FEDERAL DEPARTMENT OF WATER RESOURCES
MINISTRY OF AGRICULTURE, WATER RESOURCES
AND RURAL DEVELOPMENT
FEDERAL REPUBLIC OF NIGERIA

THE STUDY FOR GROUNDWATER DEVELOPMENT IN SOKOTO STATE

VOLUME 2
MAIN REPORT

JULY, 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Federal Republic of Nigeria, the Japanese Government decided to conduct a study on groundwater development in Sokoto State and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nigeria a survey team headed by Dr. Akira KAMATA, Kokusai Kogyo Co., Ltd., composed of members from the above company and the Sanyu Consultants Inc. from April to July, 1988; October, 1988 to March, 1989; May to July and September to December, 1989; February, 1990.

The team held discussions with concerned officials of the Government of Nigeria, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

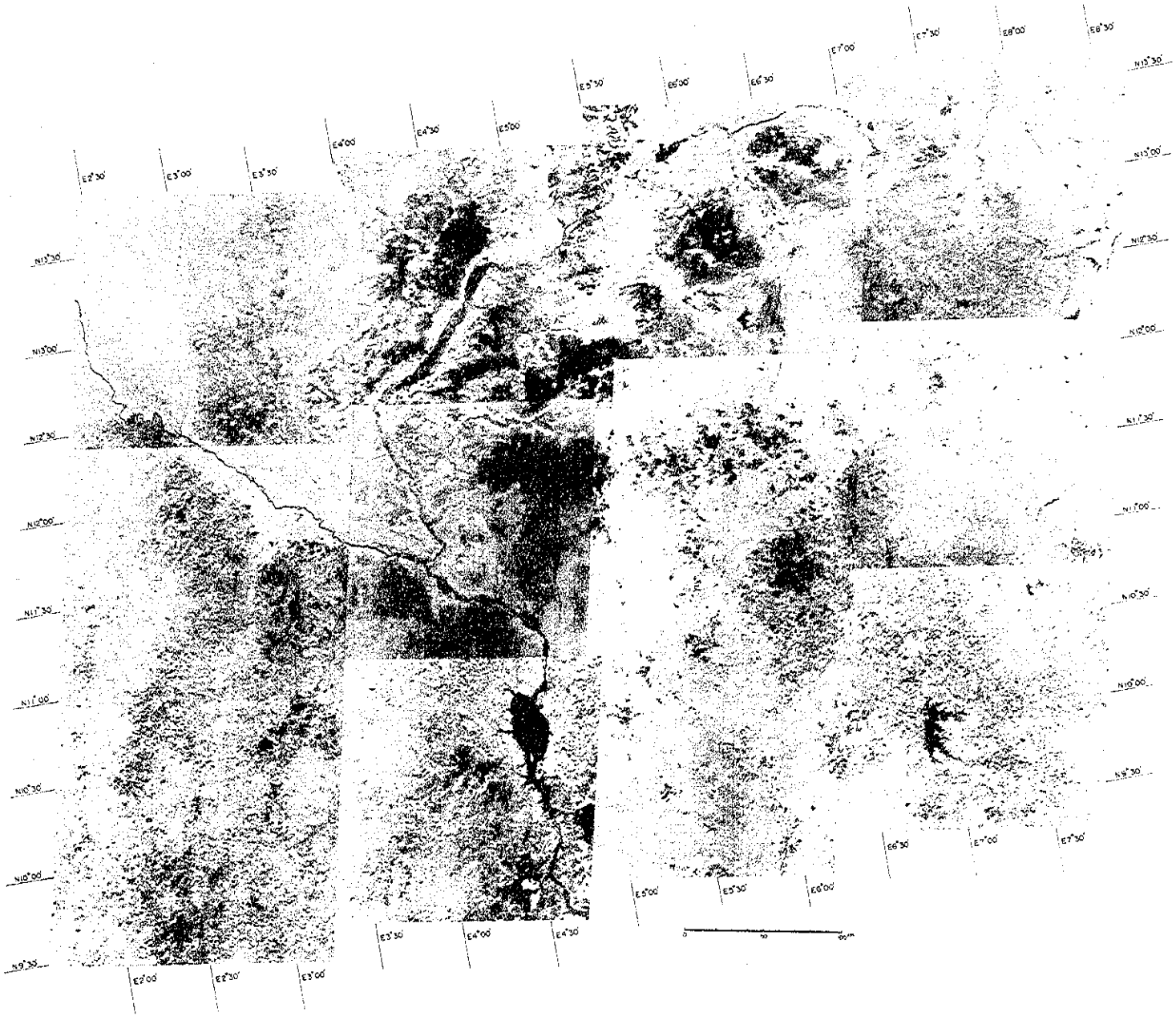
I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Federal Republic of Nigeria for their close cooperation extended to the team.

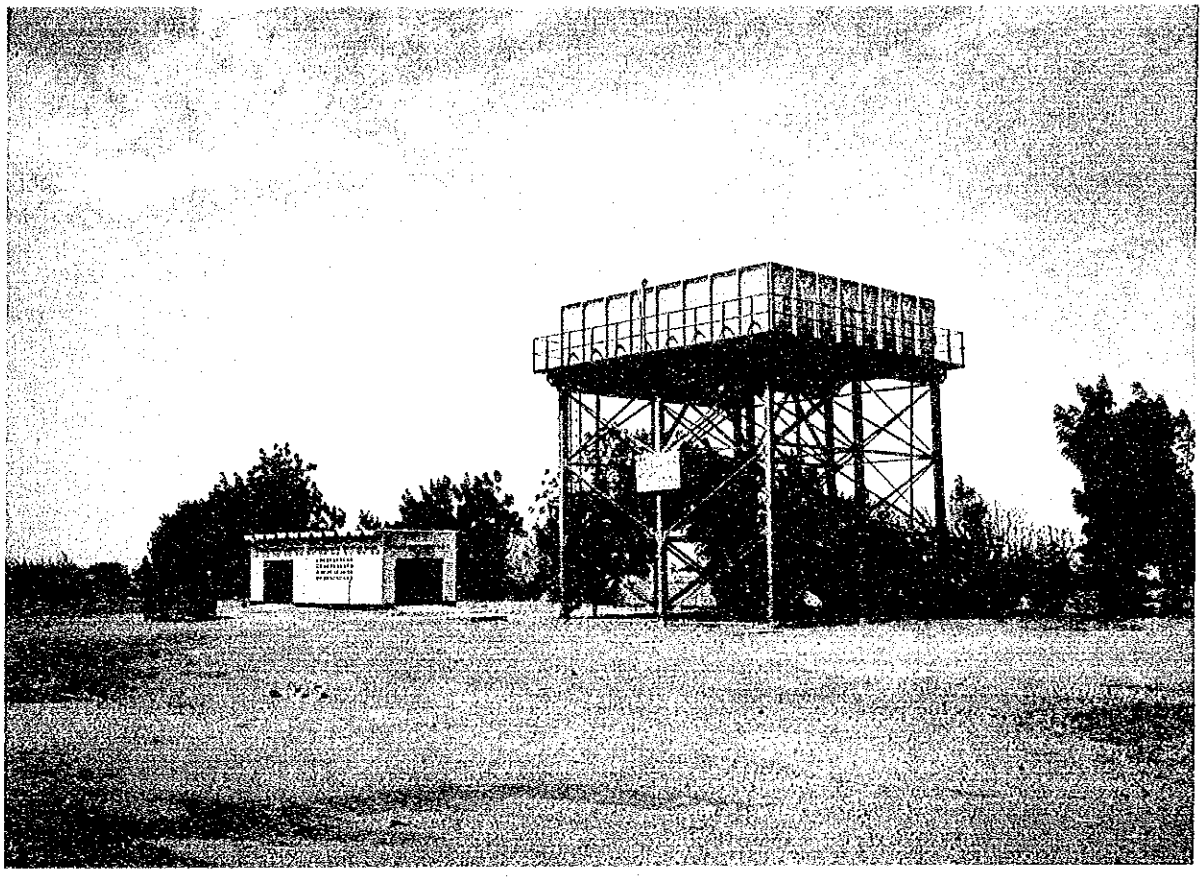
July, 1990

Kensuke Yanagiya

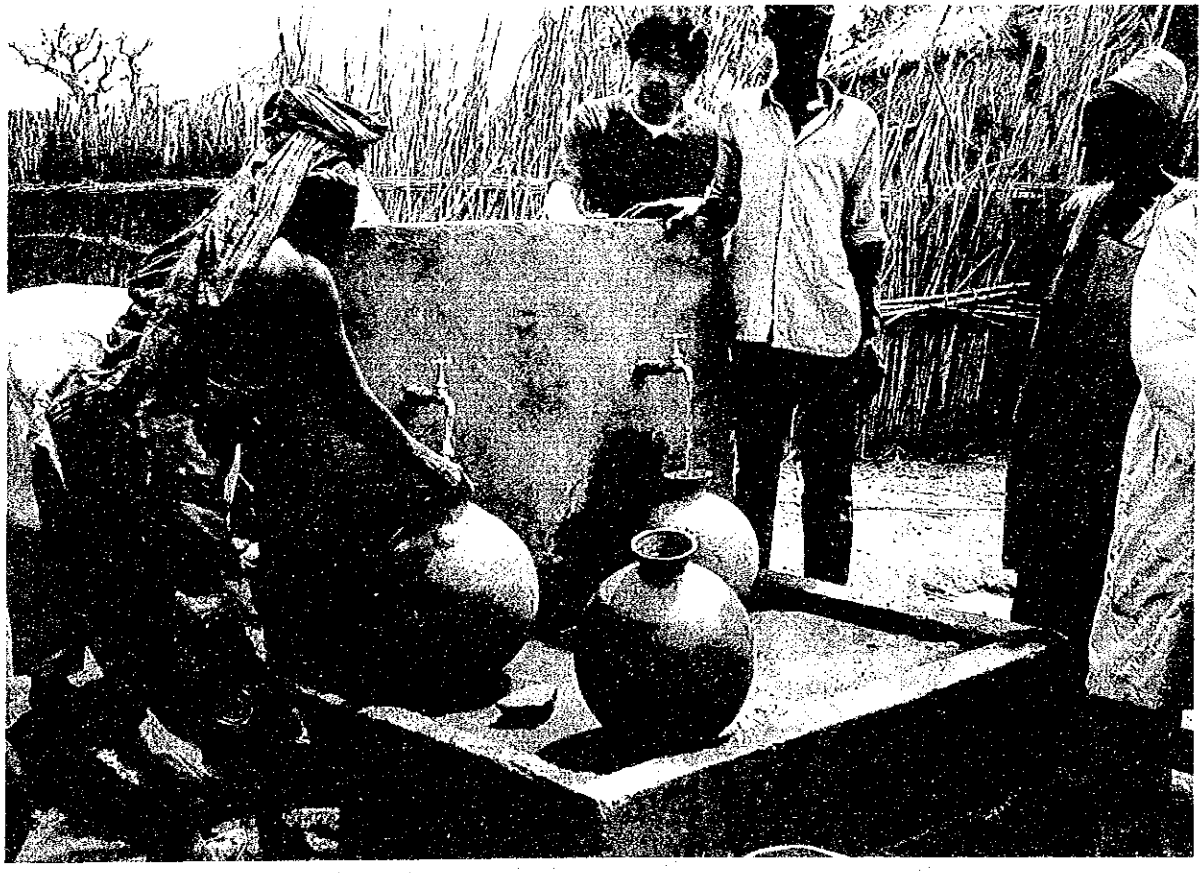
Kensuke Yanagiya
President
Japan International Cooperation Agency



