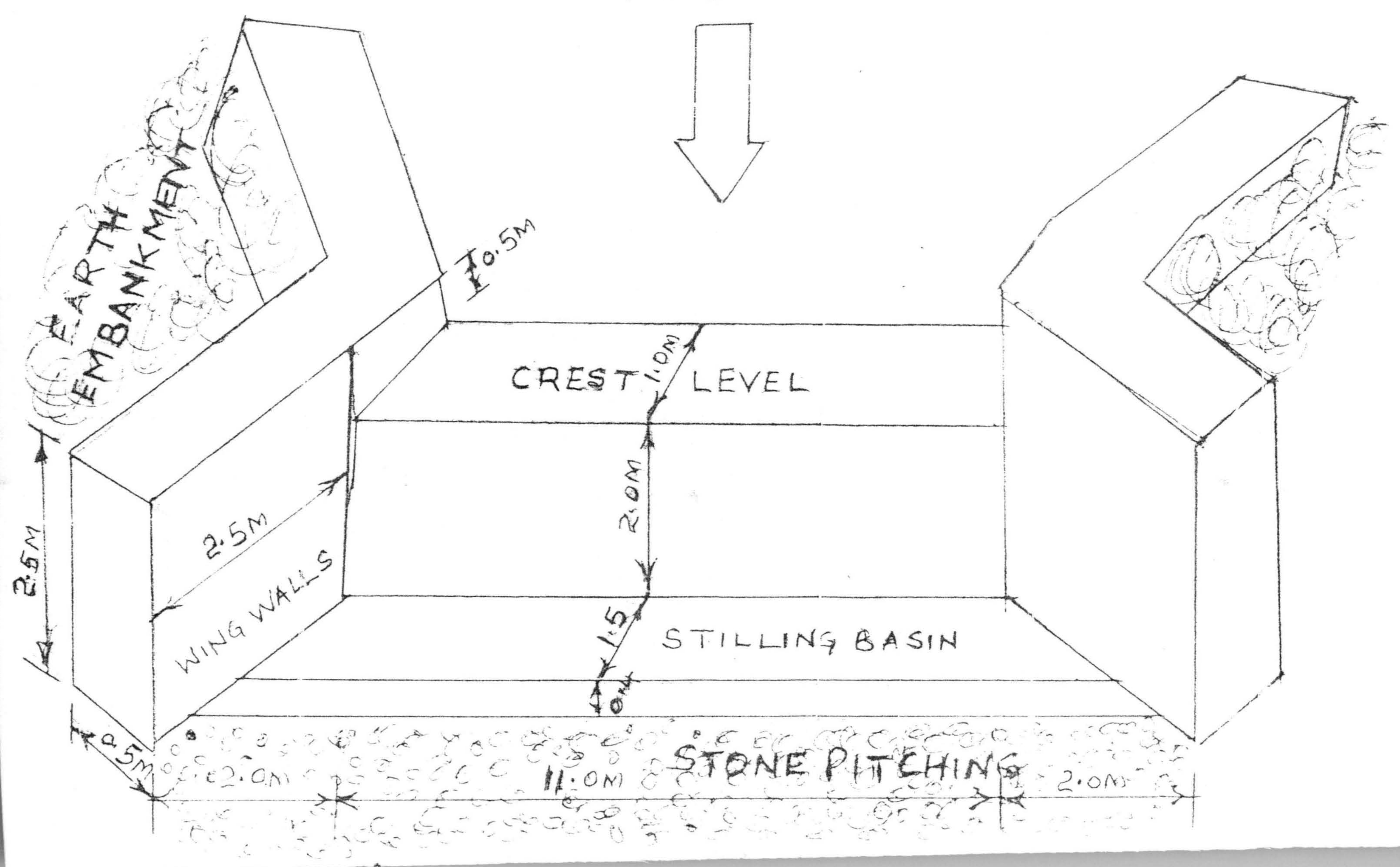
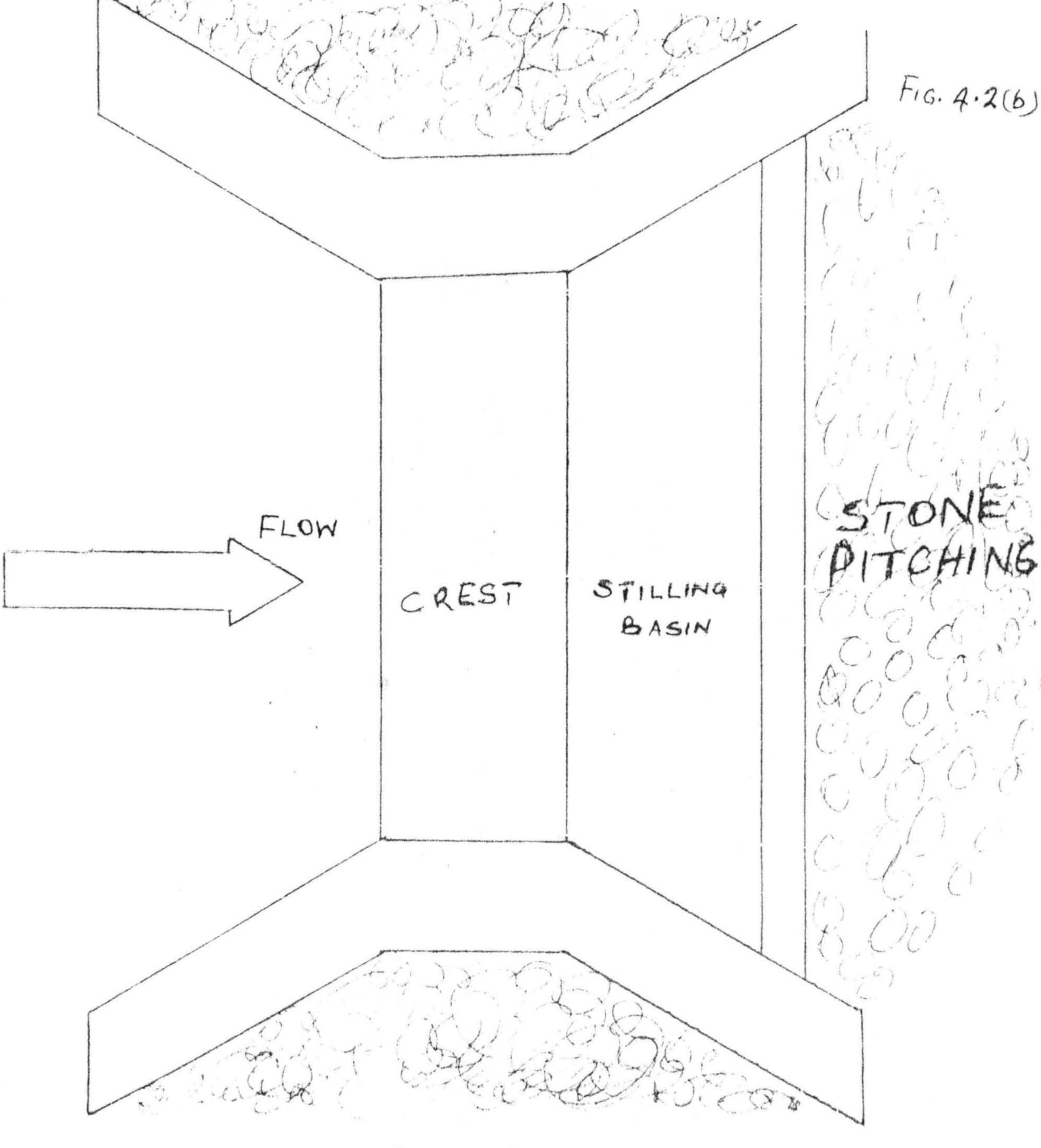
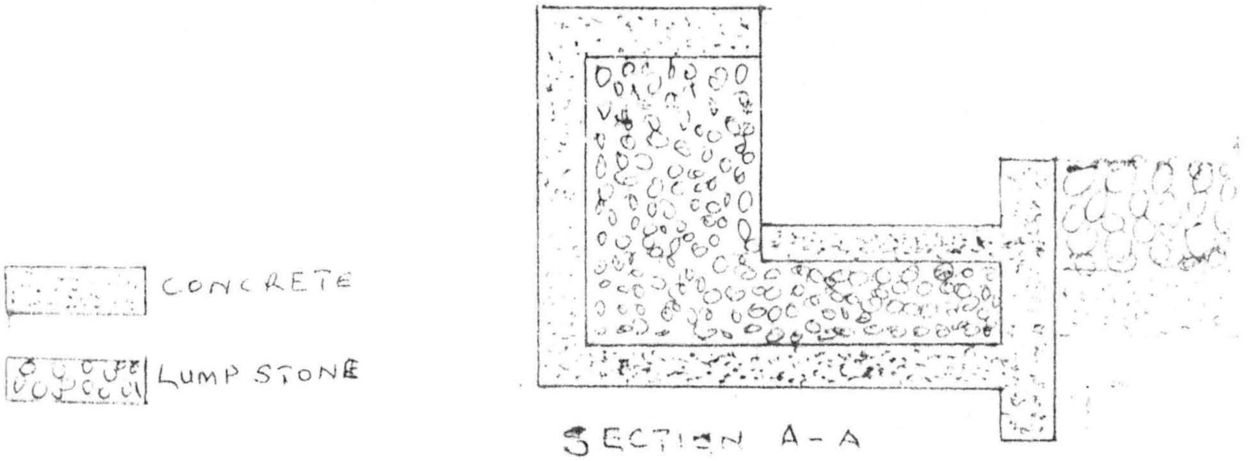