LANDSAT Image of Sokoto State

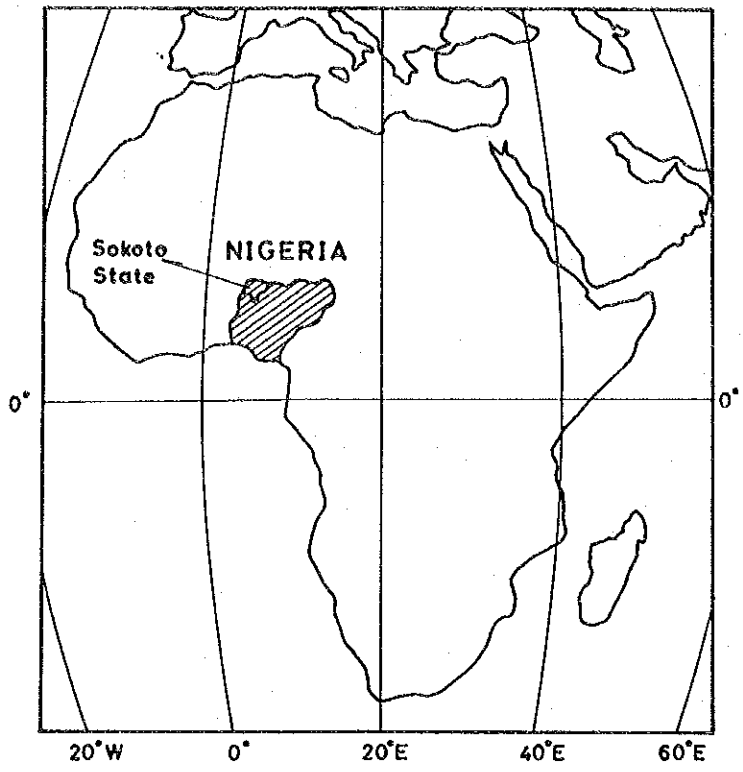


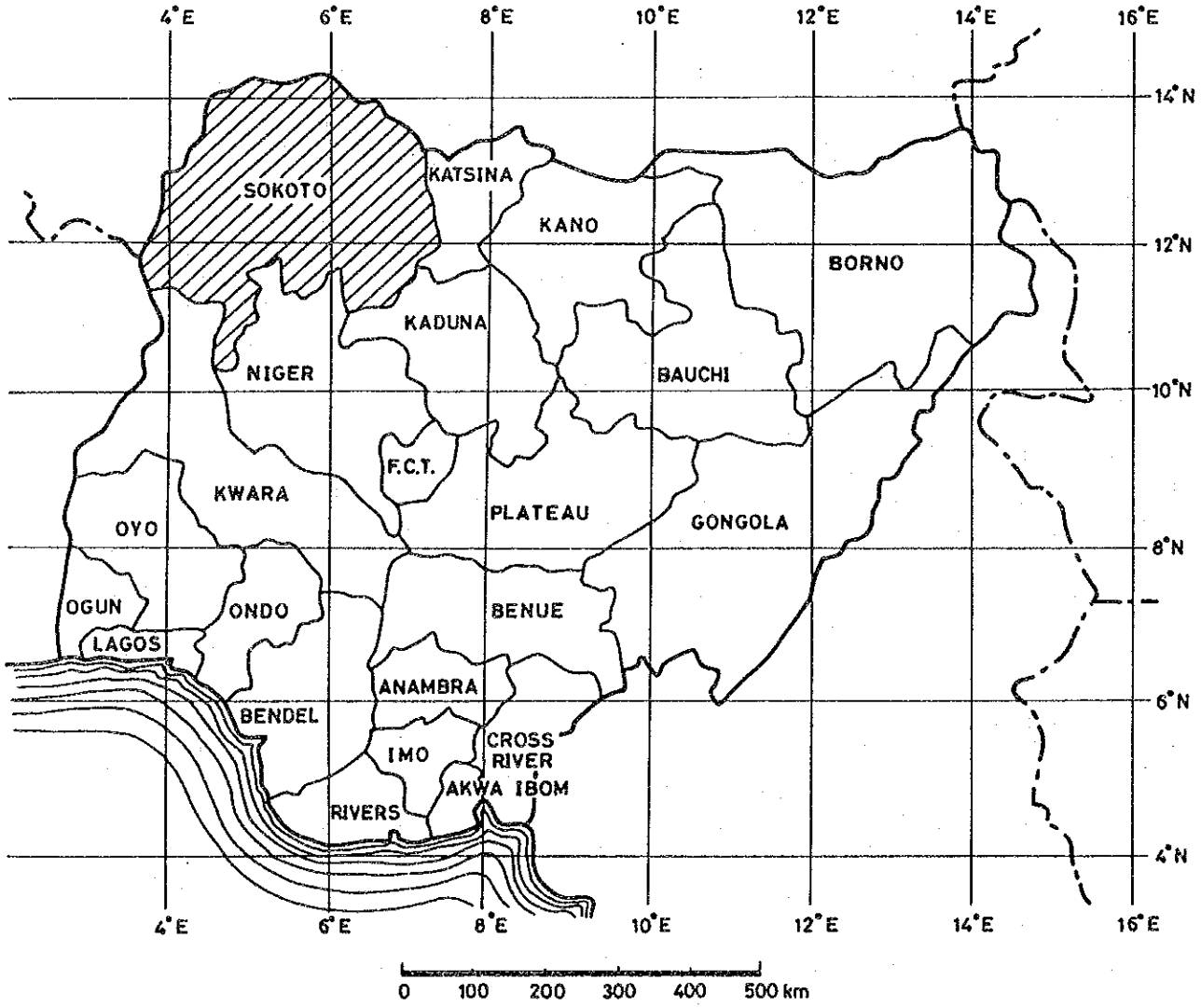
Model Water Supply System in Horo Birni

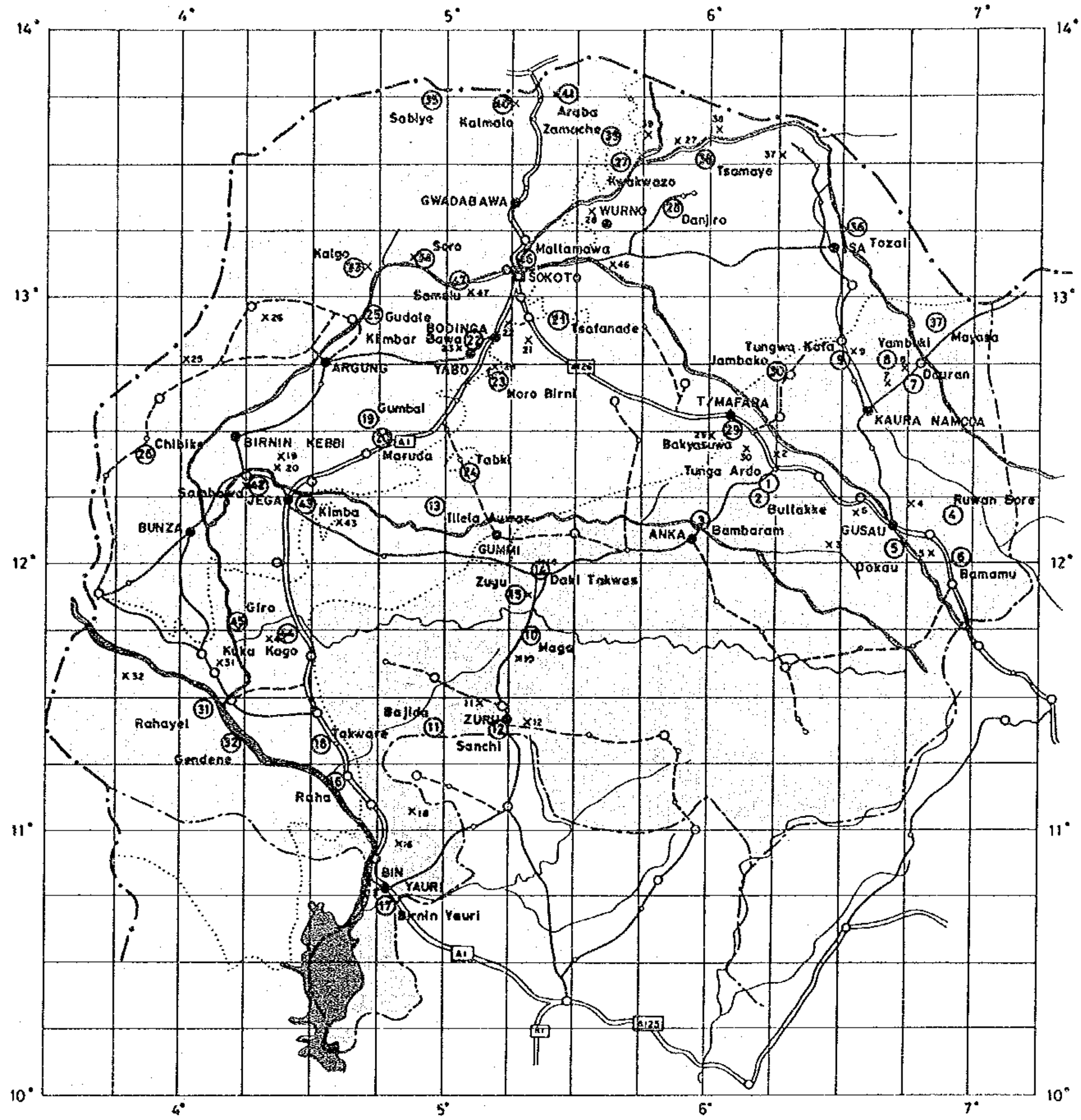


Villagers make use of the water supply system constructed in this project

LOCATION MAP OF PROJECT AREA







Location map of The Candidate Villages

Kms 50 0 50 100 150 Kms

Sedimentary rock area

Basement rock area

STRUCTURE OF THE REPORT

This report describes the results of the study carried out from March 1988 through February 1990 for the purpose of clarifying and evaluating the potential of groundwater in Sokoto State, Nigeria and preparing a groundwater development plan for selected areas.

As the study was made in various methods and volumes, the results are summarized in the separate summary report (Volume 1). Various hydrogeological data are included in the supplementary reports (VOLUME 3,4) and the data report (VOLUME 5).
This is the main report (VOLUME 2) and precisely describes major items of the study.

Chapter 1 is prepared to show the contents of this study conform to the Scope of Work concluded between Japan and Nigeria prior to the study; a brief introduction of the study area is described in the last section.

In Chapter 2, the socio-economic framework of Nigeria and Sokoto State is described. It is necessary at the start of the study to clarify the socio-economic background for the groundwater development.

In Chapter 3, the hydrological features of the Sokoto-Rima River Basin are briefly reviewed. Based on the results of discharge observation, the influent and effluent of the stream with regard to groundwater recharge and discharge are discussed.

In Chapter 4, the hydrogeological features of entire Sokoto State are described. The results of the interpretation of LANDSAT images used prior to the field reconnaissance are explained.
Aquifer properties, water quality, groundwater flow and change in water level and groundwater use are investigated and analyzed based on the existing data and observations.

In Chapter 5, the function and the structure of the database established in this study are described. In order to preserve and manage hydrological and hydrogeological data in Sokoto State, the database was installed into the micro-computer at FDWR Sokoto. The detailed database manual is contained in the supplementary report 2 (VOLUME 4).

In Chapter 6, the results of the hydrogeological survey of the candidate villages are described.
The aquifer distribution and its property in the sedimentary rock area and the basement rock area are examined. Based on the results, an effective method for hydrogeological survey is discussed and summarized as the guideline.

In Chapter 7, a basic concept for the quantitative analysis of groundwater is introduced. Then, the groundwater potential of entire Sokoto State is evaluated by means of the water balance analysis and the simulation of the Sokoto groundwater basin.

In Chapter 8, the groundwater development plan is proposed, putting particular emphasis on the design of the production well.

In Chapter 9, based on the hydrogeological data , analysis and the socio-economic study, a water supply program is formulated in the selected area. A project cost, organization and implementation schedule are proposed. The project is evaluated from the socio-economic points of view. In addition, the design and the process of construction of the model water supply system is described in this chapter. This is useful for future implementation of the project.

In Chapter 10, the results of the study are concluded briefly and the realization of the water supply project for the middle to large scale villages in Sokoto State is recommended.

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ABBREVIATION

Organization

AfDB	:	African Development Bank
DFRRI	:	Directorate for Food, Road Rural Infrastructure
FDCA	:	Federal Department of Civil Aviation
FDWR	:	Federal Department of Water Resources
IBRD	:	International Bank for Reconstruction and Development
JICA	:	Japan International Cooperation Agency
KSWB	:	Katsina State Water Board
LGA	:	Local Government Authority
MOE	:	Ministry of Education
MOW	:	Ministry of Works
MRD	:	Ministry of Rural Development and Cooperation
NMS	:	Nigerian Meteorological Service
NWRI	:	National Water Resources Institute
SARDA	:	Sokoto Agriculture and Rural Development Authority
SMA	:	State Ministry of Agriculture
SRRBDA	:	Sokoto Rima River Basin Development Authority
SSWB	:	Sokoto State Water Board
USGS	:	United States Geological Survey
WHO	:	World Health Organization

Unit

Mm^3	:	$\times 10^6 m^3$
PPM	:	Parts Per Million

Method

ELFMT	:	Extremely Low Frequency Magnetotelluric Method
ERS	:	Electrical Resistivity Sounding
MT	:	Magnetotelluric Method
PLMT	:	Power Line Magnetotelluric Method
TEM	:	Transient Electromagnetic Survey
VES	:	Vertical Electric Sounding

1. INTRODUCTION

1-1 Background of the Study

1-1-1 General

This report is the final report on the study entitled "The Study for Groundwater Development in Sokoto State" which has been carried out in accordance with the "Scope of Work" agreed upon between the Federal Government of Nigeria through the Federal Ministry of Finance and Economic Development and the Japan International Cooperation Agency (JICA).

The study area covered is almost the whole area of Sokoto State (about 100,000Km^2) which is situated in the northwestern part of Nigeria, where the forty-seven (47) villages proposed as study sites are scattered. The location of these 47 sites is shown on the location map. The number of sites involved in geologically classified units are as follows :

14 villages in the Tertiary System (9 in the Sokoto Group and 5 in the Gwandu Formation),

14 villages in the Cretaceous System (7 in the Rima Group and 7 in the Gundumi Formation) , and

19 villages in the area where the basement complex is exposed

1-1-2 The groundwater development project

In the 5th Five-Year-Development Plan (1987-1991) of the Federal Republic of Nigeria, the highest priority is given to the promotion of agriculture with emphasis on attaining self-sufficiency in food supply. This is because Nigeria has been in an economic situation of heavy dependence on oil earnings even though the oil market has been stagnant since the early 1980's.

Sokoto State, the project area, is one of the five (5) northern states of Nigeria where traditional small-scale agriculture of self-sufficiency is

practiced. Since the northern part of Nigeria has limited precipitation in its short rainy season, water for both agricultural use and drinking is in short supply for more than half of the year. In addition to this natural condition, the recent rapid increase in population in this area makes it difficult to develop the economic base of the area or to improve the living standard of the inhabitants.

Taking this into consideration, the Federal Government of Nigeria and the State Governments have made groundwater development plans, especially in order to obtain drinking water, a fundamental element of life, and in order to increase the economic potential of the area.

While water supply system construction covering urban areas and small villages is in progress, the realization of the plan for middle- to large-scale villages in Sokoto State lags behind due to difficulties such as shortage of labor, budget and equipment/materials for well and supply system construction. Moreover, the hydrogeological conditions in some parts of Sokoto State are not conducive to groundwater development, thus they are classified as "difficult" areas. High technology in groundwater investigation is especially required for areas where Pre-cretaceous basement rocks are exposed (southwestern area of Sokoto State, which constitutes about 42% of the total area). Some of the deep wells constructed through the National Borehole Program in the above areas were not productive, and some of them have not been properly functioning due to poor geological investigation prior to well construction.

In response to these conditions, the Federal Government of Nigeria has requested technical cooperation from the Japanese Government in order to conduct a study for groundwater development, and especially in order to establish effective study methodology for the difficult areas mentioned.

1-2 Objectives of the Study

The objectives of the Study are to clarify and evaluate the potential of groundwater in Sokoto State, and to prepare a groundwater development plan for selected areas through hydrogeological investigation. In particular, the Study places emphasis on the

establishment of an effective method of hydrogeological investigation in the difficult area where the basement complex or Pre-cretaceous sediment are exposed.
Also, during the Study, technology transfer regarding groundwater investigation to the counterpart engineers of Nigeria is to be focused on by the JICA Study Team, especially concerning technology regarding geophysical prospecting methods and the analysis of groundwater potential.

1-3 Outline of the Study

1-3-1 Study period and methodology

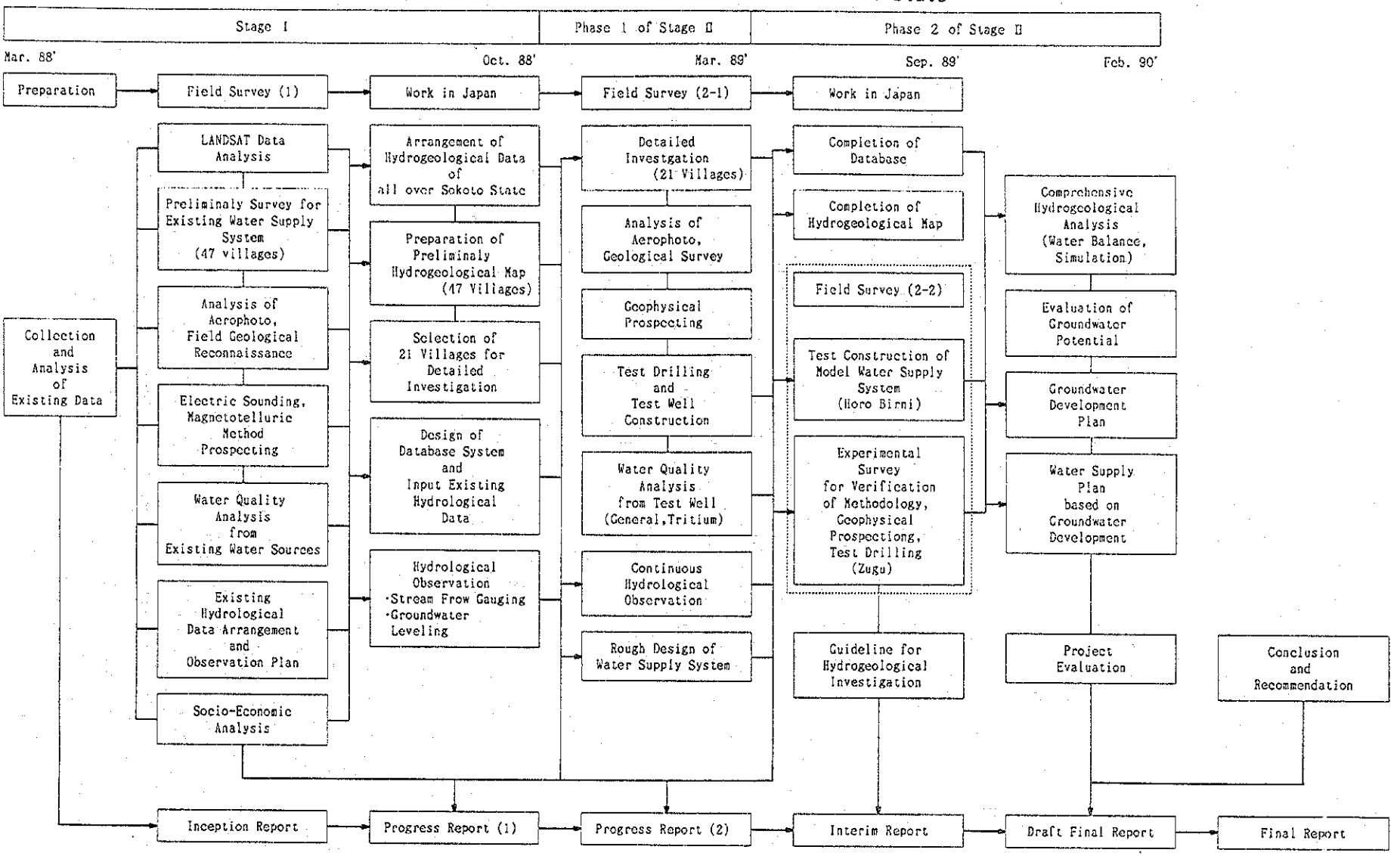
The basic project outcome sought as a result of this study is to develop groundwater as a water supply source for domestic use and to construct a simple water supply system for middle to large scale villages with populations of 2,000 to 20,000 in Sokoto State.
Therefore, the Study will, of course, constitute the basis for project implementation. However, it should be emphasized that the project area is not limited to the 47 candidate villages concerned in this study, as the study objective does not only cover the clarification of the groundwater potential of individual villages, but also the classification of groundwater potential for almost the whole of Sokoto State, through the investigation of the area surrounding each village.

The Study is divided into the following stages and phases from the viewpoint of study period and methodology(Figure 1-1).

Stage I	April to September, 1988
Stage II Phase 1	October 1988 to March 1989
Stage II Phase 2	May 1989 to February 1990

In Stage I, a hydrogeological investigation was carried out covering almost the whole area of Sokoto State, including 42 individual sites from among the 47 candidate villages, in order to establish a rough classification of the groundwater potential in Sokoto State.
As a result, twenty-one tentative sites were selected in Stage I for

Fig.1-1 Flow Chart of the Study for Groundwater Development in Sokoto State



detailed hydrogeological survey in Stage II. Parallel with the above investigation, general hydrological observation of the study area was also conducted.

In Phase 1 of Stage II, the above detailed hydrogeological survey was carried out. In eight villages, test drilling with core sampling and test well construction with pumping tests were carried out to determine the geological stratigraphy and the productivity and hydraulic constants of the aquifers.
Hydrological observation continued, during this period and a level survey was carried out in order to accurately establish the water levels of existing boreholes. In addition, a field survey for water supply system design was also conducted in the above eight villages in order to standardize the design of the system.

In the first six months of Phase 2 of Stage II, an additional detailed hydrogeological survey was carried out in order to establish an effective method of hydrogeological investigation in the so-called difficult area where the basement complex is exposed. A field survey including geological reconnaissance, geophysical prospecting and test well drillings was carried out in Zugu, in the central part of Sokoto State. Drawings and documents for trial water supply system construction in Horo-Birni were also prepared.

In the last six months of Phase 2 of Stage II, a groundwater development plan was formulated in accordance with classified groundwater potential by area, through comprehensive hydrological/hydrogeological analysis, based on the data obtained during the first and second stage.

A model water supply system was constructed in Horo Birni where a test well was constructed and facilitated with a submersible pump, a generator, a water tank and a storage house. The distribution pipeline was laid down and communal faucets were constructed as a pilot water supply system for the middle- to large-scale village.

A data base system for hydrology and hydrogeology was established and transferred to the Nigerian team for the aid of groundwater development planning and management.

Special attention was paid throughout the study period to the establishment of proper investigation methods for the so-called "difficult areas" such as the basement rock areas. The methods were summarized in a guideline and the investigation technology was transferred to the Nigerian team.

1-3-2 Organization of the Study

The organization of the Study is shown in the following organizational chart. The Study is carried out in a practical sense by the joint study team composed of the JICA team and the three Nigerian organizations (with in the doubled frames) shown in the following chart. The Nigirian team was coordinated by the zonal officer of the FDWR Sokoto.

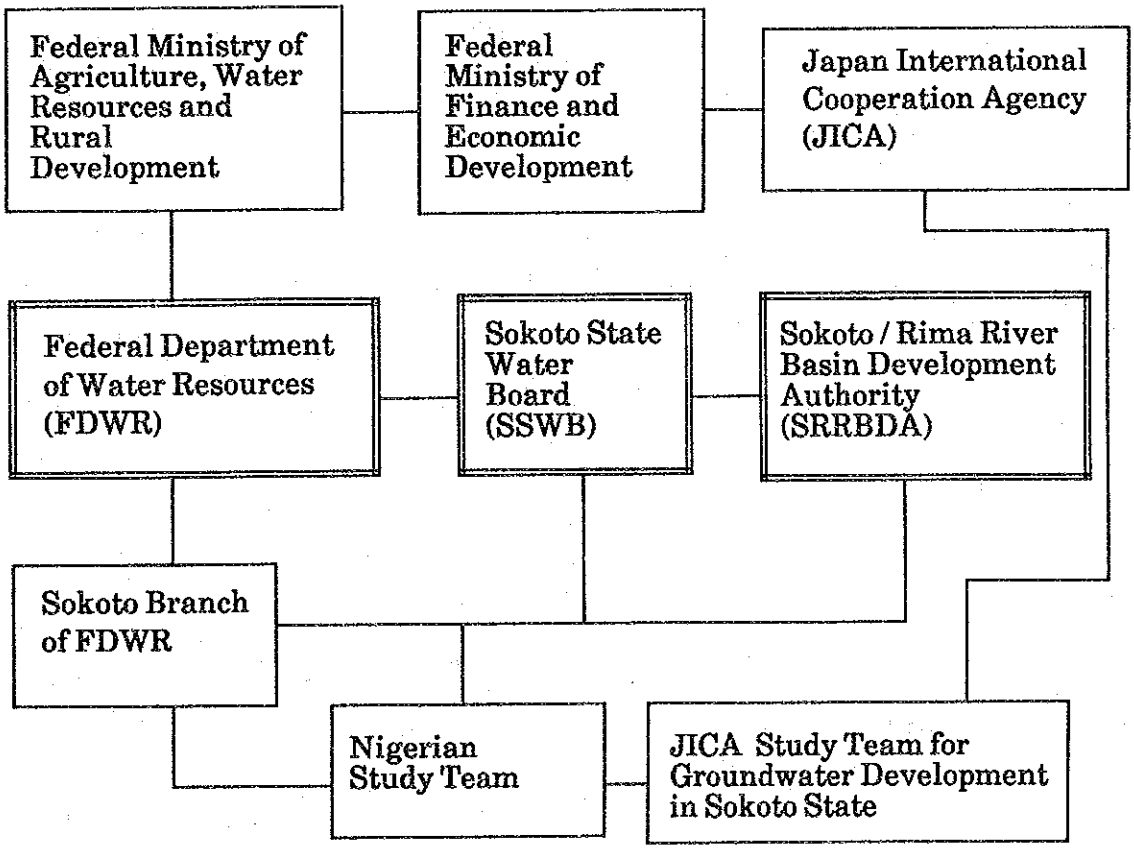


Figure 1-2 Organizational Chart for the Study

1-3-3 Staffing of the Study Teams

The JICA has organized a study team consisting of a team leader and nine (9) additional professionals and experts. The Nigerian agencies organized a study team to act as counterpart to the JICA Study Team, for smooth conduct of the Study and for effective technical transfer. The Study Team members are listed in Table 1-1.

Table 1-1 Member List of the Study Team

JICA STUDY TEAM

Speciality (Title)	Name	Qualification
Hydrogeologist Team Leader	Akira Kamata	Doctor of Science CE [3] (Hydrogeology)
Hydrogeologist Co-Team Leader	Atsuo Kanda	CE (Geology)
Geologist Survey Expert	Motoo Fujita	CE (Geology)
Hydrologist Water Balance Analyst	Toichiro Maekawa	CE (Hydrogeology)
Geophysicist (MT)[1]	Eiji Tanaka	CE (Geophysics)
Geophysicist (ERS)[2]	Kunio Fujiwara	CE (Geophysics)
Geologist Geophysicist (ERS)	Kohmei Ozaki	
Drilling Supervisor	Toyoharu Nakamura	
Water Supply Planner	Akira Naotsuka	CE (System Design)
	Ko Kawamura	CE (System Design)
Project Economist	Shigeru Kimura	Inf. Mgg. Eng. [4]

※1 MT : Magnetotelluric Method
※2 ERS : Electrical Resistivity Sounding
※3 CE : Consulting Engineer Certified by the Japanese Government
※4 IME : Information Managing Engineer Certified by the Japanese Government

NIGERIAN STUDY TEAM

Speciality (Title)	Name	Agency
Zonal Officer, FDWR Sokoto	Shamonda, J.A.	FDWR Sokoto
Hydrogeologist	Oty, R.C.	〃
Hydrogeologist	Ayuba, S.A.	〃
Agricultural Engineer	Olatinwo, O.M.	〃
Senior Geophysicist	Oburo, Patrick	FDWR Benin
Hydrogeologist	Ochigbo, John	FDWR Sokoto
Principal Hydrogeologist	Owunna, Boniface C.	SRRBDA
Hydrologist	Buba, P.M.	〃
Senior Hydrogeologist	Ibrahim, U.U.	SSWB
Hydrogeologist (NYSC)	Sani, Moh'd	〃
Hydrogeologist	Ezeh, Anselm	〃
Hydrologist	Junaidu, Moh'd A.	〃
Assistant Engineer	Kende, Mohammed	FDWR Sokoto
Assistant Engineer	Emoikhare, Ojehomo	〃

1-4 The Study Area

1-4-1 Natural conditions

(1) Location and topography

Sokoto State, the study area, is situated in the northwestern part of Nigeria, in latitude from 10 ° N to 14 ° N and in longitude from 4 °E to 7 ° E, with an elevation ranging from 150m to 850m above sea level. Most of the area is generally flat with a gentle hilly area in its southeast. This hilly area is the north-western part of the North-Middle Plateau and has typical granite monadnocks (Inselberg). Most of the rivers in Sokoto State originate from this highland and flow to the northwest, west, and southwest.

(2) Climate and hydrology

Sokoto State belongs to the climate zone of typical continental tropics. The mean maximum temperature is about 45 ° C (highest in April to June) and the mean minimum temperature is about 16 ° C (highest in April and May, lowest in December and January).

Annual precipitation is very small in the northern part of the area (400mm), but has a tendency to increase up to 1000mm in a southern direction. Distinction between rainy and dry seasons is clear, that is, about 95% of precipitation is concentrated in a five-month rainy season from May to September. The mean monthly precipitation over the past ten years (between 1974 and 1983) in Sokoto City is shown below.

Table 1-2 Mean monthly precipitation in Sokoto City (mm)

Jan	Feb	Mar	Apr	May	Jun	Jul;	Aug	Sep	Oct	Nov	Dec	Total
0	0	0	10	50	90	155	250	145	15	15	0	730

The major rivers in Sokoto State are the Rima River, which flows into the Niger River near the southwestern end of the state, and its branches, or major

tributaries the Sokoto River, the Gawon Gulbi River, the Zamfara River, and the Gilbin Ka River.

River sections having water flow throughout the year are limited to the downstream portion of the Rima River. All length of other rivers either contain only river bed water or are dried up completely in the dry season. The flow rate of the Rima River varies extensively in correlation with the extremes of the seasonal precipitation cycle in the area. An example of approximate flow rate month by month is shown below:

Table 1-3 Flow rate of the Rima River at Argungu (m^3/sec)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
less than	less than	less than	less than	more or less	5 '	10 '	60 '	220 '	300 '	10 '	less than
5	5	5	5	5	360	220	350	350	10	5	5

(3) Geology

The geology of Sokoto State is generally classified into the following three geological systems, from older to younger :

1) Pre-cretaceous basement rocks : These are widely exposed in the southeastern part of the area and are composed mainly of older granite, undifferentiated metasediment and metamorphic rock. From the middle to western part of Sokoto, these basement rocks are overlain by sedimentary rocks.

2) Cretaceous sedimentary formations : The distribution of the Cretaceous system is a belt zone in the middle part of the area which runs from the northeast to southwest. This system consists of the Gundumi formation (clay and grit with pebble

beds) , the Illo formation (pisolitic clay and grit) , and the Rima group (sandstone and mudstone) , in ascending order.

3) Tertiary sedimentary formations and younger sediments : The Tertiary system overlies the Cretaceous system in the northwestern area of Sokoto State, and consists of the Sokoto group (clay, shale, marl and clayey limestone) and the Gwandu formation (clays and grits) in ascending order. The total thickness of the system gradually increases from east to west from several meters up to about 270m.
Quaternary sediment partially covers the above three systems along the rivers with a width of from zero to several tens of kilometers and with a maximum thickness of about 30 m.

1-4-2 General social conditions

(1) Industry and economic basis

Sokoto State predominantly depends on an agricultural economy, with over 80% of its active population engaged in farming. The major agricultural establishment in the state is the Sokoto/Rima Valley Scheme of the Federal Government, which is expected to provide irrigation to a total area of about 28,000ha. The Gusau Agricultural Development Project, covering 3,800km^2 and involving not less than 86,000 small landholders was established jointly by the Federal and State Governments.
However, the majority of agriculture activity is conducted outside of these development project areas in small-scale, rain-fed cultivated fields surrounding villages.
In addition to rain-fed cultivation, Sokoto State is characterized by the second largest concentration of livestock in Nigeria, particularly cattle, sheep and goats which number over two million.
No other industries of particular significance exist, although some small-scale manufacturing takes place. Major industrial development projects are still in the planning stages.

(2) Infrastructure

The main public roads are well constructed with asphalt pavement, and the maintenance is fairly good. However, most local roads bound for small villages are left unasphalted.
Electrification is limited almost solely to the urban areas, that is, the major seats of local government and their vicinities.

(3) Water supply system

Since the areas where surface water utilization is possible are limited in Sokoto State, groundwater development is common everywhere to provide domestic water supply. Boreholes with energy pumps and gravity-type distribution systems have been increasingly constructed in the urban areas, while dug wells and tube wells with manual pumps are prevalent in the rural areas. In the southern part of the study area where the land consists of hard Pre-cretaceous rocks, however, digging of the wells by inhabitants is very difficult, so shortage of water for domestic use is particularly acute. The northern part of the study area, where sedimentary formation is widely distributed, also has the problem of shortage of drinking water, especially in the dry season, because existing dug wells have not been able to meet the demand of the rapidly growing population.

2. SOCIO ECONOMIC FRAMEWORK

2-1 General

Nigeria has continued to produce about 1.3 million barrels of oil a day over the recent years. This has covered 20 % of the Gross Domestic Product, 95 % of the export value, and 70 - 80 % of the fiscal revenue. Though Nigeria should invest capital acquired from oil producing in diversification and modernization of the economy, the oil stagnancy of the 80's decreased oil producing revenue sharply from 25 billion dollars in 1980 to 6.7 billion dollars in 1987. Thus diversification of the economy has not been achieved.

On June 27th 1986, the Structural Adjustment Program (SAP) was begun. The SAP was a policy aimed at not depending on oil and achieving diversification of production and sound finance and balance of payment. This policy has been practiced by the Second-Tier Foreign Exchange Market (SFEM) since September 1986 and by the Foreign Exchange Market (FEM) since July 1987, in the place of the SFEM, for the abolition of the export-import licensed system, placing it under private management with some public corporation, and for the estimation of tariffs.

The economic growth rate in 1986 declined to 2.1 % below the previous year's mark. But it recovered 1.2 % in 1987. This resulted due to the fact that foreign currency prevailed over domestic industry by the SFEM, and that the FEM made easier the procurement of natural resources and gained an operating rate of about 5 % above the previous year's mark.
On the other hand, the share of oil in the GDP decreased slowly from 15.6 % and 15.0 % in 1985 and 1986, to 13.5 % in 1987, and the ratio of economic dependence on oil declining.
In agricultural sector, transaction in market have liberalized by the abolition of Agricultural Crops Transaction Conference. Thus, instead of whole agricultural depression on account of unseasonable weather, production of cashable crops gained a little.
Balance of payments indicates black at 160 million naira in 1987, because of austerity measure implementing continuously, depreciation of Naira with introduction of SFEM and FEM, reduction of payment by rescheduling and stability of oil price.

The government made efforts to stop inflation by SAP, but depression in agricultural production caused the rise in commodity prices. The government publicicated the growth rate in commodity price at 10.2 %, but the true rate is estimated at more than 40 %. Above all, the price of food rose about by 60 to 100%.

The government attempted to increase wages in order to cope with this rise in prices, but delay in delivery has happened on account of the scarcity in finance resources. In private sectors, recovery is foroging ahead, and it seems difficult to increase wages for inflation except financial institutions.

Unemployment rate in 1986 stands at 10.0 % in urban area and 4.0 % rural area. In 1987 they rose at 10.6 % and 4.9 % respectively. But this estimation was made by the government, so one view holds that it is estimated at about 30 to 40 % around Lagos state in the beginning of 1988.

It is concluded that SAP brought about recovery in economy and industrial activity accompanied with inflation, and that reduction in unemployment rate, depreciation in commodity price and sharp rise in GDP haven't accomplished. They will probably be done in the Fifth Economic Development Plan.

In order to establish the need for a groundwater project to be implemented with the support of foreign found the current socio-economic conditions of Nigeria and Sokoto State are treated in this section. It should be noted, however, that this is attempted with some difficulty, for available recent statistical data is limited to 1980 to 1985.

2-2 Federal

2-2-1 Population and Labor Force

The population of Nigeria is estimated by the Federal Government based on two factors. One is the annual growth rate of the population (4 % for Lagos State, and 2.5 % for other states). The other is the 1963 census. Accordingly, it is reported the projected mid-year population in 1986 was about 98 million persons. However, it is assumed that the growth rates mentioned above may be underestimated, meaning that the actual population was significantly higher. A periodic census is needed to enhance the effectiveness of implementing economic and social development plans.

From labor force information, unemployment rates of about 33 % were calculated between 1980 to 1985 using the population of age 15 and over and a total labor force. It would be better to use a labor force working population instead of a population of age 15 and over, but the values are still useful, considering the following:

- The percentage of the population of age 15 and over which is students is low.
- The percentage of the population of age 60 and over is low.

Considering the large uncounted labor force, employment conditions in Nigeria have not been good, and this situation continues even at present.

From a sector distribution of the labor force, it is clear that the agriculture sector had the largest share of the labor force, followed by the manufacturing, distribution (wholesale and retail), and service sectors. It is expected that the share of the labor force in the manufacturing sector will expand due to efforts by the Federal Government (Tables 2-1, 2).

2-2-2 Economics

(1) GNP and Its Components

The annual growth rate of the GNP between 1980 and 1985 is calculated as 5.7 % in actual Naira and −3.9 % in constant terms, and this trend is believed to continue. The GNP deflator is calculated at 9.9 %. The change in each real GNP component is summarized as follows:

- Consumption : Public consumption grew 2.0 % annually
  Private consumption grew −1.6 % annually
- Capital formation was reduced 14.6 % annually
- Exports were reduced 10.4 % annually
- Imports were reduced 18.2 % annually

Table 2-1 Population of States (in thousands)

STATE	1963	1980	1981	1982	1983	1984	1985	63-85
Anambra	3597	5456	5735	5735	5881	6029	6182	2.5%
Bauch	2431	3688	3781	3877	3975	4076	4179	2.5%
Bendel	2461	3733	3828	3924	4026	4126	4230	2.5%
Benue	2427	3682	3775	3870	3968	4069	4172	2.5%
Borno	2997	4547	4662	4780	4901	5027	5152	2.5%
Cross River	3478	5276	5410	5546	5687	5831	5978	2.5%
Gongola	2605	3952	4052	4155	4260	4368	4448	2.5%
Imo	3673	5571	5712	5857	6005	6157	6313	2.5%
Kaduna	4098	6217	6374	6535	6701	6671	7044	2.5%
Kano	5775	8760	8982	9209	9442	9681	9926	2.5%
Kwara	1714	2601	2667	2734	2803	2874	2947	2.5%
Lagos	1444	2476	2559	2645	2734	2825	3434	4.0%
Niger	1195	1812	1858	1905	1953	2003	2053	2.5%
Ogun	1551	2353	2412	2473	2534	2600	2666	2.5%
Ondo	2730	4141	4246	4353	4463	4576	4692	2.5%
Oyo	5209	7901	8101	8306	8517	8732	8953	2.5%
Plateau	2027	3074	3152	3232	3314	3398	3484	2.5%
Rivers	1720	2609	2675	2743	2812	2883	2956	2.5%
Sokoto	4539	6885	7059	7238	7421	7609	7802	2.5%
Total	55671	84734	87040	89117	91397	93535	96611	2.5%

Source : National Population Bureau
Note : (1) 1963 estimates are derived from the census taken in that year. Subsequent years' figures are projections.
(2) Annual growth rates are shown.

Table2-2 Labor Force

	1980	1981	1982	1983	1984	1985	80～85
Total Population (Millions)	84.4	86.6	88.8	91.0	93.3	95.7	2.5%
Age15 and Over (Millions)	48.2	49.4	50.6	51.9	53.2	54.6	2.5%
Total Labor Force (Millions)	32.2	33.2	34.0	34.9	35.5	36.1	2.3%
Unemployment Rate (%)	33.2	32.8	32.8	32.8	33.3	33.9	0.4%
Sector Distribution of Labor Force (%)							
Agriculture	60.0	59.5	59.0	58.3	58.0	57.8	
Mining and Quarrying	0.4	0.4	0.4	0.4	0.5	0.4	
Manufacturing and Processing	17.0	17.3	17.7	18.0	18.1	18.2	
Building and Construction	1.1	1.1	1.1	1.2	1.2	1.2	
Electricity, Gas and Water	0.2	0.2	0.2	0.2	0.2	0.2	
Distribution	15.2	15.4	15.5	15.7	15.9	16.0	
Transport and Communication	0.6	0.6	0.6	0.6	0.6	0.6	
Services	5.5	5.5	5.5	5.6	5.6	5.6	
Total	100.0	100.0	100.0	100.0	100.0	100.0	

Source:(1) National Population Commission

(2) National Manpower Board-Federal Ministry of National Planning

The situation is understood to be: oil exports decrease --- capital formation decreases --- import of capital goods decreases.

The National Disposable Income indicates the following:

- The share of labor income (compensation to employees) to gross added value (national disposable income) was 22.7 - 28.5 % between 1980 and 1985. These shares are very small.

- Depreciation (consumption of fixed capital) is extremely small.

What is needed to improve this situation is a more highly integrated economic structure (Tables 2-3, 4, 5).

(2) Price Conditions

The Consumer Price Index multiplied about 5 times from 1975 to 1985. It is believed that this inflation was caused by an inbalance in the supply and demand. Supply consists of domestic production and imports, and domestic production depends on capital stock like equipment and facilities. The reduction in oil revenue has brought about the decrease of both capital investment and the import of goods (Table 2-6).