FLOW
EARTH EMBANKMENT
0.5M
CREST LEVEL
1.0M
2.0M
2.5M
2.5M
WING WALLS
1.5
STILLING BASIN
0.4
0.5M
STONE PITCHING
2.0M
11.0M
2.0M

FIG. 4.2(b)



PLAN



SECTION A-A

When this occurs, it may lead to progressive removal of the soil beneath the foundation of the work resulting in the failure of the structure.

(ii) UPLIFT PRESSURE:- Seepage water exerts an upward or uplift pressure on the floor of the weir. The tickness of the floor is therefore designed adequately to with and the uplift pressure so as not to result to the failure of the floor.

The surface flow will endanger the weir by:-

(i) **UNBALANCED HEAD DUE TO STANDING WAVES:-**

The floor is designed with adequate thickness to with stand the effect of the hydraulic jump which will be caused by high unbalanced pressures developed in the trough.

(ii) SCOUR ON THE UP AND DOWN STREAM

The scour on the upstream and down stream is designed to be adequately checked so as not to cause considerable damage to the works due to undermining.

4.3 THE STORAGE RESERVOIR

The objective of the storage reservoir is to locate, design and construct the most economical structure that will be used to store the impounded water for the use of dry season vegetable production in the project area. The necessity of the storage reservoir arises from in sufficient and erratic rainfall with which crops cannot be raised to maturity. The stream in the project area flows like torrents for a few months after the rains and then remains dry before the on-set of the rainy season. The situation has resulted in crop failure due to insufficient water. Hence, the necessity of constructing a weir and a storage reservoir.

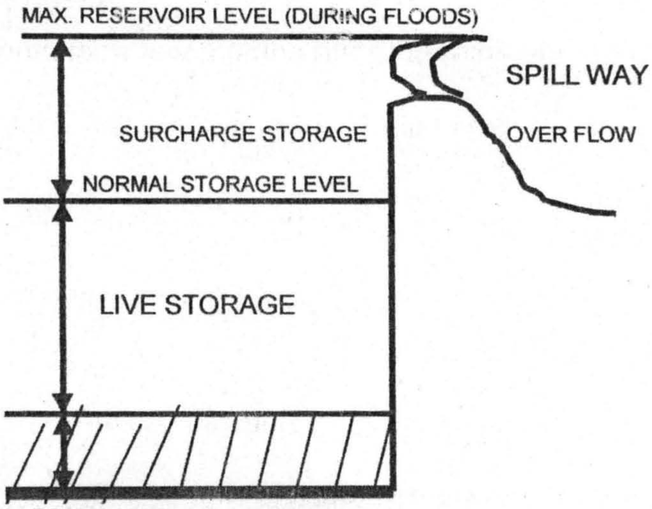
The types of the reservoir under consideration is the flood control reservoir which will serve the purpose of storing water during the mon soom periods and released gradually for irrigation purposes when required.

The reservoir is designed to have the following zones:_

(i) LIVE STORAGE:- This is a zone in which the storage water will usually be maintained at a normal or full reservoir level, the maximum level to which the water will rise in the reservoir during normal operating conditions.

(ii) DEAD STORAGE:- This is the lowest elevation below which the water in the reservoir will not be expected to go beyond the level. The storage in this zone will normally be taken to be equal to the sediment volume during the life span of the reservoir.

(iii) SURCHARGE STORAGE:- This is the water in the reservoir between the normal reservoir elevation and the flood level. This is required in order to evaluate the routed flood capacity of the reservoir.



The provision of a storage reservoir on the river in the project area will put more cultivable area under irrigation command both in the rainy season and in the dry season.

The main parameters that have to be determined from the hydrological observations for the reservoir are:-

(a) The total storage capacity (i.e live plus dead storage) of the reservoir that would optimise land and water resources.

(b) The inflow hydrograph of the design return period to determine the spillway for the safe discharge of flood water.

4.4 THE HYDROLOGICAL INVESTIGATIONS

This investigation is very important in the conception and design of storage reservoir project. The study is to focus on the total quantity of water that will be available at the reservoir site and the best method of regulating, controlling and using the water for irrigation and other purpose.

Other parameters that have to be considered include:-

(i) Quantity, distribution and intensity of rainfall.

(ii) Maximum, mean and minimum total run-off that could be expected from the catchment feeding the reservoir. Records of stream flows, losses in capacity due to sedimentation, evaporation, infiltration e.t.c. have to be determined.

(iii) Estimation of annual yields and their break-up into monthly, moon soon and non-moonsoon run-offs.

(iv) Maximum intensity of floods, their duration and probabilities of frequency of their occurrence.

(v) Quantities of water required for irrigation during different stages of crop growth.

The main aim of hydrological studies is to obtain as close an estimate of run-off pattern at the proposed dam site or on-stream reservoir. This estimate will be based on the assumption that the run-off pattern for future would be the same as has been in the past years.

4.5 ESTIMATION OF PEAK FLOODS

Since the source of the storage water is by the stream flow and surface run-off, it is very necessary to estimate run-off from the total or each individual rainfall.

This will assist in ascertaining the quantity of water available for utilisation directly or through the storage. Also, determination is to be made of the maximum rate of run-off to be expected. The various methods of estimating the peak floods are:-

(i) Physical indications of the past floods.

(ii) Empirical formulae

(iii) Flood frequency studies

(iv) Regional floods studies and

(v) Unit hydrographs.

It is observed that no discharge measurements or other hydrometeorological observations have been collected in the project area in the past. In view of this, the "Physical Indications of the past floods method was used to determine the peak flood of the area. This method entails enquiries from local people about the marks of the highest floods on the banks of the river. Also, by observation of elevations of deposited bush, logs, alluvial water and scars from the floating logs etc.