(3) Production Indices

The IIP (Index of Industrial Production) in 1984 was about half of that of 1980. The IIP of the mining and quarrying sector decreased due to the world-wide reduction of demand for oil. The IIP of other sectors was lowered by the reduction of domestic demand (Table 2-7).

Table2-3 Gross National Products in Constant 1977/78 Naira
(in millions)

	1980	1981	1982	1983	1984	1985	80-85
Consumption	19238	19525	20570	19369	17258	18224	-1.1%
Pirvate	16646	16594	17744	16520	14412	15365	-1.6%
Public	2592	2931	2826	2849	2846	2859	2.0%
Gross Dom. Investment	8962	10987	8527	6434	4649	4113	-14.4%
Fixed Capital Form.	8564	10555	8247	6195	4453	3881	-14.6%
Changes in Stocks	398	432	280	239	196	232	-10.2%
Exports	12758	9781	7343	5756	6227	7349	-10.4%
Imports	8561	10471	7488	4521	2831	3127	-18.2%
Net Factor Income from Abroad	-884	-703	-827	-532	-674	-821	-1.5%
Gross Nat. Products	31513	29119	28125	26506	24629	25738	-4.0%
GNP Deflator:77/78=100	157.9	179.6	186.7	207.6	241.4	253.5	9.9%
Consumption	61.0	67.0	73.1	73.1	70.1	70.8	
Private	52.8	57.6	63.1	62.3	58.5	59.7	
Public	8.2	10.0	10.0	10.8	11.6	11.1	
Gross Dom. Investment	28.4	37.7	30.3	24.3	18.9	16.0	
Fixed Capital Form.	27.2	36.2	29.3	23.4	18.1	15.1	
Changes in Stock	1.2	1.5	1.0	0.9	0.8	0.9	
Exports	40.5	33.6	26.1	21.7	25.3	28.6	
Imports	-27.2	-35.9	-26.6	-17.0	-11.5	-12.1	
Net Factor Income from Abroad	-2.7	-2.4	-2.9	-2.1	-2.8	-3.3	
Gross Nat. Products	100.0	100.0	100.0	100.0	100.0	100.0	

Source : Federal Office of Statistics
Note : Annual growth rates are shown.

Table2-4 Gross National Products in Unadjusted Naira

(in millions)

	1980	1981	1982	1983	1984	1985	80～85
Consumption	36746	42330	44293	46810	49817	55326	8.5%
Private	31695	36827	38789	41249	44210	49668	9.4%
Public	5051	5503	5504	5561	5607	5658	9.4%
Gross Dom. Investment	11431	15020	12451	9664	7304	6693	-10.2%
Fixed Capital Form.	10842	14346	12001	9273	6974	6290	-10.3%
Change in Stock	589	674	450	391	300	403	-7.3%
Exports	14307	11584	9542	8031	9425	12002	-3.5%
Imports	11636	15723	12439	8302	5749	7021	-9.6%
Net Factor Income from Abroad	-1090	-910	-1335	-1167	-1352	-1747	
Gross Nat. Product	49758	52301	52512	55036	59445	65253	5.6%
Consumption	73.8	80.9	84.3	85.0	83.8	84.8	
Private	63.7	70.4	73.8	74.9	74.4	76.1	
Public	10.1	10.5	10.5	10.1	9.4	8.7	
Gross Dom. Investment	23.0	28.7	23.7	17.5	12.2	10.2	
Fixed Capital Form.	21.8	27.4	22.9	16.8	11.7	9.6	
Change in Stock	1.2	1.3	0.8	0.7	0.5	0.6	
Exports	28.8	22.2	18.2	14.7	15.9	18.5	
Imports	-23.4	-30.1	-23.7	-15.1	-9.6	-10.8	
Net Factor Income from Abroad	-2.2	-1.7	-2.5	-2.1	-2.3	-2.7	
Gross Nat. Product	100.0	100.0	100.0	100.0	100.0	100.0	

Source: Federal Office of Statistics Note : Annual growth rates are shown

Table2-5 National Disposable Income and Its Appropriation

(Million Naira)

	1980	1981	1982	1983	1984	1985	80～85
Compensation of Employees	11883	13789	15373	15275	15243	15188	5.0%
	(23.4)	(25.9)	(28.5)	(27.2)	(25.1)	(22.7)	
Operating Surplus	36556	36247	35334	38029	43319	49586	6.3%
	(71.9)	(68.1)	(65.6)	(67.7)	(71.3)	(74.0)	
Consumption of Fixed Capital	1192	1578	1320	1020	767	691	-10.3%
	(2.3)	(3.0)	(2.5)	(1.8)	(1.3)	(1.0)	
Indirect Taxes	1423	1887	2048	2136	1724	1790	4.7%
	(2.8)	(3.5)	(3.8)	(3.8)	(2.8)	(2.7)	
Subsidies	-207	-290	-228	-257	-257	-257	4.4%
	(0.4)	(0.9)	(0.4)	(0.5)	(0.4)	(0.4)	
National Disposable Income and its Appropriation	50848	53212	53847	56204	60797	67000	5.7%
	(100)	(100)	(100)	(100)	(100)	(100)	

Source: Federal Office of Statistics

Note : (1)Annual growth rates are shown.

(2)"( )"shows percentage.

Table2-6 Composite Consumer Price Index

COMPONENT	1980	1981	1982	1983	1984	1985	80~85
All Items	205	248	267	328	458	484	18.7%
Accomodation, Fuel, and Light	170	173	180	240	270	258	8.7%
Food	200	250	272	336	479	499	20.1%
Drinks	188	193	208	236	290	380	15.1%
Tobacco and Cola	229	264	278	318	436	549	19.1%
Clothing	270	314	335	398	543	610	17.7%
H.H.Goods and Other Purchases	182	195	213	328	516	542	24.4%
Transport	197	202	224	271	316	357	12.6%
Other Services	235	283	296	357	497	612	21.1%

Source: Federal Office of Statistics

Note :(1) Base Year 1975=100

(2) Annual growth rates are shown

Table2-7 Index Number of Nigeria Industrial Production

SECTOR	WEIGHTS	1980	1981	1982	1983	1984	80～84
Mining and Quarrying	630	94.0	67.5	59.2	56.9	61.7	-10.0%
Manufacturing (Large Scale)	111	207.3	129.0	108.6	137.7	121.2	-12.5%
Manufacturing (Small Scale)	13	191.1	125.1	101.6	128.9	113.8	-12.1%
Building and Construction	239	102.2	107.1	89.4	77.3	56.3	-13.8%
Electricity	7	139.0	162.6	177.3	181.1	187.8	7.8%
Overall Index	1000	110.2	95.2	73.3	72.5	68.6	-11.2%

Source: Federal Office of Statistics

Note :(1) Base year 1977/78=100

(2) Annual growth rates are shown

(4) Foreign Exchange Rate

The exchange rate, naira to dollar has fluctuated as follows.

Year	Rate (Naira/US$)
Dec. 1983	0.7486
Dec. 1984	0.8083
Dec. 1985	0.9996
Dec. 1986	3.3168
Dec. 1987	4.1408
Apr. 1988	4.2928
Feb. 1989	7 - 8 (approx.)

Because of world-wide reduction in the demand for oil since 1980, the exchange rate has depreciated, first slowly up to 1985, and then steeply from 1986, as oil prices rapidly decreased. The SAP was introduced in order to decreased the dependency on oil, to achieve a diversification in production, and to balance trade. The SFEM was introduced to eradicate the variance between the official and unofficial markets. The First-Tier market was governmentally dictated, and the Second-Tier depended on demand. The SFEM brought about vigorous production activity and transformed the GNP growth rate from minus to plus by 1987. The SFEM was discontinued in July, 1987, because the difference in the markets had disappeared. The autonomous Exchange Market, a free market, is now in effect. But low oil prices still remain, however. The Nigerian economy has not seen smooth grown, and the exchange rate is still rapidly dropping.

2-2-3 Industries

The transition of real added values (GDP) produced by each industrial sector, from 1980 to 1985, shows the following:

- Agriculture grew slightly.
- Oil, manufacturing, and construction were largely reduced.

- Wholesale and retail trade were also reduced by the stagnation of the Nigerian economy.

Accordingly, the share of real added value in agriculture increased.

In order to study the industrial structure of Nigeria, an input-output table is needed. Because of the lack of statistical data, only an input-output table from 1973 is available. However, it is believed that this table is still useful since oil and agriculture are still leading industries. By share of outputs, Nigeria's leading industries are:

Sector	Share (%)
Agriculture, Livestock, Forestry, and Fishing	24.0
Distribution trade	17.8
Oil mining	13.7
Building and Construction	13.0

As the ratios of value added concerning these industries, with the exception of building and construction, were over 85 %, their economic effects were small. The import ratios of manufacturing sectors that have great effects were relatively high. For example, the import ratio of the fabricated metal sector was 55.2 %. This situation indicates that only foreign countries enjoyed the economic development occurring in Nigeria. Again, the integration of Nigeria's industrial structure is essential to the recovered health of its economy (Tables 2-8, 9, 10).

2-2-4 Foreign Trade

Oil has been Nigeria's major export, while machinery and transport equipment, manufactured goods, food, and chemicals have been major imports.

From 1980 to 1985, foreign trade shrank with the decrease in oil exports. However, considering the expected expansion of demand for oil and the increase of oil prices in the mid-1990's, foreign trade is expected to grow greatly in the near future (Tables 2-11, 12).

Table2-8 Gross Domestic Product by Industry in 1977/78 Naira

(in millions)

	1980	1981	1982	1983	1984	1985	80～85
Agriculture	6501	6113	7005	6792	6638	6947	1.3%
Crops and Other	4944	4553	5387	5077	4813	5017	0.3%
Livestock	1557	1560	1618	1714	1825	1930	4.4%
Mining and Quarrying	7437	5339	4680	4497	4874	5184	-7.0%
Petroleum	6754	4625	4086	3983	4500	4885	-6.0%
Other	682	713	594	513	374	299	-15.2%
Manufacturing	3485	2179	1828	2318	2041	2433	-7.0%
Electricity, Gas, and Water	143	171	192	200	206	213	8.3%
Construction	3056	3204	2674	2312	1684	1347	-15.1%
Transportation	1168	1399	1446	1080	811	689	-10.0%
Communication	58	61	60	57	57	56	-0.7%
Wholesale and Retail Trade	6317	6342	5642	4973	4559	5012	-4.5%
Housing	978	1026	1056	793	793	1032	1.1%
Government Services	1678	2141	2270	2127	2162	2140	5.0%
Other Services	720	920	1115	1064	1015	1101	8.9%
GDP at Factor Cost	31546	28899	27974	26217	24845	26158	-3.7%
Net Indirect Taxes	850	923	978	820	458	400	14.0%
GDP at Market Prices	32397	29822	28952	27038	25303	26559	-3.9%
Agriculture	20.6	21.2	25.0	25.9	26.7	26.6	
Crops and Other	15.7	15.8	19.3	19.4	19.4	19.4	
Livestock	4.9	5.4	5.8	6.5	7.4	7.4	
Mining and Quarrying	23.6	18.5	16.7	17.2	19.6	19.8	
Petroleum	21.4	16.0	14.6	15.2	18.1	18.7	
Other	2.2	2.5	2.1	2.0	1.5	1.1	
Manufacturing	11.1	7.5	6.5	8.8	8.2	9.3	
Electricity, Gas, and Water	0.5	0.6	0.7	0.8	0.8	0.8	
Construction	9.7	11.1	9.6	8.8	6.8	5.2	
Transportation	3.7	4.8	5.2	4.1	3.3	2.6	
Communication	0.2	0.2	0.2	0.2	0.2	0.2	
Wholesale and Retail Trade	20.0	22.0	20.2	19.0	18.4	19.2	
Housing	3.1	3.6	3.8	3.0	3.2	4.0	
Government Services	5.3	7.4	8.1	8.1	8.7	8.2	
Other Services	2.3	3.2	4.0	4.1	4.1	4.2	
GDP at Factor Cost	100.0	100.0	100.0	100.0	100.0	100.0	

Source: Federal Office of Statistics

Note : Annual growth rates are shown

Table2-9 Gross Domestic Product by Industry in Unadjusted Naira
(in millions)

	1980	1981	1982	1983	1984	1985	80～85
Agriculture	10011	12882	15199	18505	23072	24379	19.5%
Crops and Other	8140	10868	12110	14308	17541	18520	17.9%
Livestock	1870	2014	3089	4197	5530	4858	21.0%
Mining and Quarrying	15012	13330	11251	9923	11284	13026	-2.8%
Petroleum	14137	12442	10454	9201	10730	12583	-2.3%
Other	875	888	797	722	553	442	-12.8%
Manufacturing	5162	3400	2843	3802	3450	4216	-4.0%
Electricity, Gas and Water	244	309	386	402	391	395	10.1%
Construction	3671	4001	3604	3268	2494	1995	-11.5%
Transportation	1635	2009	2301	2079	1821	1796	1.9%
Communication	69	73	74	78	81	83	3.8%
Wholesale and Retail Trade	9617	10449	10463	10344	10548	12425	5.3%
Housing	1309	1398	1491	1498	1686	2486	13.7%
Government Services	2014	2569	2809	2911	2959	2928	7.8%
Other Services	883	1189	1502	1509	1541	1732	14.4%
GDP at Factor Cost	49632	51615	52027	54325	59330	65466	5.7%
Net Indirect Taxes	1216	1597	1819	1879	1467	1533	4.7%
GDP at Market Prices	50848	53212	53847	56204	60797	67000	5.7%
Agriculture	20.2	25.0	29.2	34.1	38.9	37.2	
Crops and Other	16.4	21.1	23.3	26.3	29.6	28.3	
Livestock	3.8	3.9	5.9	7.7	9.3	9.0	
Mining and Quarrying	30.2	25.8	21.6	18.3	19.0	19.9	
Petroleum	28.5	24.1	20.1	16.9	18.1	19.2	
Other	1.8	1.7	1.5	1.3	0.9	0.7	
Manufacturing	10.4	6.6	5.7	7.0	5.8	6.4	
Electricity, Gas and Water	0.5	0.6	0.7	0.7	0.7	0.6	
Construction	7.4	7.8	6.9	6.0	4.2	3.1	
Transportation	3.3	3.9	4.4	3.8	3.1	2.7	
Communication	0.1	0.1	0.1	0.1	0.1	0.1	
Wholesale and Retail Trade	19.4	20.3	20.1	19.0	17.8	19.0	
Housing	2.6	2.7	2.9	2.8	2.8	3.8	
Government Services	4.1	5.0	5.4	5.4	5.0	4.5	
Other Services	1.8	2.3	2.9	2.8	2.6	2.7	
GDP at Factor Cost	100.0	100.0	100.0	100.0	100.0	100.0	

Source: Federal Office of Statistics
Note : Annual Growth Rates are shown

Table2-10 Input-Output Condition (1973)

	Ratio of Value Added(%)	Ratio of Imports(%)	Percentage of Total Output
Agriculture	92.9	1.5	15.9
Livestock	98.9	0.2	3.3
Forestry	98.9	-	1.5
Fishing	94.6	-	3.3
Oil Mining	90.5	7.0	13.7
Other Mining and Quarrying	66.7	2.1	2.0
Food, Drink, Beverages, and Tobacco	47.1	9.0	3.8
Textiles, Apparel, and Leather Products	29.2	6.2	2.2
Wood and Wood Products Including Furniture	46.0	12.0	0.3
Paper and Paper Products, Printing and Publishing	42.9	7.2	0.7
Drugs and Chemicals	54.7	14.3	1.9
Rubber and Plastic Products	35.6	24.8	0.7
Basic Metal Products	23.6	26.1	1.5
Fabricated Metal Products, Machinery, and Equipment	31.8	55.2	1.0
Other Manufacturing Products	54.0	4.8	0.7
Electricity and Water	65.3	0.5	0.5
Building and Construction	46.1	15.7	13.0
Transport	65.3	11.6	4.7
Communication	64.3	2.3	0.3
Distributive Trade	86.0	-	17.8
Finance and Insurance	83.9	2.4	1.1
Producers of Goverment Services	100.0	5.3	4.5
Hotels and Catering	62.7	-	0.3
Professional Businesses and Other Services	67.9	79.7	0.6
Housing	87.4	-	4.9

Source:National Accounts of Nigeria

Table2-11 Exports by Commodity Sections

(Million Naira)

	19	1981	1982	1983	1984	1985	80~85
Food	221 (1.6)	214 (1.9)	183 (2.0)	273 (3.5)	234 (2.6)	243 (2.1)	2.0%
Beverages and Tobacco	-	-	-	-	-	-	-
Inedible crude materials except fuels	43 (0.3)	35 (0.3)	25 (0.3)	22 (0.3)	15 (0.2)	15 (0.1)	-19.0%
Mineral Fuel, Lubricants and Related Materials	13330 (97.5)	10687 (97.1)	8929 (97.1)	7303 (94.5)	8685 (95.2)	11335 (96.7)	-3.2%
Animal and Vegetable Oils and Fats	15 (0.1)	6 (0.1)	2 (0)	3 (0)	4 (0)	3 (0)	-27.5%
Chemicals	- (0)	2	-	-	- (0)	1	-
Manufactured Goods Classifies Chiefly by Materials	17 (0.1)	23 (0.2)	14 (0.2)	8 (0.1)	12 (0.1)	6 (0.1)	-18.8%
Machinery and Transport Equipment	-	-	-	-	-	-	-
Miscellaneous Manufactured Articles	-	-	-	-	-	-	-
Commodities and Transactions Not Clasified According to Kind	56 (0.4)	39 (0.4)	40 (0.4)	124 (1.6)	174 (1.9)	114 (1.0)	15.3%
Total Exports	13682 (100)	11006 (100)	9193 (100)	7733 (100)	9124 (100)	11717 (100)	-3.1%

Source: Federal Office of Statistic

Note : (1) Annual growth rates are shown.
(2) "( )" shows percentage.

Table2-12 Imports by Commodity Sections

(Million Naira)

	1980	1981	1982	1983	1984	1985	80～85
Food	1049 (12.8)	1820 (14.4)	1642 (16.3)	1296 (19.8)	843 (18.8)	940 (17.0)	-2.2%
Beverages and Tobacco	12 (0.1)	16 (0.1)	16 (0.2)	13 (0.2)	10 (0.2)	7 (0.1)	-10.2%
Inedible crude materials except fuels	164 (2.0)	218 (1.7)	207 (2.1)	204 (3.1)	187 (4.2)	274 (5.0)	10.8%
Mineral Fuel, Lubricants and Related Materials	118 (1.4)	151 (1.2)	115 (1.1)	52 (0.8)	52 (1.2)	47 (0.9)	-16.8%
Animal and Vegetable Oils and Fats	96 (1.2)	128 (1.0)	151 (1.5)	105 (1.6)	101 (2.3)	55 (1.0)	-10.5%
Chemicals	881 (10.7)	1220 (9.7)	981 (9.7)	713 (10.9)	656 (14.6)	868 (15.7)	-0.03%
Manufactured Goods Classified Chieifly by Materials	1929 (23.5)	2540 (20.1)	2137 (21.2)	1477 (22.5)	845 (18.9)	1263 (22.9)	-8.1%
Machinery and Transport Equipment	3363 (41.0)	5548 (44.1)	4169 (41.1)	2365 (36.2)	1604 (35.8)	1892 (34.1)	-10.9%
Miscellaneous Manufactured Articles	589 (7.2)	947 (7.5)	642 (6.4)	316 (4.8)	171 (3.8)	176 (3.2)	-21.5%
Commodities and Transactions Not Clasified According to Kind	12 (0.1)	25 (0.2)	36 (0.4)	9 (0.1)	11 (0.2)	5 (0.1)	-16.1%
Total Exports	8213 (100)	12613 (100)	10096 (100)	6550 (100)	4480 (100)	5527 (100)	-7.7%

Source: Federal Office of Statistics

Note : (1)Annual growth rates are shown.

(2)"( )" shows percentage.

2-2-5 Social Conditions

(1) Electricity Production

The production of electricity has grown favorably, but sales, as economic conditions have grown worse, have not. This sector will be especially important in integrating the industrial structure in the near future (Table 2-13).

(2) Health

The prevalent diseases found in Nigeria result in death rates that are significantly high. Insufficient medical equipment and the lack of doctors are key contributors to inadequate treatment, but prevention of disease is more directly related to a lack of sanitary drinking water (Table 2-14).

(3) Education

The percentage of children enrolled in primary school is fairly high, but the participation rate in secondary school and the number of students going on to higher education is low. Major expenditures will have to be made to expand education in support of the economy and the general welfare of the people (Table 2-15).

2-2-6 Finance

Since 1980, both the income and expenditures of the Federal Government have decreased with oil revenues. Accordingly, social development investment, including the development of water resources, has stagnated (Tables 2-16, 17).

2-2-7 Summary

- The low oil prices and the surplus of the world's oil supply in the 1980's brought Nigeria severe economic conditions: a reduction of real GNP, significant inflation and an inbalance in trade. This situation continues. Large investment is and will be needed to correct inadequate public and private capital.

Table2-13 Electricity Generation and Sales

Consumer Group	1980	1981	1982	1983	1984	80～84
Total Production (1,000 Kw)	6,911,765	7,781,828	8,512,302	8,641,183	8,964,269	6.7%
SALES						
Industrial/Commercial	2,500,249	2,902,984	2,897,501	2,970,666	2,615,910	1.1%
Non-Factor Services	2,013,793	2,724,093	3,018,136	3,135,699	2,857,325	9.1%
Excess Production over Domestic Consumption (Unsold Power)	2,397,723	2,154,751	2,596,665	2,534,817	3,491,034	9.8%
Number of Residential Consumers	1,105,791	1,031,997	1,156,319	1,201,524	1,409,106	6.2%
Per Capital Residential	1.7	2.6	2.6	2.6	2.0(1000KWH)	
RATIOS(%)						
Percentage of Total Production to						
Industrial/Commercial	37.5	37.3	34.0	34.4	29.2	
Residential	28.8	35.0	35.5	36.3	31.9	
Unsold Generated Power	33.8	27.7	30.5	29.3	38.9	

Source: National Electric Power Authority, NEPA and F.O.S.

Note : Indicates Number of Meters Installed in Consumer's Premises.
1984 Figures are Provisional.

Table2-14 Health Indicators

(Person)

DISEASES (CASES REPORTED)	1980	1981	1982	1983	1984	80～84
Malaria	1,171,071	1,471,561	1,147,518	1,273,090	1,242,882	1.5%
Dysentery	234,071	293,747	272,079	251,241	222,879	-1.2%
Measles	142,106	129,671	139,785	136,778	188,591	7.3%
Pneumonia	88,595	114,692	96,364	99,070	101,455	3.4%
Gonorrhoea	65,914	68,087	56,731	53,732	55,139	-4.4%
Whooping Cough	48,696	56,913	77,830	70,024	62,751	6.5%
Chickenpox	19,161	26,384	34,573	41,203	65,932	36.2%
Filariasis	22,561	27,521	14,640	14,970	12,746	-13.3%
Schistosominsis	24,550	41,662	40,028	41,889	36,710	10.6%
Tuberculosis	9,694	10,838	10,949	10,212	10,677	2.4%

Source: Federal Ministry of Health

Table2-15 Education Enrollment

	1980	1981	1982	1983	1984	1985	80~85
1. PRIMARY SCHOOL							
Population in Primary Age Bracket (1000person)	13,632	15,082	15,467	15,862	16,350	16,684	4.1%
Number of Primary Schools	35,723	36,626	37,611	37,888	38,211	-	1.4%
Total Enrollment in Primary Schools (1000person)	12,117	13,777	14,397	14,533	14,387	14,611	3.8%
Primary Enrollment Ratio(%)	84	91	93	92	88	88	-
2. SECONDARY EDUCATION -ALL PHASES							
Total Enrollment in Secondary Education (1000person)	1,864	2,345	2,880	3,234	3,402	-	12.8%
Participation Rate Per 10000 Pupils	226	277	321	358	329	-	-
3. POST-SECONDARY INSTITUTIONS							
Polytechnics/Colleges of Technology							
Number of Institutions	23	24	27	29	29	29	4.7%
Total Enrollment	30466	46244	52373	61630	59585	-	14.4%
Number of Graduates	4574	7730	17411	22738	-	-	37.8%
ATC'S/Colleges of Education							
Number of Institutions	36	36	36	36	36	36	-
Total Enrollment	26792	26300	36667	38772	-	-	7.7%
Number of Graduates	5329	7336	8308	12842	-	-	19.2%
Universities							
Number of Institutions	16	18	20	24	27	26	10.2%
Total Enrollment	57542	75921	89096	97407	113158	109228	13.7%
Number of Graduates	11610	12422	13020	15066	-	-	5.3%

Source: Federal Ministry of Education

Table2-16 Central Government Revenue

(Million Naira)

	1980	1981	1982	1983	80～85
Oil Revenue	12353	9267	7815	6786	-18.1%
Profit Tax	8564	6326	4840	3747	-24.1%
Rents and Royalties	3789	2942	2969	3040	-7.1%
Non-Oil Revenue	2878	3400	3934	4161	13.1%
Import Duties	1403	1749	1648	1115	-7.4%
Export Duties	-	-	-	-	231.7%
Excise Duties	406	577	688	869	28.9%
Company and Other Taxes	597	522	762	1145	24.3%
Non-Tax Revenue	472	552	836	1031	29.7%
TOTAL CURRENT REVENUE	15231	12682	11749	10947	-10.4%
Allocation to State and Local Government	3095	4911	4258	4156	10.3%
Retained Federal Revenue	12136	7771	7490	6791	-17.6%

Source:Federal Republic of Nigeria Official Gazette

Table2-17 Central Government Expenditure

(Million Naira)

	1980	1981	1982	1983	1984	1985	80～85
Current Expenditure	5975	7065	7358	5624	7873	6976	
General Administration	727	368	1020	1361	1178	838	2.9%
Defense	1035	1015	916	808	802	1101	1.2%
Internal Security	36	392	478	574	596	698	13.8%
Education	509	713	512	589	658	697	6.5%
Health	173	112	146	162	87	164	-1.0%
Water Resources	10	4	231	216	-	-	84.9%
Housing	58	83	98	59	203	185	26.1%
Other Social Services	104	89	129	160	166	288	22.6%
Agriculture and Non-mineral Resources	56	28	31	38	42	41	-6.0%
Fuel and Power	12	8	8	9	14	11	-2.5%
Industry	9	9	9	10	22	21	18.6%
Transport and Communi-cations	83	20	21	20	46	58	-7.0%
Other Economic Services	40	53	15	13	-	-	-19.6%
Other Current Expendi-tures	2793	4994	3855	1607	4061	2875	1.0%
Capital Expenditure	8089	5697	6423	5875	3812	7613	-1.2%
General Administration	485	115	86	126	112	137	-22.4%
Defense	723	479	155	358	99	284	-17.0%
Internal Security	76	69	78	113	45	28	-17.9%
Education	729	382	369	367	88	126	-29.6%
Health	188	139	53	93	35	59	-20.7%
Water Resources	443	624	169	434	156	171	-17.3%
Housing, Environment, Town&Co. Planning	333	422	116	142	25	653	14.4%
Other Social Services	131	14	26	79	11	12	-37.9%
Agriculture and Non-mineral Resources	414	400	137	228	129	135	-20.1%
Fuel and Power	1119	540	659	210	-	211	-28.4%
Industry	1132	248	780	700	82	168	-31.7%
Transport and Communi-cations	2271	1179	677	766	248	204	-38.3%
Other Economic Services	15	13	43	46	28	28	13.1%
Other Capital Expendi-tures	30	1072	3074	2214	2756	5397	282.5%

Source:Federal Republic of Nigeria Official Gazette and Central Bank of Nigeria

Note :(1)In Current Expenditure, Water Resources and Works are combined between 1981 and 1983 only.

(2)From 1984, Water Resources is merged with Ministry of Agriculture, Transport with Civil Aviation/Communication, and Works with Housing.

(3)Other Capital Expenditure – Rural Deveropment, Federal Capital Territory, National Loan Fund for Parastatals and Government owned-Companies.

- Therefore, social development programs, including those relating to water resources, have been delayed.
- However, the expectation of high oil prices, brought about by an increasing demand in the mid-1990's, promises that the Nigerian economy will show significant growth in the near future.

2-3 Sokoto State

2-3-1 Organization

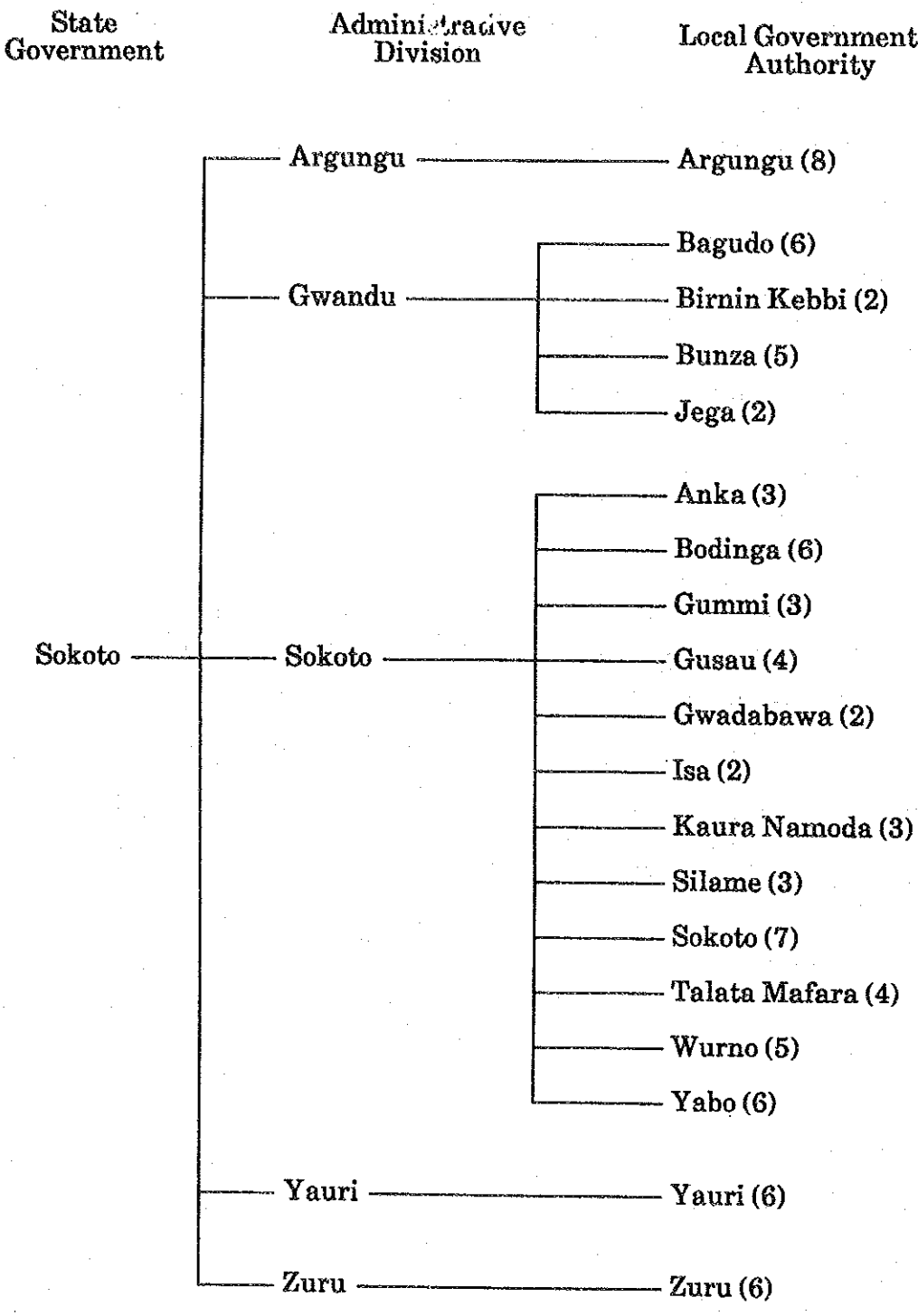
Sokoto State consists of five administrative divisions and nineteen local governmental authorities. Eighty-three districts exist under these local governmental authorities (Figure 2-1).

2-3-2 Population

The population of each local government authority in 1963 and 1987 is shown in Table 2-18. A population growth rate of 2.5 % estimated by the Federal Government suggests that the population of Sokoto State is growing rapidly.

2-3-3 Price Conditions

The escalation of retail market prices in Sokoto City is shown in Table 2-19. This table indicates that inflation was a serious problem and is so even now.



Note: Figures in ( ) show numbers of districts

Figure 2-1 Governmental Organization of Sokoto State

Table 2-18 Population of Sokoto State

(Unit: Persons)

Local Government	1963 Census Figures		1987 Estimation	
Argungu	293,985		531,740	
B/Kebbi	183,413		331,740	
Bunza	190,723		344,970	
Jega	193,404	Sub-Total	349,820	Sub-Total
Bagudo	165,150	732,690	298,710	1,325,240
Anka	120,099		217,230	
Bodinga	212,561		384,460	
Gwadavana	397,874		719,650	
Gummi	163,254		295,280	
Gusau	374,300		677,010	
Isa	258,491		467,540	
K/Namoda	299,938		542,510	
Silame	191,943		347,170	
Sokoto	312,821		565,810	
T/Mafara	284,389		514,380	
Wurno	320,990	Sub-Total	580,580	Sub-Total
Yabo	256,360	3,193,020	463,690	5,775,310
Yauri	115,075		208,140	
Zuru	204,019		369,020	
Total	4,538,789		8,209,440	

Notes: 1987 population is projected at the rate of a 2.5 % rate of growth based on 1963 census figures.

Source: Papers prepared for Sokoto State Statistical Handbook 1987, Sokoto State Economic Planning Dept.

Table 2-19 Escalation of Retail Market Prices in Sokoto City (Unit: Naira)

Commodity	Description	Measure/ Quantity	1976 Oct. - Dec.	1980 Jul. - Sep.	1986 Jul. - Sep.	Amn. Infl. Rate (%) 76/80	80/86
Rice	White	Mudu	0.51	0.95	4.20	23.0	28.0
Rice	Brown	Mudu	0.44	1.23	3.69	29.0	20.1
Guinea Corn	Grain	Mudu	0.18	0.30	0.82	13.6	18.2
Millet	Grain	Mudu	0.17	0.30	0.79	15.3	17.5
Maize	Grain	Mudu	0.15	0.40	0.85	27.8	13.4
Wheat	Grain	Mudu	–	–	2,32	–	–
Ground-nut	Shelled	Mudu	–	0.20	2.45	–	51.8
Yam	Tubers	5 Medium	–	7.00	9,53	–	5.3
Cassava (Gari)	Yellow	Mudu	0.30	0.50	1.11	13.6	14.2
Banana	Ripe	Bunch of 10	–	1.60	1,87	–	2.6
Oranges	Ripe	5 Medium	–	–	1,20	–	–
Palm Oil	Oil	Large Beer B	0.45	1.00	2,50	22.1	16.5
Eggs	Agric	10 Eggs	0.50	1.00	3.43	18.9	22.8
Beef	Agric	1 Kilo	–	4.00	7.04	–	9.9
Sugar	St. Louis	1 Pkt	0.39	0.85	2.13	21.5	26.5
Salt	Cooking	1 Bag	–	5.00	28.32	–	33.5
Soap	Lux	1 Cake	–	0.25	0.97	–	25.3
Tyres	175×14	One	–	–	215.00	–	–

Notes: Soap price, 0.25, is as of Jan. - Mar., 1980

Source: Quarterly Reports on Prices of Selected Commodities in Some Towns in Sokoto State Jan. - Mar., 1977; Jan. - Mar., Apr. - Jun., Jul. - Sep., 1980; Jul. - Sep., 1986

2-3-4 Budget

The state budget consists of two portions: the recurrent portion and the capital portion. The recurrent portion is comprised of working expenses, like personnel costs, overhead costs, and debt service payments composed of by interest, repayments and refunds. Statutory allocation and locally generated revenue are income sources for the recurrent portion.