Under the empirical formulae, the following formulaes can be used to determine peak floods:-

(i) Dicken's Formula:-

$$Q = CA^{0.75}$$

Where Q = flood peak in m^3/s

A = Catchment area in sq.km

C = Coefficient which according to Dicken varies from 1.67 – 10.5, but actual observed values can be up to 35.

(ii) Ryve's formula

$$Q = CA^{0.67}$$

The value of C is 6.8 with 80km of coast; 8.3 for areas Between 80 and 2400km from the coast; 10.0 for limited areas near the hills.

Actual observed values are up to 37.

(iii) Inglish formular (for fan-shaped catchment)

$$Q = \frac{124A}{\sqrt{A + 10.4}}$$

(iii) Myer's Formular

$$Q = 175\sqrt{A}$$

4.6 STORAGE CAPACITY OF THE RESERVOIR

After going through the history of the project area in order to collect necessary hydrological information, it was necessary that the real success of the project depends on flood control combined with irrigation facilities. As the flow in river Kontagora is very flashy and difficult to depend upon even in the wet season, the only alternative is to conserve water at a suitable place in order to have enough water for irrigation all the year round.

4.7 LOSSES IN RESERVOIRS

The expected losses in reservoirs can be summarised as follows:-

(i) EVAPORATION LOSSES:

The evaporation losses in reservoirs will depend largely on the area of location and are expressed in centimeter of water depth. Other factors that influence evaporation are temperature, wind velocity, relative humidity and proximity to other structures. Evaporation losses can be measured using standard pans.

In order to reduce evaporation losses in reservoirs, a chemical known as "Cetyl Alcohol" also called "Hexadecanol" a waxy substance is added to water to form a mono-molecular thin layer over the water surface. The invisible film is non-toxic and retards evaporation, while allowing free passage of rain, oxygen and sunlight. The reduction in evaporation using this method can be as high as 50-60% of natural evaporation.

(ii) ABSORPTION LOSSES

These losses depend on the type of soil that forms the reservoir basin. They may be quite large at the beginning, but gradually reduced as the pores get saturated.

(iii) SEEPAGE LOSSES

They are usually small but may be quite significant where there may be continuous seam of porous strata.

4.8 SEDIMENTATION IN RESERVOIRS

Sedimentation in reservoirs is a difficult problem for which an economical solution has not yet been discovered, except by providing a "Dead Storage" to accommodate the deposits during the life – span of the reservoir. Disintegration, erosion, transportation and sedimentation are different stages leading to the silting of reservoirs.

Sedimentation is also a product of erosion in the catchment area of the reservoir and hence, the lesser the rate of erosion the smaller is the sediment load entering the reservoir.

4.10. LIFE SPAN OF A RESERVOIR

The dead storage provided in the reservoir capacity is allowed for sedimentation during the design. Actually, all the sediment load do not go into the dead storage. Some encroaches upon the Live storage also. This encroachment may be attributed to many factors such as reservoir operation, valley characteristics, capacity of the inflow ratio and sediment content in the inflow etc.

The rate of sedimentation is higher in the initial stages and decreases as the years go by. This is due to the fall in the trap efficiency of a medium size reservoir.

CHAPTER FIVE

5.0 RESULTS AND DISCUSSIONS

5.1 EXPERIMENTAL RESULT

5.1.1. RESULTS OF THE LABORATORY ANALYSIS OF THE SOILS

Soil samples were obtained using a hand auger from two pits in the project area. This is in order to obtain an average good evaluation of the sample as below:-

(i) 0 – 25cm (deep) This is a surface layer which is normally regarded as a major zone of crop production.

(ii) 25 – 50cm (deep) This is usually regarded as mineral soil zone.

This soil analysis was carried out in FUT Minna soil science laboratory using standard soil analysis as documented in the IITA soil manual.

5.1.1(a) SOIL REACTION PH

The PH values of the soils from the two pits are 6.71 and 6.51 respectively which are slightly acidic. The PH value of 7.0 is termed Neutral, while the PH 7.0 – 7.21 are mild alkaline and PH value below 7.0 is acidic. Most plants and soil micro-organisms thrive well in soils with PH 6.0 – 7.5. Though plant species and varieties differ in degree to which they favour or tolerate PH, all crops grown in the project area can thrive well with the PH of the soils observed.

5.1.1(b) THE CATION EXCHANGE CAPACITY (CEC).

The cation Exchange Capacity is a fertility indicator. The exchangeable cations by the laboratory analysis is usually restricted to the cations Ca, Mg, K and Na quantities expressed as mm equivalent/100g of soil. The total quantities of these four exchangeable cations to CEC value.

The results of the analysis of the soil samples indicate quite good values of CEC. This is an indication of good fertility of the soil.

5.1.1(c) THE SOIL SALINITY

The general parameter of salinity is the Electrical conductivity of 25^0C of the saturation extract denoted as Ece. The FAO concept of high salinity are soils that have Ece 4 million hos/cm is free from salts (Ece & 2 million hos/ 1cm). This result may be attributed to the good drainage of the soils and the amount of rainfall the project area enjoys and seasonal variations.

5.1.1(d) SOIL ORGANIC MATTER

The potential fertility of a soil is determined by the Chemical composition of the soil such as Organic matter (OM), Organic Carbon (OC) and Nitrogen (N). The result of the analysis shows that the values of organic matter content and organic carbon was rated from Medium to Low.

Note that

Values of OM 4.3% - 6.0% are rated high

Values of OC 2.57% - 3.0% are rated high

Values of N 0.2% - 0.3% are rated high.

5.1.1(e) AVAILABLE PHOSPHOROUS

The result shows that available phosphorous measured by Bray Method was rated low. ie. 7-6ppm is low (Bray Method).

5.1.2 LABORATORY ANALYSIS OF WATER

Surface irrigation water usually carry suspended solids and salts. The amount and nature of salts depends upon the mineralogical composition and physical structures of the rocks through which the water flows, the temperature, pressure and the duration of contact.

Dissolved salts may have favourable or unfavourable effects:

(i) Favourable in that they may contain valuable plant nutrients and

(ii) Unfavourable in that irrigation with salty water may lead to soil salinization which will impede the water uptake of the plants.

Moreover certain salts have toxic effects. Common chemical constituents found in irrigation water are cations calcium, magnesium, sodium and iron (Ca, Mg, Na, Fe), and anions, bi-carbonate sulphate, fluoride, silica ($HC0_3$, $S0_4$, F, $Si0_2$). The concentration of salts in water may not appear to be harmful to plants at the beginning of irrigation, but with the passage of time, the salt concentration in the soil may increase to a harmful stage as the soil solution gets concentrated by evaporation.

The parameters generally accepted for assessing the suitability of irrigation water are:-

5.1.2(a) THE PH VALUE

Acidic water has PH value of less than 7.0 while alkaline water has PH value more than 7.0. The results of the analysis of water has PH value slightly greater than 7 which indicates that the samples are non-acidic, but very slightly alkaline. The value does not constitute any hazard for irrigation

5.1.2(b) TOTAL QUANTITY OF DISSOLVED SALTS (TDS)

TDS is easily measured by the determination of Electrical conductivity (EC). It measures the ability of the solution to conduct electricity. The result of the EC of the sample is 4×10^{-5} mmhos/cm. This indicates that salinity of the water sample is very low. It is therefore likely to take long time (years) before any salts problem is likely to be noticed in the project area.

The salinity concentration of the soil solution (Cs) after the consumptive use Cu has been extracted from the soil can be given by:-

$$Cs = \frac{C \times Q}{\{Q - (Cu - Peff)\}}$$

Where

Q	=	Total Quantity of Water applied
Cu	=	Consumptive use of water
Peff	=	Effective rainfall
C	=	Concentration of salt in irrigation water.