The capital portion is comprised of expenses to promote public enterprise, such as agriculture, irrigation, power, roads, education, health, water supply, sewerage and drainage, housing, and son on. Grants from the Federal Government, domestic loans, foreign sources such as the World Bank, and some local funds are income sources for the capital portion (Figure 2-2).

Table 2-20 summarizes the state budget from 1981 to 1987. The actual recurrent portion, revenue and expenditure, from 1981 to 1985, is unknown due to a lack of statistics. This table reveals that:

- The capital portion is much too small in comparison with the recurrent portion.
- No growth has taken place in the capital portion.

2-3-5 Summary

In summary:

- Sokoto State's population is surely and rapidly growing.
- Prices are increasing too.
- Capital expenditure is not growing at all due to the current recession in Nigeria.

Accordingly, Sokoto State needs to increase its capital, to be paid for promoting public enterprises, like water supply, from foreign countries, besides at low cost.

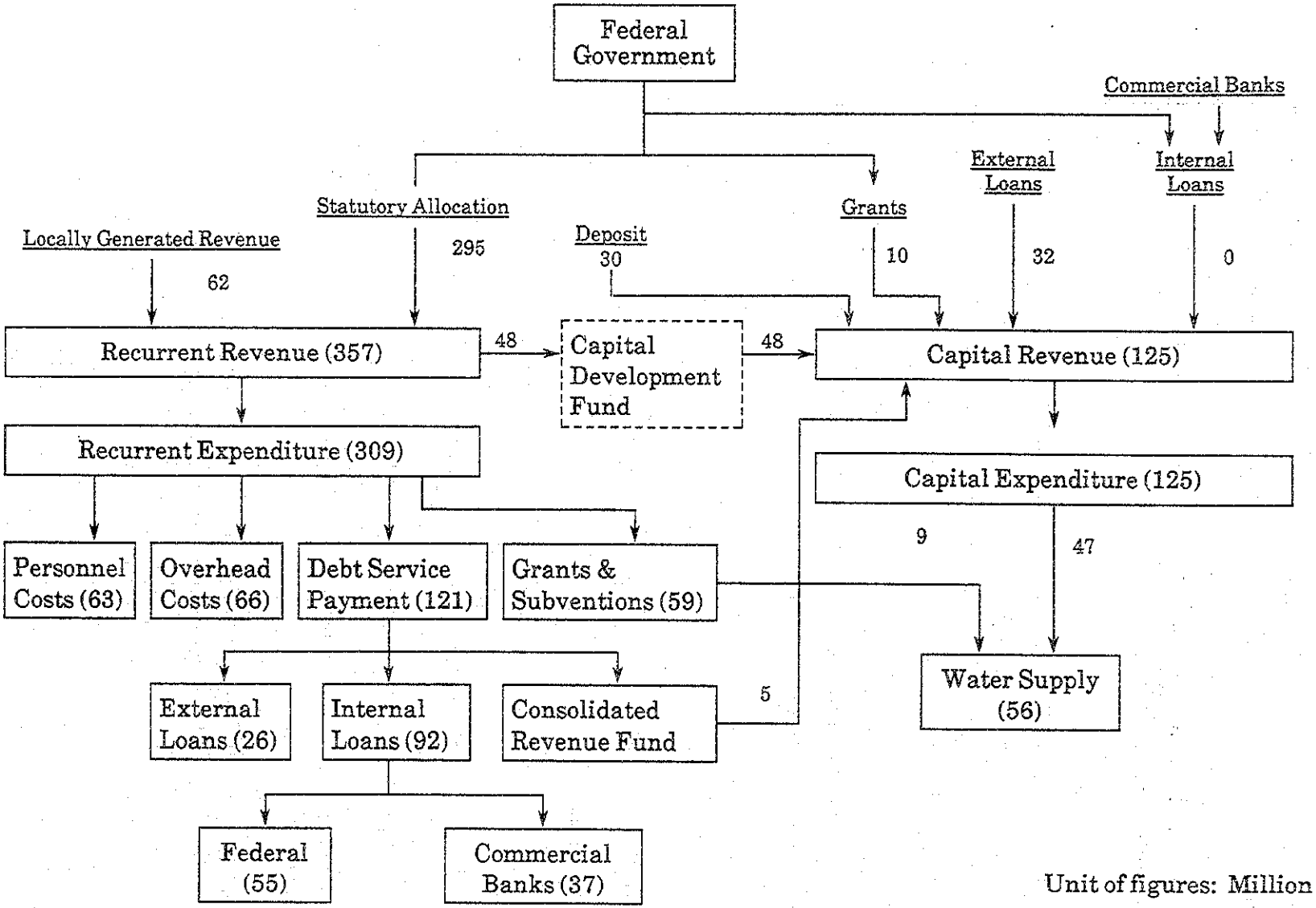


Figure 2-2 1987 Budget Estimate of the Government of Sokoto State

Table 2-20 Actual and Estimated Budget of Sokoto State Government 1981 - 1987

	Actual 1981	Actual 1982	Actual 1983	Actual 1984	Actual 1985	Revised 1986	Estimated 1987
Revenue:							
Recurrent Revenue							
Statutory Allocation	–	–	–	–	–	238	295
Locally Generated Revenue	–	–	–	–	–	55	62
Transfer from Reserves	–	–	–	–	–	22	0
Transfer to Capital Dev. Fund	–	–	–	–	–	5	48
Sub-Total	–	–	–	–	–	310	309
Capital Budget							
Transfer from Consolidated Funds	110	0	0	0	29	60	83
Internal Loans	21	53	39	49	20	25	0
External Loans	0	0	52	0	65	29	32
Grants	0	0	5	4	7	9	10
Sub-Total	131	53	100	53	121	123	125
Total	–	–	–	–	–	433	434
Expenditure:							
Recurrent Expenditure							
Personal Costs	–	–	–	–	–	59	63
Overhead Costs	–	–	–	–	–	53	66
Debt Service Payments	–	–	–	–	–	119	121
Grants & Subventions	–	–	–	–	–	80	59
Sub-Total	–	–	–	–	–	311	309
Capital Expenditure							
Economic Sector	72	72	57	59	49	44	37
Social Sector	44	21	22	6	17	35	34
Regional Dev. Sector	33	18	23	30	34	44	51
General Administration	8	5	4	2	1	1	3
Sub-Total	157	116	106	97	101	124	125
Total	–	–	–	–	–	435	434
Balance	–	–	–	–	–	–2	0

Note: (1) " – " means unknown
(2) Water supply is included in regional development sector

Source: Recurrent and Capital Estimates of The Government of Sokoto State, 1987

3. HYDROLOGY

3-1 Conditions of Existing Monitoring Network and Related Data

3-1-1 Meteorological stations

Meteorological stations are classified into four types :

1. Synoptic meteorological stations operated by the Federal Department of Civil Aviation (FDCA), which have standardized and high quality data collected over long periods.

2. Agrometeorological stations generally operated by agencies involved in the agricultural sector such as the State Ministry of Agriculture (SMA) and the Sokoto-Rima River Basin Development Authority (SRRBDA).

3. Meteorological stations often operated by schools for educational purposes or by development agencies, such as the Sokoto State Water Boards (SSWB) or the SRRBDA, particularly in relation to water resource management.

4. Rainfall stations, where only precipitation is measured. They are often sited at schools and colleges. As precipitation has the greatest variation in time and space of all the meteorological variables, a great number of rain gauges were installed throughout the whole area. However, because of unsystematic management, data available are scant compared to the number of rain gauges installed.

The number of existing meteorological stations in the Sokoto-Rima basin is given in Table 3-1, and their locations are shown in Fig. 3-1.
Specifications of synoptic, agrometeorological, and meteorological stations are given in Table 3-2.

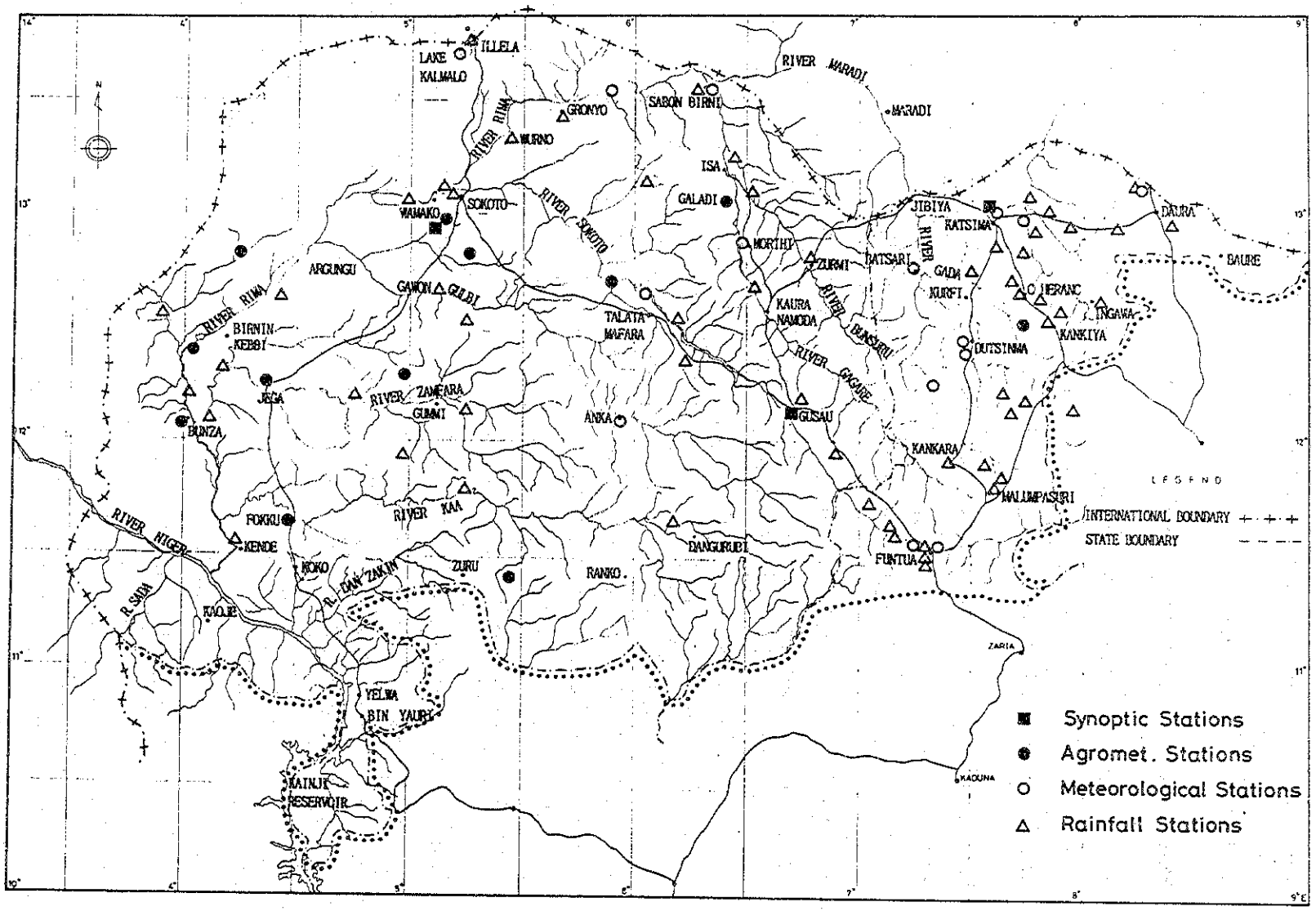


Fig. 3-1 Location Map of Meteorological Stations

Table 3-1 Number of Existing Meteorological Stations

Station Type	Number
Rainfall Stations	27
Meteorological Stations	12
Agrometeorological Stations	8
Synoptic Stations	3

3-1-2 Hydrological stations

There are more than 50 hydrological stations in the Sokoto-Rima basin (Fig. 3-2). However, discharge measurements have been carried out only at 18 stations. The distribution of discharge stations is shown schematically in Fig. 3-3. At the other stations, only gauge readings have been carried out. The conditions of the stations are generally poor. Many of them need to be rehabilitated.

3-1-3 Data collection

Several existing reports and yearbooks were reviewed, and several relevant organizations were visited to collect meteorological and hydrological data on the Sokoto-Rima basin. Available data are summarized in Tables 3-3.

They have been entered into the data-base constructed by JICA study team for the project. For detailed explanation about the data-base, the reader can refer to Chapter 5.

3-2 Hydrological Climate

The most reliable and complete data is obviously that gathered at the synoptic stations: Sokoto, Gusau and Katsina Aerodromes. Besides this, data at Yelwa Station is considered reliable, because the station is operated by the Nigerian Meteorological Service (NMS). These four stations were chosen as the basis for discussing the general climate conditions of the area.

Table 3-2 Specifications of Meteorological Stations

Station Type	STATION NAME	AGENCY	LATITUDE	LONGITUDE	EQUIPPED WITH								
					RAINGAGE	AEMOMETER	WIND VANE	EVAPO PAN	MAX. THERM	MIN THERM	WET BULB	DRY BULB	SUNSHINE RECORD
Synoptic	GUSAU AERODROME	1	12°10′ ″	06°42′ ″	○	○	○	○	○	○	○	○	○
	KATSINA AERODOME	1	13°01′ ″	07°41′ ″	○	○	○		○	○	○	○	○
	SOKOTO NEW AIRPORT	1	12°55′ ″	05°15′ ″	○	○	○	○	○	○	○	○	○
Agrometeorologic	I.R.S BAKURA	2	12°40′ ″	05°53′ ″	○		○	○	○	○	○	○	○
	KASARAWA	3	12°57′ ″	05°12′ ″	○				○	○	○	○	
	BIRNI-TUDU	4	12°40′ ″	06°01′ ″	○	○		○					
	DUTSIN-MA(ZOBE DAM)	5	12°24′ ″	07°30′ ″	○	○		○					○
	GALADI	5	13°02′50″	06°25′40″	○	○	○	○					○
	KAFINSOLI	6	12°32′ ″	07°45′ ″	○				○	○	○	○	
	MORIKI	5	12°53′ ″	06°28′ ″	○			○					
	ZURU	3			○				○	○	○	○	
Meteorologic	BATSARI	8	12°50′ ″	07°12′ ″	○			○					
	F.G.G.C BAKORI	8			○		○		○	○	○	○	
	AJIWA DAM	8	12°56′ ″	07°45′ ″	○	○		○	○	○	○	○	
	DAN MUSA	8	12°15′ ″	07°18′ ″	○			○	○	○	○	○	
	DAURA	8	13°02′ ″	08°17′ ″	○			○	○	○	○	○	
	DUTSIN-MA WATER WORKS	8	12°25′ ″	07°30′ ″	○	○		○	○	○	○	○	
	L.KALMALO	7	13°43′ ″	05°13′ ″	○	○	○	○	○	○	○	○	
	KATSINA T.C	8	13°00′ ″	07°37′ ″	○		○						
	MAIRUWA	10	11°38′ ″	07°14′ ″	○			○	○	○	○	○	
	SABON BIRNI J.P.S	11	13°43′ ″	06°20′ ″		○	○		○	○			
	GORONYO DAM	4	13°30′30″	05°53′20″	○	○	○	○	○	○			○
	YELWA	1	10°53′ ″	04°45′ ″	○	○	○	○	○	○	○	○	○

Abbreviation of Agency

1:Met. Service
2:Ahmadu Bello University
3:Ministry of Natural Resources
4:Impresit Bakolori
5:S.R.R.B.D.A.
6:Kaduna State Agric Dev. Project
7:F.D.W.R. / M.W.E.S.
8:K.S.W.B.
9:Geography Master
10:K.S.W.B. / S.R.R.B.D.A.
11:School Master

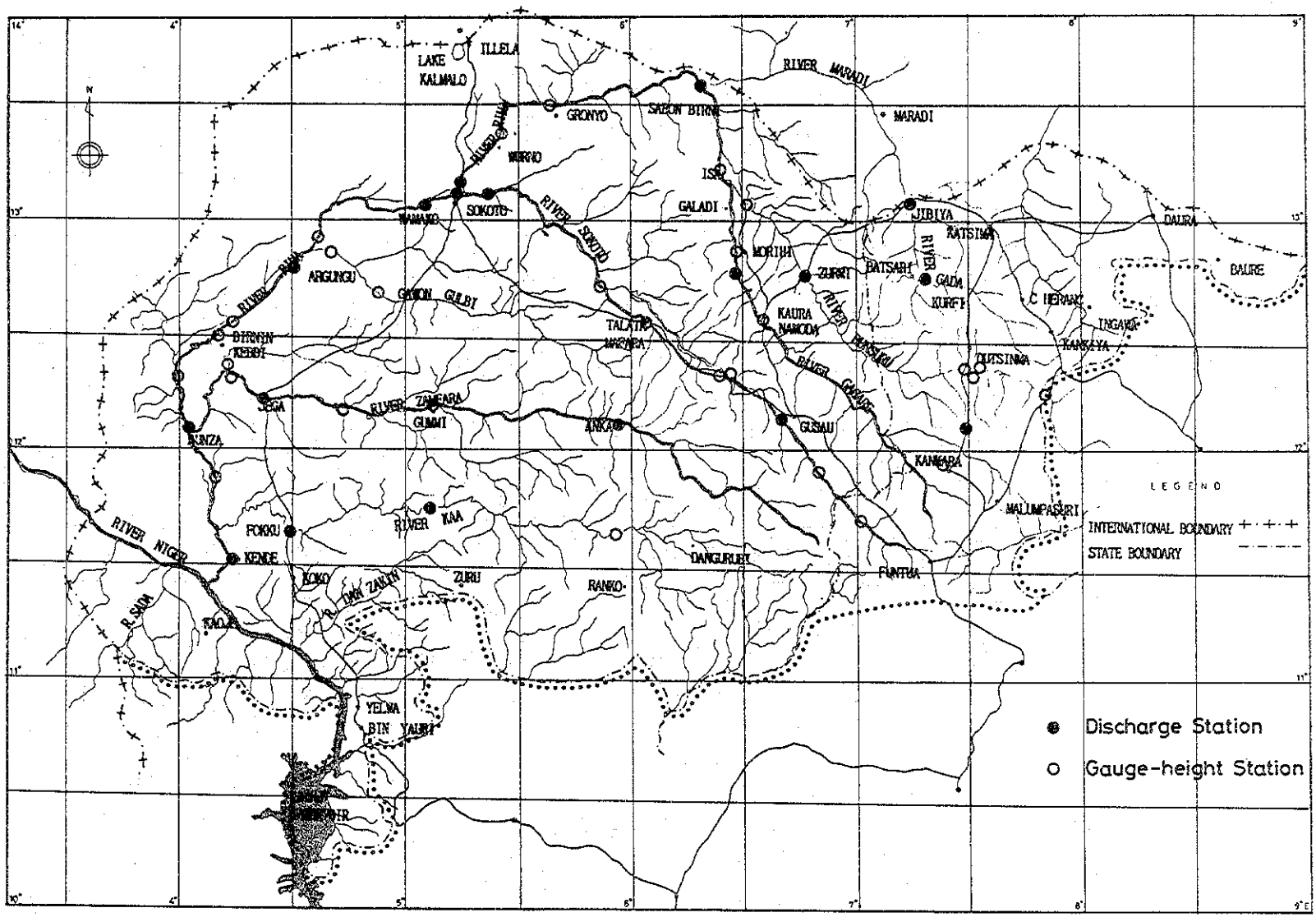


Fig. 3-2 Location Map of Hydrological Stations

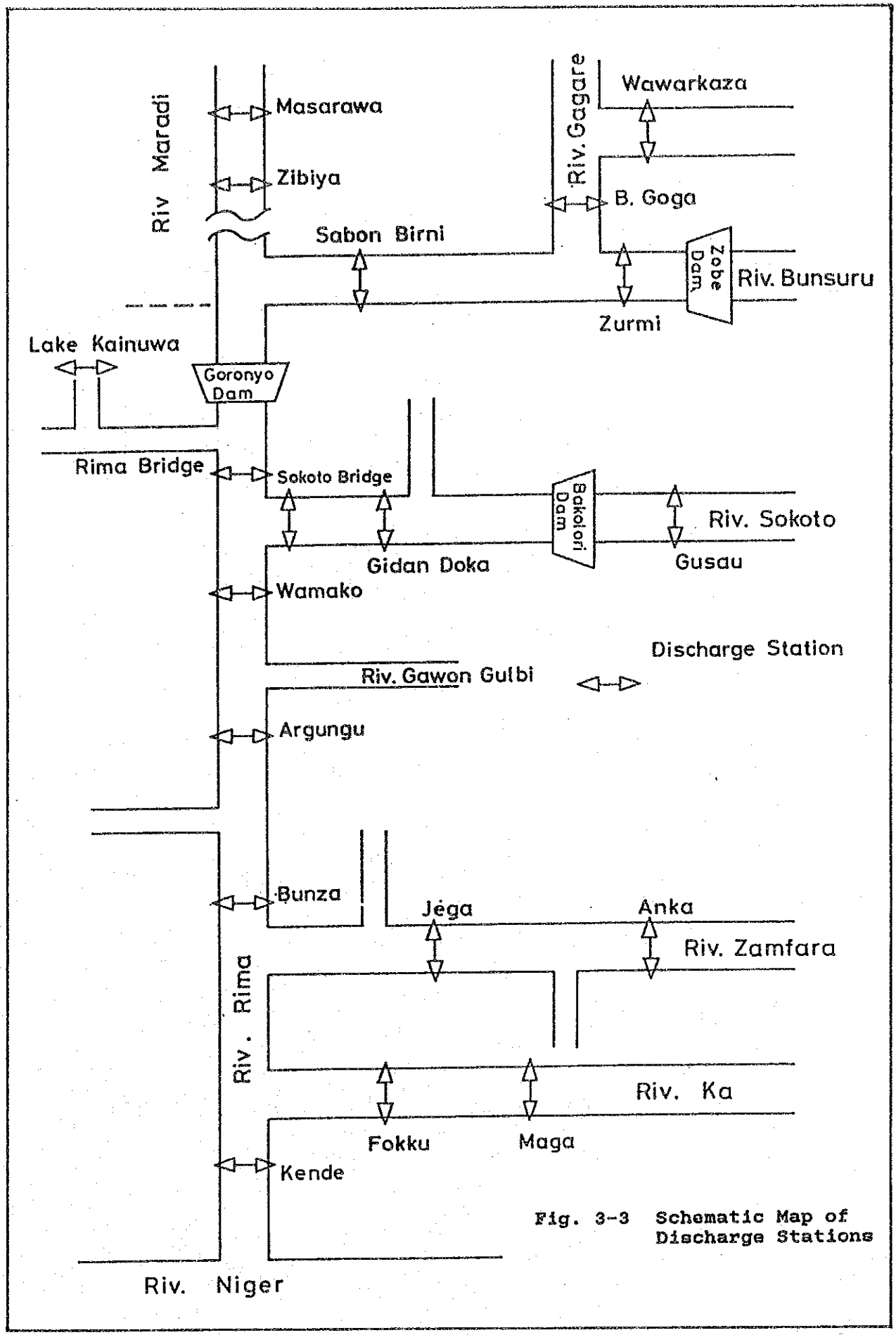


Fig. 3-3 Schematic Map of Discharge Stations

Table 3-3 (1) LIST OF METEOROLOGICAL AND HYDROLOGICAL DATA COLLECTED DURING THE STUDY

DATA ITEM	UNIT	STATION NAME	PERIOD DATA AVAILABLE
RAIN	DAY	ARGUNGU	1979-1979
RAIN	DAY	GUSAU	1962-1987
RAIN	DAY	KALMALO	1975-1975 1977-1986
RAIN	DAY	KATSINA	1965-1966 1968-1987
RAIN	DAY	KATSINA AJIWA	1979-1980
RAIN	DAY	SOKOTO	1955-1987
RAIN	DAY	YELWA	1965-1966 1968-1987
RAIN	MON	BAKORI L A SCHOOL	1951-1962 1966-1967
RAIN	MON	BAKURA	1950-1966 1968-1975 1977-1977
RAIN	MON	BATAGARAWA JNR PRY SCHOOL	1951-1962 1966-1966 1968-1969
RAIN	MON	BATSARI ELE SCHOOL	1950-1970 1973-1975
RAIN	MON	BICHI ELE SCHOOL	1950-1970 1972-1973 1976-1976
RAIN	MON	BINDAWA JNR PRY SCHOOL	1950-1962 1965-1969 1972-1975
RAIN	MON	BUNSURU AT ZURMI	1966-1975
RAIN	MON	CHAFE	1953-1954 1964-1966 1968-1972 1975-1975
RAIN	MON	CHERANCHI ELE SCHOOL	1950-1951 1953-1970 1975-1975
RAIN	MON	DAN MUSA EDUCATION OFFICE	1952-1961 1963-1967 1969-1970 1973-1975
RAIN	MON	DANKAMA ELE SCHOOL	1950-1965
RAIN	MON	DAUDAWA GOVT FARM	1944-1967 1970-1974
RAIN	MON	DAUDAWA JNR PRY SCHOOL	1950-1956 1958-1960 1962-1962 1964-1971 1973-1974 1978-1983
RAIN	MON	DAURA FARM CENTRE	1947-1952 1954-1966 1968-1975
RAIN	MON	DAURA JNR PRY SCHOOL	1950-1962
RAIN	MON	DAURA SNR PRY SCHOOL	1958-1966 1968-1970
RAIN	MON	DUTSI PRY SCHOOL	1951-1951 1953-1967 1971-1976
RAIN	MON	DUTSIN MA JNR PRY SCHOOL	1950-1967 1969-1971 1975-1975
RAIN	MON	FASKARI JNR PRY SCHOOL	1950-1954 1956-1964 1969-1969 1971-1971
RAIN	MON	FUNTUA C A P GINNERY	1951-1976
RAIN	MON	FUNTUA JNR PRY SCHOOL	1927-1927 1930-1944 1950-1966 1968-1970 1974-1977
RAIN	MON	GADA	1950-1953
RAIN	MON	GAFAI JNR PRY SCHOOL	1950-1955 1957-1961
RAIN	MON	GIDADO CENTRAL SCHOOL	1950-1970
RAIN	MON	GOBARAN JNR PRY SCHOOL	1950-1960 1962-1963
RAIN	MON	GORONYO	1961-1964 1966-1968
RAIN	MON	GORONYO DAM RAIN	1981-1983
RAIN	MON	GUSAU AERODROME	1952-1982
RAIN	MON	GUSAU AGRIC	1942-1973 1975-1975
RAIN	MON	GWADABAWA	1952-1957 1960-1968 1976-1979
RAIN	MON	ILLELA	1950-1951 1953-1966 1976-1978
RAIN	MON	INGAWA ELE SCHOOL	1950-1951 1953-1957 1960-1965 1967-1969 1973-1974 1976-1978
RAIN	MON	ISA PRY SCHOOL	1959-1976
RAIN	MON	ISAGERO ELE SCHOOL	1950-1969 1971-1975
RAIN	MON	JIBIYA JNR PRY SCHOOL	1950-1960 1962-1964 1968-1968
RAIN	MON	KADANDANI	1963-1970
RAIN	MON	KAFINSOLT AGRIC STATION	1934-1937 1939-1966 1969-1972 1975-1980
RAIN	MON	KAITZ ELE SCHOOL	1950-1965 1967-1968 1973-1975
RAIN	MON	KANKARA ELE SCHOOL	1950-1962 1964-1971
RAIN	MON	KANKIYA PRY SCHOOL	1950-1960 1962-1971 1973-1975
RAIN	MON	KASARAWA	1952-1973
RAIN	MON	KATSINA AERODROME	1922-1946 1949-1982
RAIN	MON	KATSINA TRAINING COLLEGE	1963-1965 1967-1969 1975-1977

Table 3-3 (2) LIST OF METEOROLOGICAL AND HYDROLOGICAL DATA COLLECTED DURING THE STUDY

DATA ITEM	UNIT	STATION NAME	PERIOD DATA AVAILABLE
RAIN	MON	KAURA NAMODA D D	1946-1946 1953-1953 1955-1972 1974-1975
RAIN	MON	KETARE JNR PRY SCHOOL	1950-1960 1962-1962 1965-1969 1973-1975
RAIN	MON	KIRA JNR DRY SCHOOL	1958-1960 1962-1963 1967-1975
RAIN	MON	KOTORKOSHI AGRIC	1956-1966 1970-1975
RAIN	MON	KURFI EDUCATION OFFICE	1952-1962 1967-1967 1969-1972
RAIN	MON	KUSADA ELE SCHOOL	1950-1961 1963-1963 1965-1969 1972-1975
RAIN	MON	KWARE	1947-1968
RAIN	MON	MAI INCHI	1952-1969
RAIN	MON	MAIDUWA ELE SCHOOL	1950-1965
RAIN	MON	MALLAMAWA JNR PRY SCHOOL	1963-1974
RAIN	MON	MALUMFASHI JNR PRY SCHOOL	1927-1927 1931-1938 1950-1969 1978-1979 1981-1982
RAIN	MON	MANI ELE SCHOOL	1950-1969
RAIN	MON	MARU T T C	1952-1956 1960-1969 1971-1972
RAIN	MON	MASHI ELE SCHOOL	1950-1955 1957-1957 1959-1960 1963-1963 1965-1965 1967-1967 1969-1971
RAIN	MON	MATAZU JNR PRY SCHOOL	1950-1965 1967-1969 1971-1974
RAIN	MON	MORIKI	1927-1927 1930-1940 1953-1955 1957-1958 1961-1976
RAIN	MON	MUSAWA L A SCHOOL	1950-1958 1960-1963 1967-1970 1972-1973 1975-1975
RAIN	MON	RAFINDADI SCHOOL	1950-1955 1962-1962
RAIN	MON	RIMI JNR PRY SCHOOL	1950-1962 1964-1969
RAIN	MON	SABON BIRNI	1962-1972
RAIN	MON	SAFANA JNR PRY SCHOOL	1950-1963 1966-1967 1969-1969
RAIN	MON	SHINKAFE	1958-1963 1966-1977
RAIN	MON	SHINKAFE N T C	1962-1967 1969-1975
RAIN	MON	SOKOTO AERODROME	1910-1948 1950-1982
RAIN	MON	SOKOTO AT GUSAU	1961-1975
RAIN	MON	SOKOTO FORESTRY DEPARTMENT	1952-1966 1968-1981
RAIN	MON	SOKOTO GAGE BLUFF	1952-1963 1965-1966 1968-1976 1980-1981
RAIN	MON	TALATA MAFARA C M C	1956-1964 1966-1968
RAIN	MON	TALATA MAFARA D C	1953-1965 1967-1970
RAIN	MON	TANGAZA	1952-1963 1965-1965 1967-1967
RAIN	MON	TURETTA	1951-1951 1953-1960
RAIN	MON	WURNO	1957-1959 1964-1968
RAIN	MON	YANDAKI JNR PRY SCHOOL	1955-1962 1964-1965 1969-1969
RAIN	MON	YELWA	1965-1987
RAIN	MON	ZANGO ELE SCHOOL	1950-1969 1971-1972

Table 3-3 (3) LIST OF METEOROLOGICAL AND HYDROLOGICAL DATA COLLECTED DURING THE STUDY

DATA ITEM	UNIT	STATION NAME	PERIOD DATA AVAILABLE
MAX. TEMP	MON	GORONYO DAM	1981-1983
MAX. TEMP	MON	GUSAU	1952-1985
MAX. TEMP	MON	KATSINA	1941-1946 1949-1966 1968-1984
MAX. TEMP	MON	KATSINA AJIWA	1978-1980
MAX. TEMP	MON	SOKOTO	1943-1984
MAX. TEMP	MON	YELWA	1943-1966 1968-1984
MIN. TEMP	MON	GORONYO DAM	1981-1983
MIN. TEMP	MON	GUSAU	1952-1985
MIN. TEMP	MON	KATSINA	1941-1946 1949-1966 1968-1984
MIN. TEMP	MON	KATSINA AJIWA	1978-1980
MIN. TEMP	MON	SOKOTO	1943-1984
MIN. TEMP	MON	YELWA	1943-1966 1968-1978 1980-1984
EVAPORATION	DAY	KATSINA	1969-1971
EVAPORATION	DAY	ZOBE DAM	1985-1987
EVAPORATION	MON	GORONYO DAM	1981-1983
EVAPORATION	MON	GUSAU	1963-1965 1967-1985
EVAPORATION	MON	KATSINA AJIWA	1978-1980
EVAPORATION	MON	SOKOTO	1962-1978 1980-1984
EVAPORATION	MON	YELWA	1960-1966 1968-1981 1983-1984
MAX. HUMID	MON	GORONYO DAM	1981-1983
MAX. HUMID	MON	KATSINA AJIWA	1978-1980
MIN. HUMID	MON	GORONYO DAM	1981-1983
MIN. HUMID	MON	KATSINA AJIWA	1978-1980
0900 HUMID	MON	GUSAU	1962-1985
0900 HUMID	MON	KATSINA	1951-1966 1968-1980
0900 HUMID	MON	SOKOTO	1966-1983 1987-1987
0900 HUMID	MON	YELWA	1951-1966 1968-1976
1500 HUMID	MON	KATSINA	1951-1966 1968-1980
1500 HUMID	MON	SOKOTO	1951-1980
1500 HUMID	MON	YELWA	1951-1966 1968-1976
MAX. WIND	MON	GORONYO DAM	1981-1983
MIN. WIND	MON	GORONYO DAM	1981-1983
AVE. WIND	MON	KATSINA AJIWA	1978-1980
SUNSHINE	MON	GUSAU	1982-1982 1985-1985
SUNSHINE	MON	KATSINA	1966-1966 1971-1980 1983-1985
SUNSHINE	MON	YELWA	1966-1966 1971-1979 1981-1984

Table 3-3 (4) LIST OF METEOROLOGICAL AND HYDROLOGICAL DATA COLLECTED DURING THE STUDY

DATA ITEM	UNIT	STATION NAME	PERIOD DATA AVAILABLE
DISCHARGE	DAY	RIVER BUNSURU AT ZOBE	1977-1977
DISCHARGE	DAY	RIVER BUNSURU AT ZURMI	1968-1977
DISCHARGE	DAY	RIVER GADA AT NASARAWA ML21	1969-1969
DISCHARGE	DAY	RIVER GAWON AT SAINYINAN DAJI	1968-1968
DISCHARGE	DAY	RIVER KA AT FOKKU	1968-1968
DISCHARGE	DAY	RIVER KARADUWA AT ML G5	1972-1976 1978-1978 1980-1983
DISCHARGE	DAY	RIVER KARADUWA AT ZOBE DAM	1985-1987
DISCHARGE	DAY	RIVER MARADI AT JIBIYA	1972-1977 1979-1980
DISCHARGE	DAY	RIVER MARADI AT NASARAWA KM 30	1972-1975
DISCHARGE	DAY	RIVER RIMA AT ARGUNGU	1968-1968
DISCHARGE	DAY	RIVER RIMA AT SABON BIRNI	1962-1970
DISCHARGE	DAY	RIVER RIMA AT WAMAKO	1962-1971
DISCHARGE	DAY	RIVER SHELLA AT KALGO	1968-1968
DISCHARGE	DAY	RIVER SHINACHE AT MALUMFASHI	1978-1983
DISCHARGE	DAY	RIVER SOKOTO AT BAKOLORI	1964-1967
DISCHARGE	DAY	RIVER SOKOTO AT GIDAN DOKA	1962-1971
DISCHARGE	DAY	RIVER SOKOTO AT GUSAU	1969-1973 1975-1977
DISCHARGE	DAY	RIVER SOKOTO AT TALATA MAFARA	1984-1987
DISCHARGE	DAY	RIVER TURAME AT WAWAKAZA	1978-1983
DISCHARGE	DAY	RIVER ZAMFARA AT ANKA	1968-1968
DISCHARGE	DAY	RIVER ZAMFARA AT KALGO	1968-1968

3-2-1 Precipitation

Annual precipitation at Sokoto Aerodrome from 1955 to 1987 is given in Fig. 3-4 and Table 3-4. Average precipitation during the period was 632mm/year. The wettest year was 1965, when annual precipitation was 974mm. The driest year was 1987, with only 325mm of precipitation. A series of dry years lasted through the late sixties and early seventies after a series of wet years in the early sixties. A similar condition resumed from the late seventies into the eighties.