5.1.2(C) PROPORTION OF SODIUM IONS TO OTHER CATIONS

High sodium concentration in irrigation water affects the soil structure, infiltration and permeability. A high percentage of exchangeable sodium in soil containing swelling type of clay results in a dispersed condition unfavourable for water movement and plant growth.

The most reliable index of the tendency of an irrigation water to form exchangeable sodium in the soil is the sodium adsorption ration (SAR). The values of SAR for the samples is less than 10 which indicates that the water can be used for irrigation in the project area without danger of development of harmful levels of exchangeable sodium. The SAR formula used is:-

$$SAR = \frac{Na^{+}}{\sqrt{Ca^{++} + Mg^{++}}}$$

5.1.2(d) CATIONS AND TRACE ELEMENTS

The result of the water analysis shows that cations (Na, K, Ca, Mg) and trace elements (Zn, Fe, Cu) are present in small quantities in the project area. This is an indication that the samples contain valuable nutrients and can be used for irrigation successfully.

5.2 DISCUSSIONS

The results of the water quality analysis of the project area obtained are within the permissible limit for irrigation water quality (Table 5.0(a). It is therefore recommended for irrigating the crops grown in the area.

Similarly, the results of the soil samples taken from the project area shows slight acidic soils. Therefore, fertilizers with acidic residual effects in the soil such as Ammonium Nitrate are to be used as a source of Nitrogen on the soils, while single superphosphate is to be used as a source of phosphorous.

From the discussions and interactions made with the farmers during the course of the study showed that the major limitation to higher agricultural production is the inadequate surface water for dry season vegetable production. Other constraints included the inability of the government to provide agricultural inputs to them in the dry season. Land preparation, fertilizer demand and insect attack on vegetables are some of the major set backs to dry season cropping.

5.3 OBSERVATIONS FROM THE FIELD

It was observed from the field that all the farmers adopt Lift Irrigation systems using small centrifugal irrigation pumps owned by individual farmers. They pump water direct from the river channel into plots of farm lands. These pumps are easy to operate and their maintenance and spare parts are no problem. Government should therefore make these pumps more available at subsidized rates to these farmers in order to increase their agricultural production.

5.4 BENEFITS OF THE PROJECT

The project covers an area of about 45 ha which is intended to give direct benefit from increased agricultural production. There are however, other benefits that would be realised from the construction of the project. The major benefit is the development of the natural resources of the area thereby improving the condition of the people. There will also be the development of trade and transportation. The project will also be of great benefit for livestock and development of fishery. Other benefits may include:-

(i) Additional employment opportunities for workers thereby increasing the revenue base of the government, and

(ii) The development of the project will cater for farmers in the neighbour hood thereby increasing agric., production.

5.5 COST ESTIMATE OF THE CONCRETE STRUCTURE

CONCRETE WEIR STRUCTURE

S/NO.	I T E M S	QTY	UNIT	RATE	AMOUNT
I	Clearing of Construction site	20	M^2	100.00	2,000.00
II	Stripping/Excavation of the top soil	15	M^2	150.00	2,250.00
III	Excavation for foundation	15	M^3	200.00	3,000.00
IV	Cement	60	Bags	800.00	48,000.00
V	Gravel	25	M^3	600.00	15,000.00
VI	Lump Stones	50	M^3	800.00	40,000.00
VII	Sharp Sand	50	M^3	300.00	15,000.00
VIII	Planks for formwork	30	Pcs	200.00	6,000.00
IX	Assorted Nails	2	Bgs	1,500.00	3,000.00
X	M. S. Rods	40	Pcs	700.00	28,000.00
XI	Binding Wires	3	Pcs	500.00	1,500.00
XII	Stone Pitching of the Bank Upstream	40	M^3	800.00	32,000.00
					#195,750.00
	Add 10% for Contingencies				19,575.00
	GRAND TOTAL				**#215,325.00**

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The project is proposed for development of the area to its maximum capacity by providing irrigation, drainage and flood control. Irrigation activities will be provided to the irrigable area through Lift Irrigation system using small irrigation pumps owned by individual farmers from the On-Stream reservoir located within the project area.

Based on the investigations and analysis made in connection with this project, it is concluded that the project has good potentials for development which will contribute towards increasing food production thereby saving our foreing exchange by cutting down the importation of edible items.

6.2 RECOMMENDATIONS

In order to maximise the benefits of implementing the irrigation project, the following recommendations should be strictly adhered to:-

- Irrigation and Agricultural experts should be provided, to assist and train farmers in the use of modern technologies in agricultural and water management practices.
- Demonstration plots may be established by Extension staff in the project area and the results should be communicated to the farmers for comprising with their own yields over equal piece of land.
- The use of improved high yielding and drought resistant varieties should be made available to the farmers by the Extension agents.

- The farmers should select irrigation pumps based on availability, performance, provision of spare parts and cost. Honda and Yamaha models are found to be popular among the dry season farmers in the project area.
- The state government should, therefore guarantee technical support and proper guidance on the use and maintenance of these pumps and the hydraulic structures.

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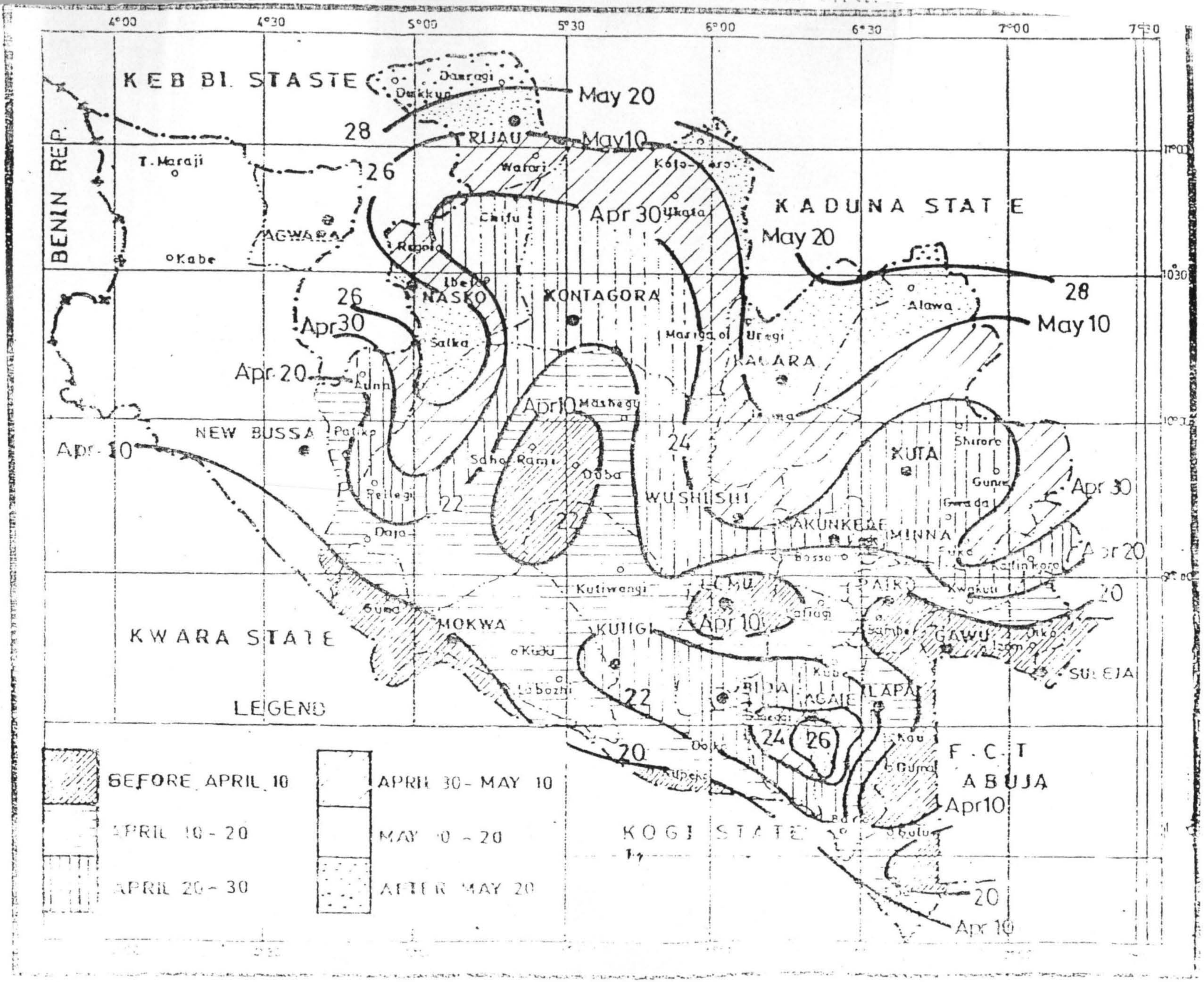

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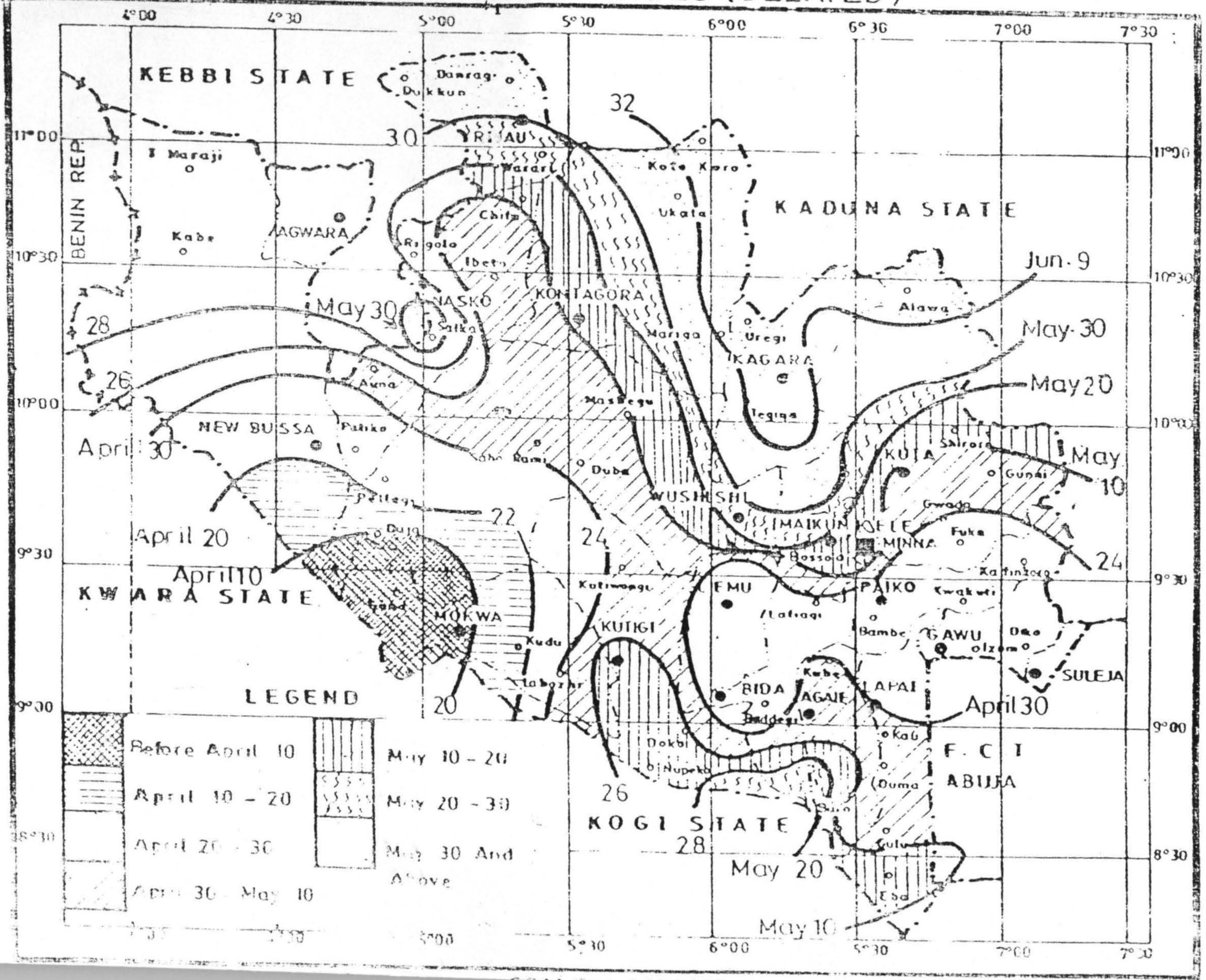
Fig 3.1(h)

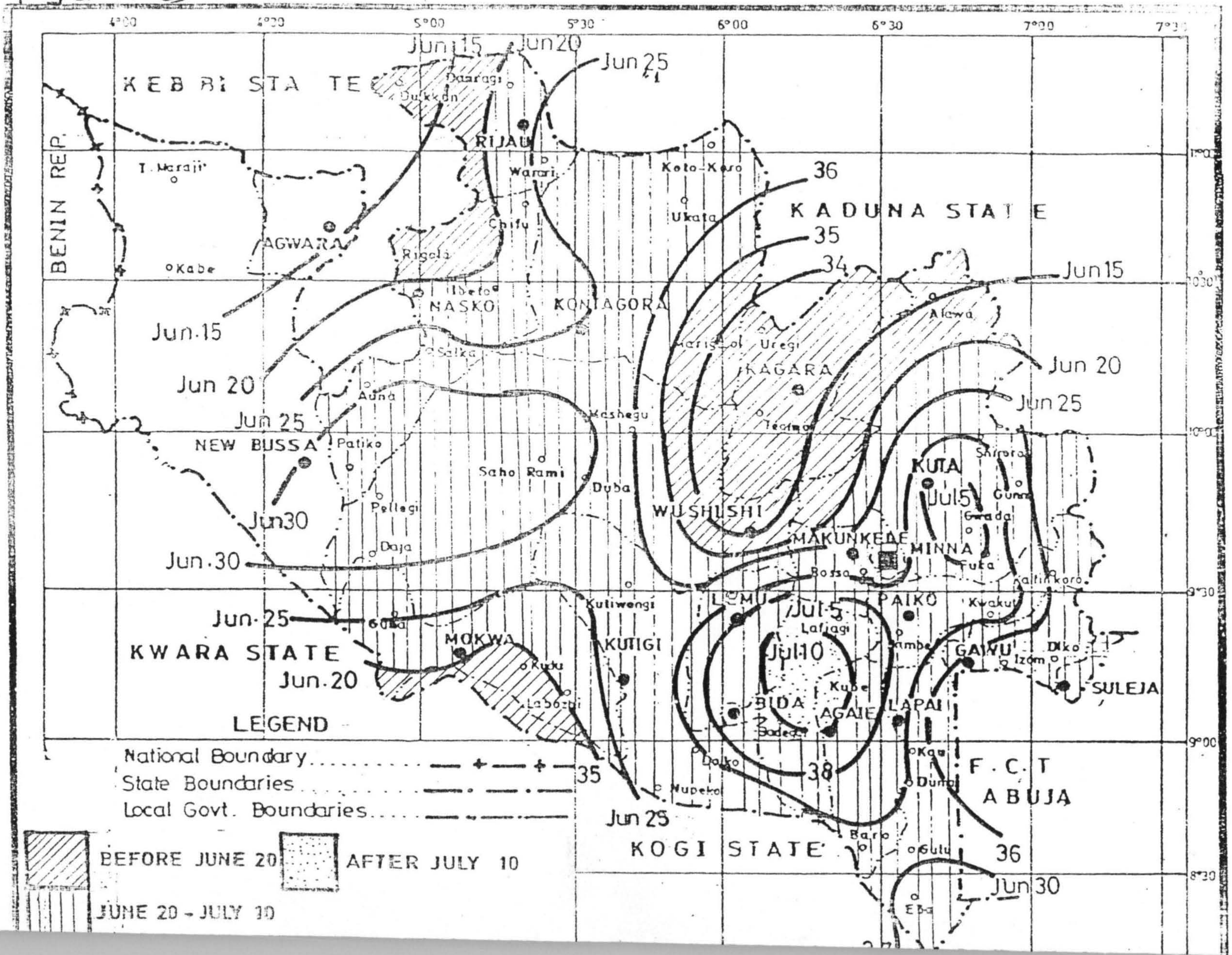
NIGER STATE

MEAN ONSET DATES (DELAYED)



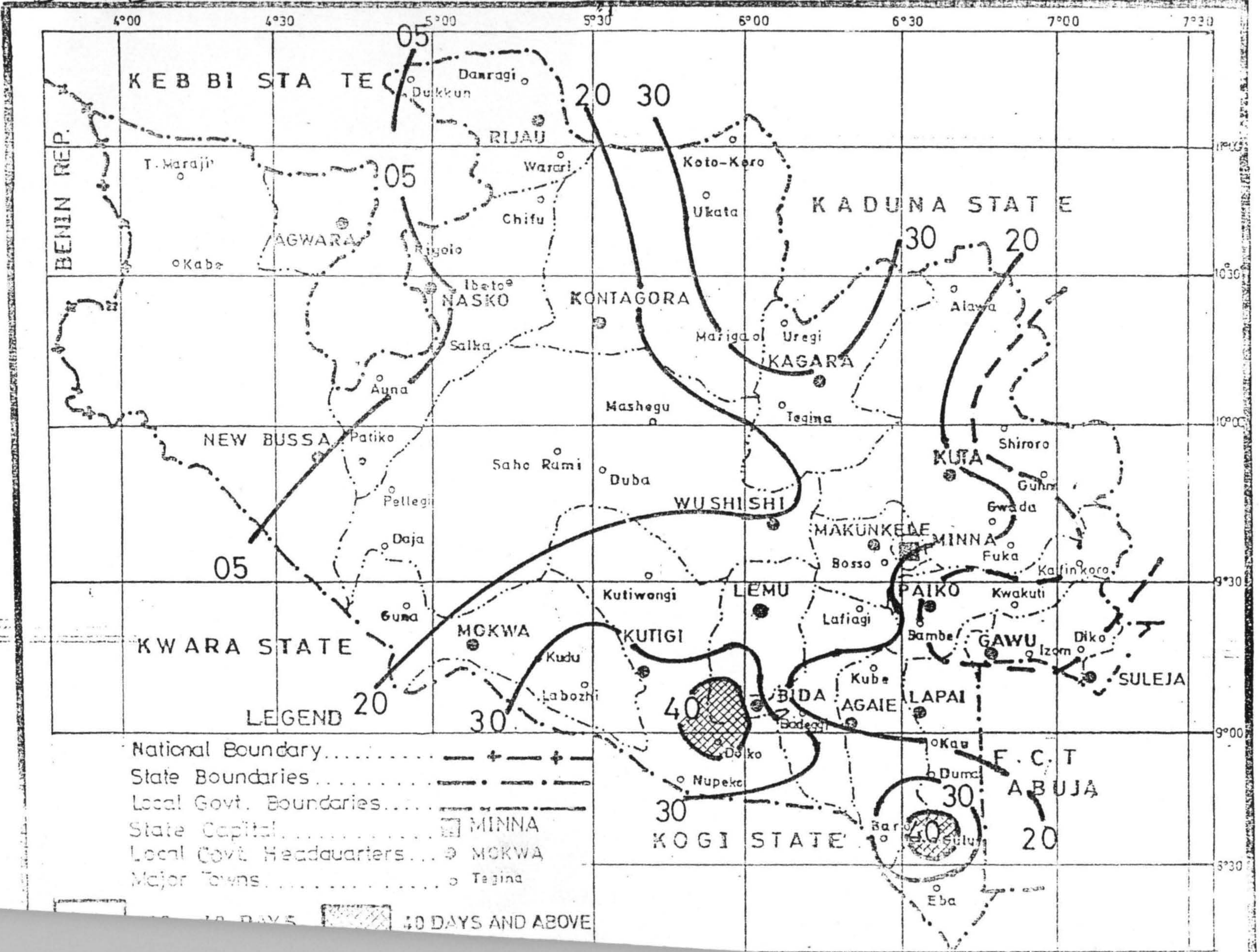
NIGER STATE

Fig 3.116(i) BEGINNING DATES OF BREAK IN THE RAINY SEASON.



NIGER STATE

Fig 3.1.(6ii) LENGTH OF BREAKS (IN DAYS) DURING THE RAINY SEASON



NIGER STATE

Fig 3.1.6(k) MEAN LENGTH OF THE RAINY SEASON (L.R.S.) IN DAYS

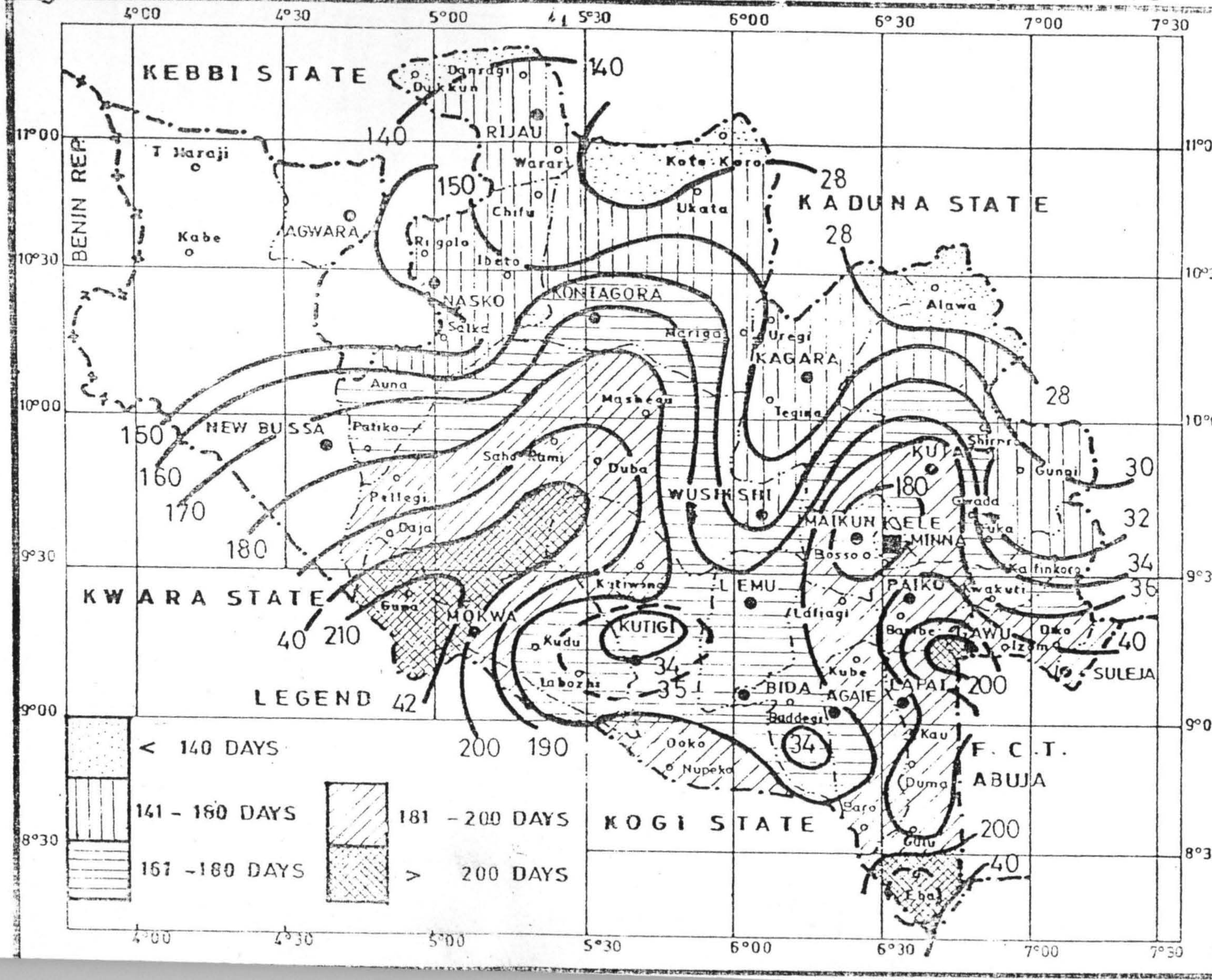


Fig 3.1.6(C) MEAN CESSATION DATES OF THE RAINS

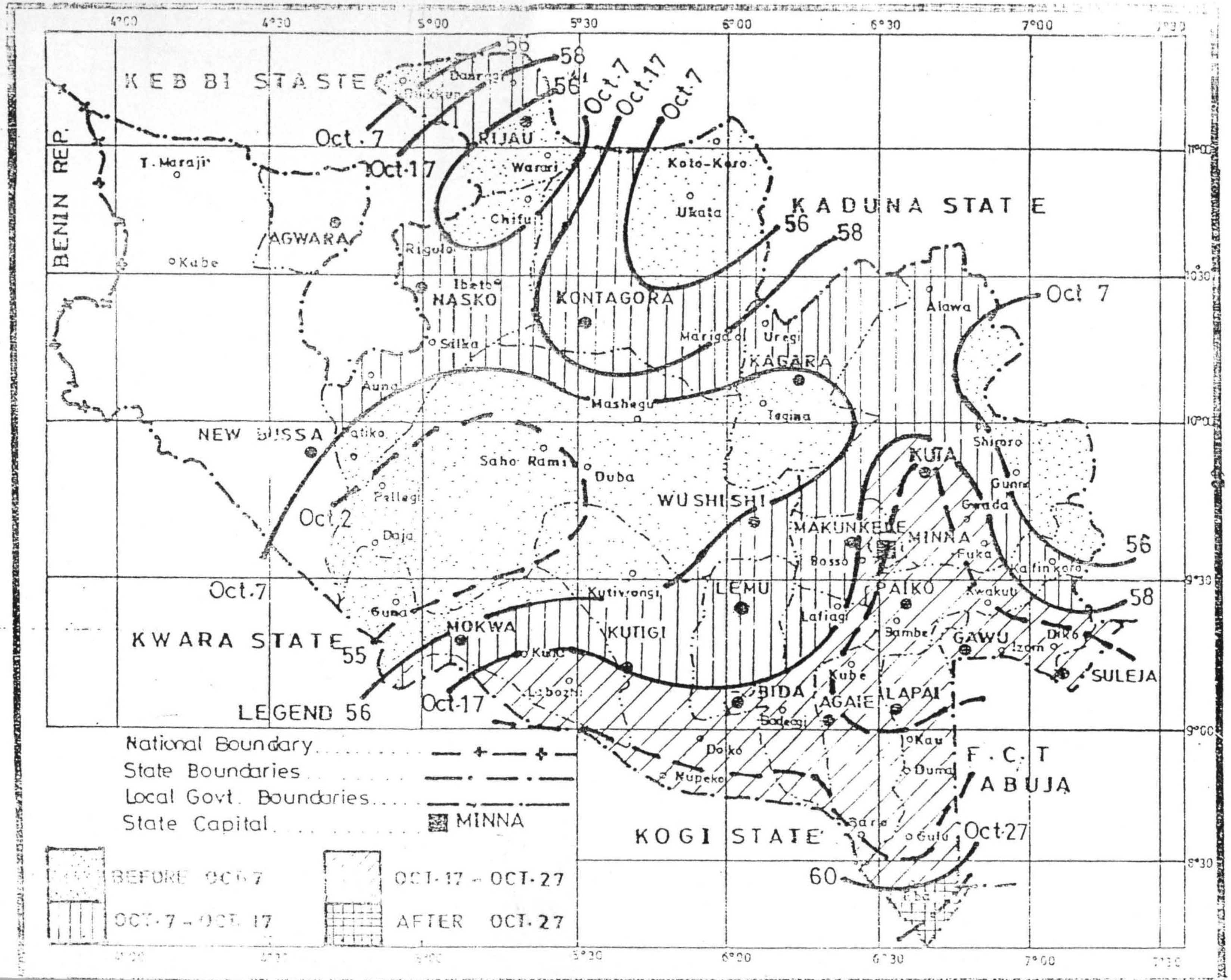


Fig 3.1.6(m)

NIGER STATE
CESSATION DATES OF THE RAINS (DELAYED)

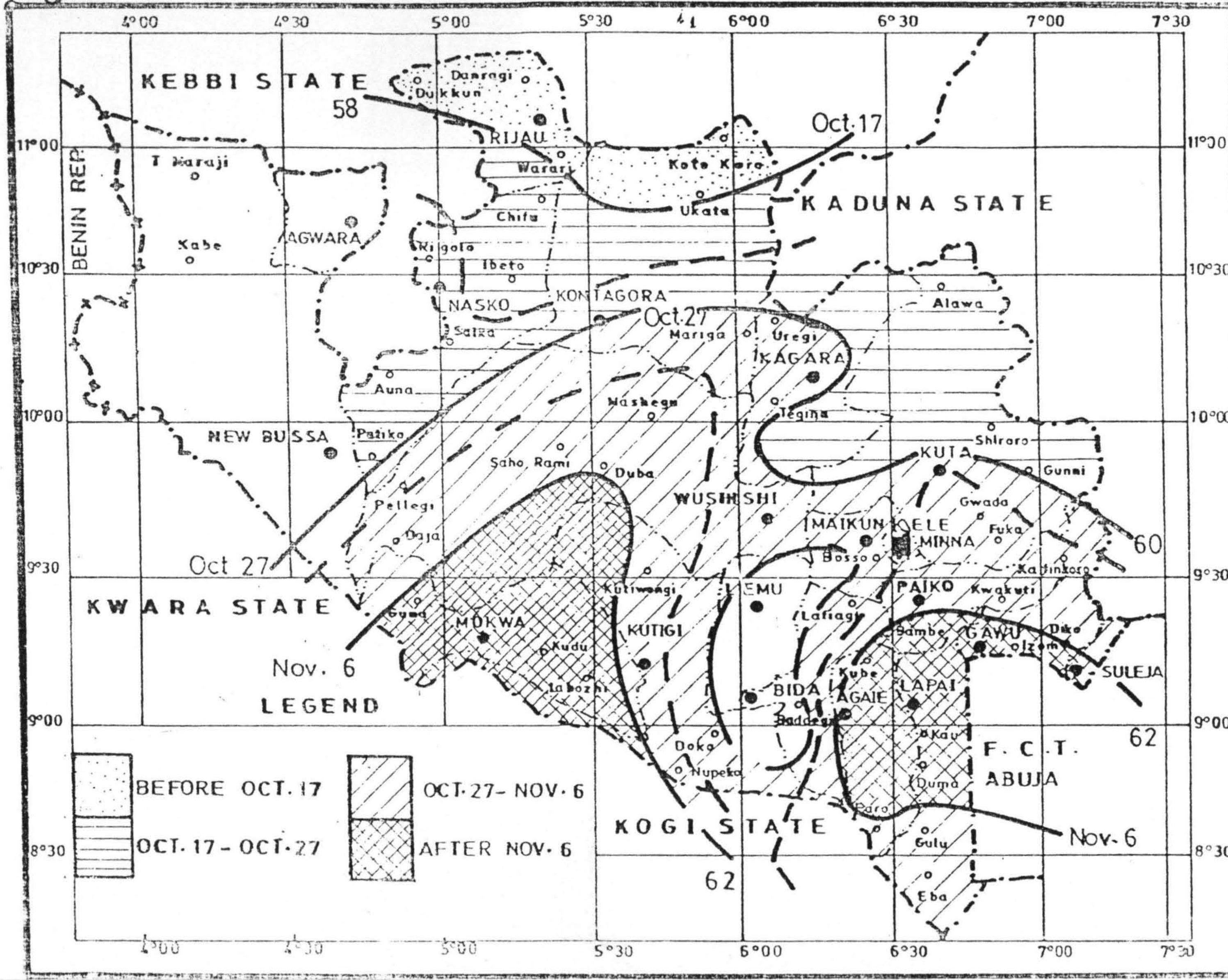
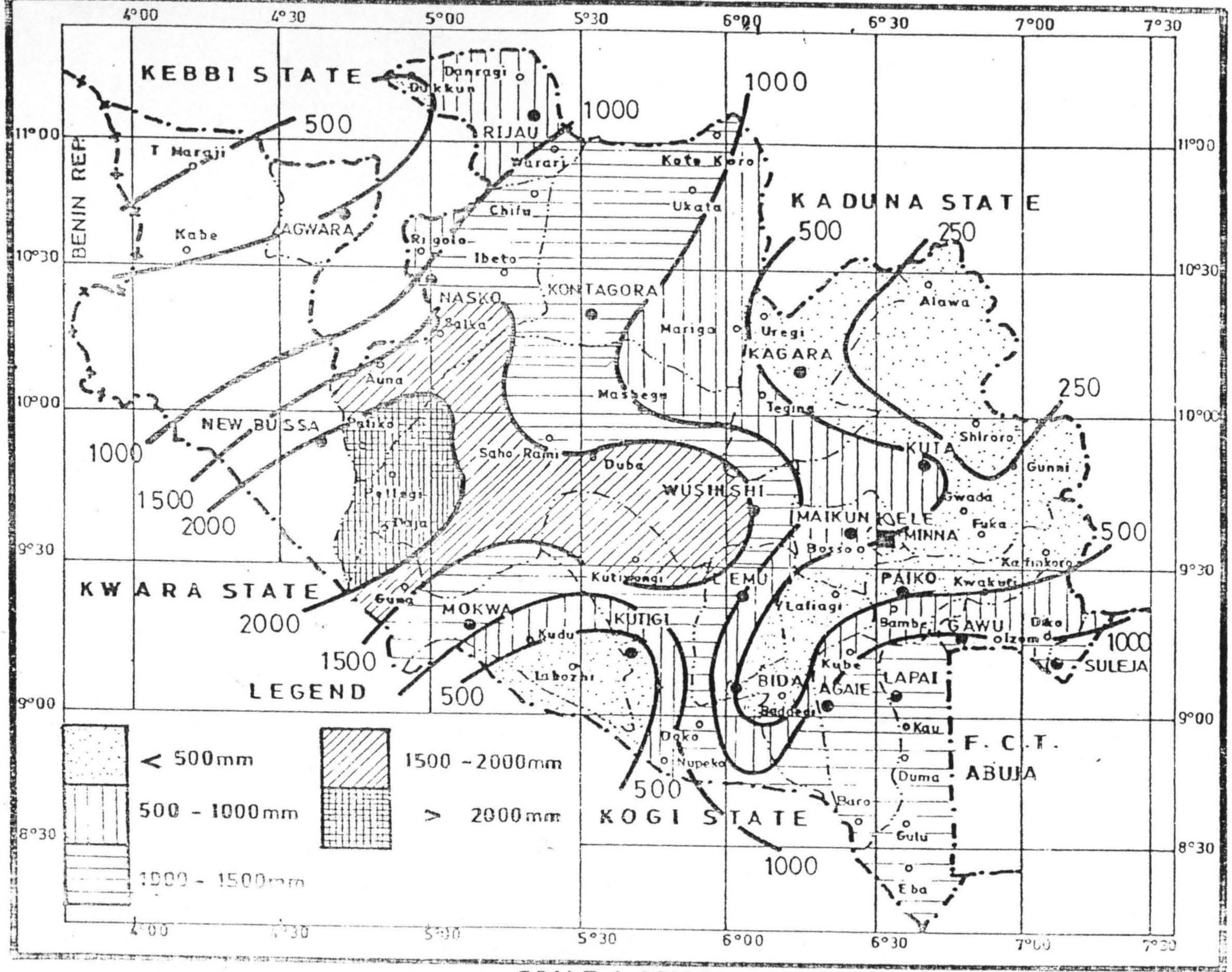


Fig. 3.1.6(n)

NIGER STATE

WATER EQUIALENT TO AVERT DROUGHT (MAXIMUM)



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3.1.7. THE SOILS

The soil in the project area is clay-loam and is well – drained and water logging does not occur in the area. Soils are natural bodies on which plants grow, provide support to plants and supply nutrients, water and oxygen essential for sustaining plants growth.

Plants obtain about fourteen (14) essential elements from the soill; six of them are used in relatively large quantities such as Nitrogen, Phosphorons, Calcium, Magnesium, Potassium and Sulphur. The other nutrient elements such as Iron, Manganess, copper, zinc, moly bodenum chlorine cobalt and boron are used by plants in very small quantities.

Nitrogen, Phosphorons and Pottasium (NPK) are commonly supplied to the soils as farm manure and as chemical fertilisers.

3.1.8. THE WATER QUALITY

The suitability of water for irrigation in the project area is of paramount importance. It is therefore necessary to determine the quality of water for use in irrigated agriculture.

The parameters used in determining the quality of the irrigation water are as follows:-

(a) The PH value

(b) Total Dissolved Salts (TDS)

(c) Proportion of Sodium iron to other cations

(d) Bio-Carbonate concentration as related to the concentration calcium plus magnessium.

(e) Concentration of potentially toxic elements.

The poor quality of irrigation water may not appear to be harmful to plants at the beginning of irrigation, but with the passage of time, the following problems are likely to appear:-

(a) Salinity problems

(b) Permeability problems

(c) Toxicity problems

(d) Miscellaneous problems

It is therefore necessary to have water quality analysis in order to determine the suitability of the irrigation water of the project area.

3.1.9. AGRICULTURAL PRACTICES

The project area lies in the flood plain of river Kontagora. The valley bottoms of the project area is used for rice and other low-land crops cultivation in the rainy season, while most parts are used for the cultivation of assorted vegetables in the dry – season. A major limitation to higher agricultural production in the area has been the in-sufficient irrigation water ir the dry-season to boost dry season cultivation. This constrain would be thing of the past when the project design and construction is completed.