The monthly average precipitation from 1969 to 1987 from Sokoto, Yelwa, Katsina, and Gusau is given in Fig. 3-5 and Table 3-5. Each location has a very similar monthly change in precipitation. The driest place is Katsina, having 536mm. This great difference in annual precipitation (nearly 400mm) is probably caused by a regional change in climate conditions. Fig. 3-6 is an iso annual precipitation map drawn from average annual precipitations from 1953 to 1957.

3-2-2 Temperature

The average daily minimum and maximum temperature at Sokoto Aerodrome from 1955 to 1982 are given in Fig. 3-4 and Table 3-4. The average daily minimum and maximum temperatures throughout the period were 21.2°C and 34.8°C, respectively. Changes in the average daily maximum temperature are not seen over the course of time, though the average daily minimum temperature has been increasing slightly.

The average daily minimum and maximum temperatures by month, from 1952 to 1984, are given in Fig. 3-6 and Table 3-6, and in Fig.3-7 and Table 3-7, respectively.

The maximum average daily temperature is the lowest in January, during the dry season, and August, the wettest month. The minimum average daily temperature, on the other hand, is the lowest only during the dry season. Changes of temperature at each station are quite similar. The hottest area is around Sokoto, which has average minimum temperature of 21.1°C and 34.8°C respectively. The coolest place is Katsina, which has average minimum and maximum temperature of 19.3°C and 33.3°C respectively.

TABEL3-4 METEOROLOGICAL DATA FROM SOKOTO

UNIT:mm/year ℃

	PREP.	TEMP MAX	TEMP MIN
1955	708.9	33.4	20.1
1956	707.4	34.7	20.7
1957	880.6	34.3	20.3
1958	887.7	35.0	20.7
1959	561.1	35.0	20.6
1960	894.8	34.6	20.7
1961	640.6	34.0	20.0
1962	672.1	35.2	21.5
1963	792.5	35.5	21.5
1964	729.2	34.9	20.7
1965	973.6	34.8	20.2
1966	648.2		
1967	586.7	34.3	20.9
1968	488.7	35.0	20.5
1969	629.9	35.4	22.0
1970	629.4		20.7
1971	483.6	35.2	21.3
1972	547.6	35.3	21.8
1973	388.1	36.2	22.6
1974	472.9		21.7
1975	558.3	34.5	21.3
1976	850.4	34.7	21.6
1977	812.0	34.7	21.0
1978	712.6	34.7	21.7
1979	595.6	35.3	21.5
1980	557.5	35.1	21.7
1981	556.9	34.0	21.7
1982	568.8	34.3	
1983	620.7		
1984	466.8		
1985	434.8		
1986	475.8		
1987	324.5		

TABEL 3-5 AVERAGE MONTHLY PRECIPITATION (1969-1987)

(UNIT:mm)

	SOKOTO	YELWA	KATSINA	GUSAU
1	0	0	0	0
2	0	0	0	0
3	2	14	1	3
4	3	30	2	21
5	35	90	27	72
6	76	127	63	109
7	155	205	161	196
8	191	229	186	240
9	85	175	87	168
10	14	44	9	21
11	0	1	0	0
12	0	0	0	0
TOTAL	561	915	536	830

TABEL 3-6 AVERAGE DAILY MAXIMUM TEMPERATURE (1952-1984)

(UNIT:°C)

	SOKOTO	YELWA	KATSINA	GUSAU
1	32.4	35.1	29.1	31.6
2	35.5	37.3	32.7	34.7
3	38.6	38.6	36.3	37.7
4	40.1	37.9	38.7	38.6
5	38.4	34.9	37.6	36.3
6	35.6	32.5	35.2	33.1
7	32.1	30.4	31.4	30.3
8	30.5	29.8	29.9	29.3
9	32.3	30.7	31.9	31.1
10	35.1	33.0	34.5	33.8
11	34.6	35.9	32.7	34.0
12	32.8	35.2	30.3	32.2
AVERAGE	34.8	34.2	33.3	33.6

TABEL 3-7 AVERAGE DAILY MINIMUM TEMPERATURE (1952-1984)

(UNIT:°C)

	SOKOTO	YELWA	KATSINA	GUSAU
1	15.7	15.7	12.1	14.4
2	18.0	19.0	14.9	16.9
3	21.9	23.8	19.4	20.7
4	25.5	26.3	23.5	23.8
5	26.1	25.3	24.8	23.8
6	24.3	23.5	23.2	22.0
7	22.6	22.9	21.6	21.1
8	22.0	22.5	20.9	20.8
9	22.1	22.2	21.3	20.4
10	21.7	21.9	19.8	19.0
11	18.4	17.2	15.5	15.2
12	15.9	14.6	14.6	14.1
AVERAGE	21.1	21.2	19.3	19.4

Fig. 3-4 Meteorological Data from Sokoto

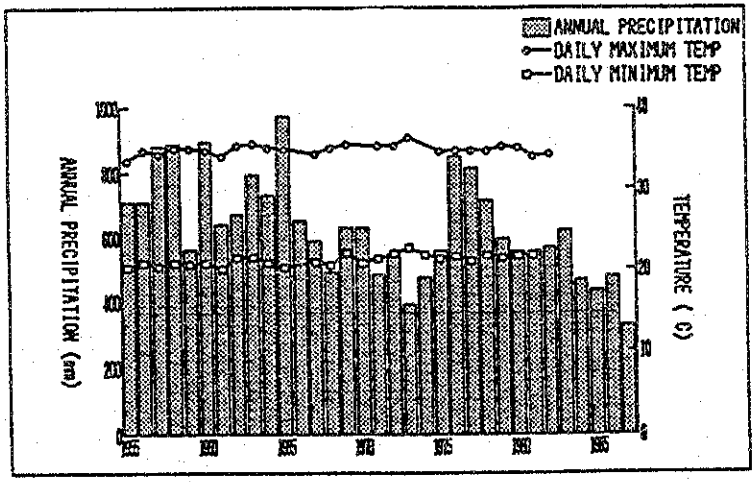


Fig. 3-5 Average Monthly Precipitation (1969 - 1987)

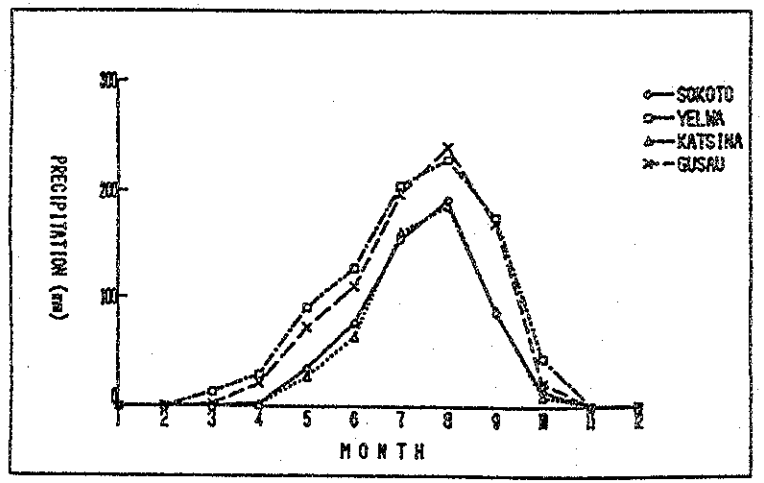


Fig. 3-7 Average Daily Maximum Temperature (1952 - 1984)

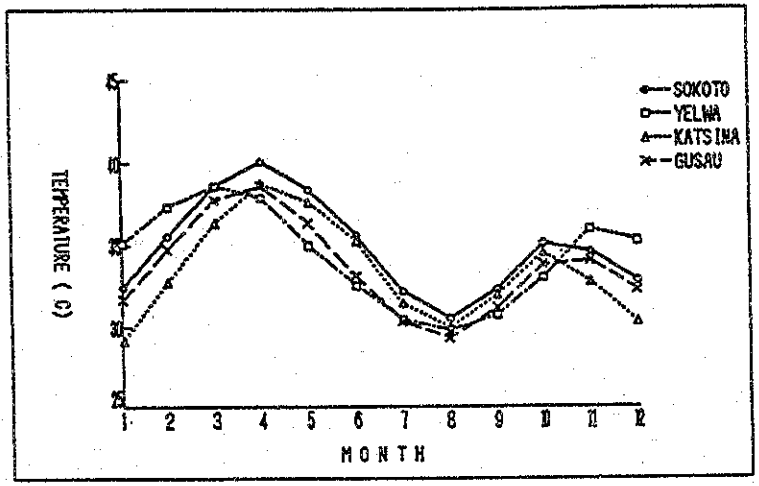
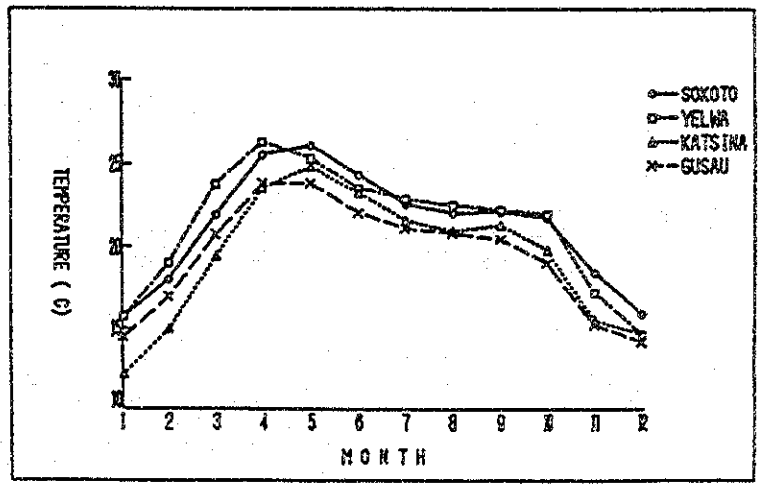


Fig. 3-8 Average Daily Minimum Temperature (1952 - 1984)



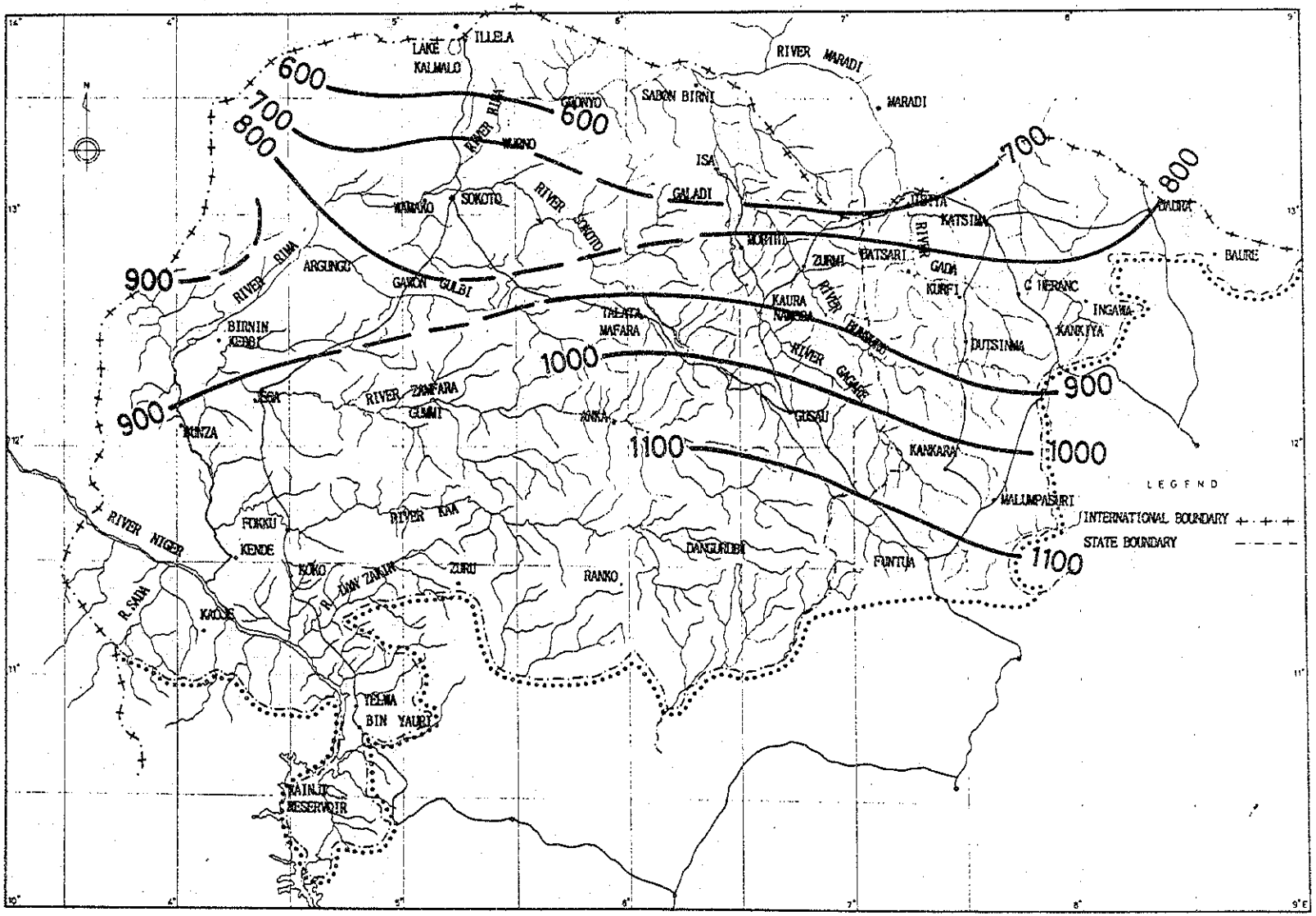


Fig. 3-6 Iso Annual Precipitation Map (mm/year)

3-2-3 Evaporation

The annual total evaporation at Katsina, Gusau, Sokoto, and Yelwa are given in Table 3-8 and Fig. 3-9. Potential evapotranspiration calculated by the Thornthwaite empirical formula and annual precipitation at each station are shown in the Table. Evaporation and potential evapotranspiration are both sometimes greater than precipitation observed at the same point. Although they do not represent an actual volume of water withdrawn as evapotranspiration, it appears that most of the water supplied by precipitation is lost to evapotranspiration.

3-3 Discharge Observation

Discharge observation at some hydrological stations was carried out monthly.

The purpose of discharge observation is to determine river flow at hydrologically important points along the main river. River flow is the basic data in investigating the feature of water balance, especially in regards to circulation between shallow groundwater and surface water. River flow is known directly from the results of observation. It can also be determined from the water level recorded by a gauge reader by using a rating curve. All of the points selected for discharge observation have had published rating curves.

However, the curves are not adequate for application to recent river conditions, because significant changes of river bed morphology caused by high annual sedimentation are believed to have taken place after the establishment of the curves.

New rating curves will be established after gathering sufficient discharge data.

3-3-1 Field measurements

Four discharge stations were chosen as observation points.

1. Kainuwa at Lake Kainuwa
2. Argungu on the Rima River

Tab. 3-8 ANNUAL EVAPORATION AND POTENTIAL EVAPOTRANSPIRATION
A: EVAPORATION B: POTENTIAL EVAPOTRANSPIRATION (THORNTHWAITE FORMULA)
C: PRECIPITATION (UNIT : MM/YEAR)

	KATSINA AERODROME			GUSAU AERODROME			SOKOTO AERODROME			YELWA MET. STA.		
YEAR	A	B	C	A	B	C	A	B	C	A	B	C
1960	4341.2	1481.0	702.0	3828.1	1549.3	908.0	4960.7	1689.6	873.0	2682.0	1737.9	
1961	4727.3	1329.3	771.0	3897.7	1455.2	851.0	5195.9	1590.3	641.0	2710.2	1672.7	
1962	4533.0	1513.3	691.0	3708.6	1547.2		4939.4	1773.7	671.0	2887.7	1712.1	
1963	4455.0	1549.9	785.0	3584.7	1585.6	1121.0	4791.2	1770.5	793.0	2872.2	1733.4	
1964	4385.2	1452.0	995.0	3820.6	1522.7	899.0	4288.0	1694.6	729.0	2844.5	1737.4	
1965	4420.2	1470.2	738.0	4043.0	1512.0	826.0	4939.5	1664.4	974.0	2934.7	1730.4	979.0
1966	3652.3			3138.3		947.0	4473.0					675.0
1967	4730.4			4064.7	1534.6	911.0	2760.8	1673.4	586.0			
1968	4342.2			3731.1	1573.4	1016.0	4471.9	1747.9	487.0			
1969	4624.8	1571.4	450.0	3973.9	1573.0	938.0	3638.6	1810.9			1735.7	1048.0
1970	4823.6	1468.7	672.0	4309.9	1546.7	833.0	3946.2		632.0	3163.5		981.0
1971	4972.1	1444.4	489.0	4220.5	1521.0	809.0	5234.9	1726.7	485.0	3310.5	1670.8	991.0
1972	4469.4	1561.5	474.0	4068.9	1633.1	741.0	4114.7	1790.1	547.0		1741.0	928.0
1973	4955.0	1616.4	442.0	4511.0	1692.0	722.0	4561.8	1870.9	389.0		1805.9	811.0
1974	4531.9	1478.2	630.0	4125.8	1533.2	852.0	4172.3		473.0	3627.3	1679.9	1077.0
1975	4307.5	1533.3	557.0	3921.5		866.0	3965.7	1706.8	557.0		1663.4	974.0
1976	4433.1	1599.9	568.0	4035.8		885.0	4085.9	1767.5	870.0		1704.2	872.0
1977	4335.2	1521.8	597.0	3946.7	1533.6	766.0	5289.1	1688.2	812.0	2800.9	1736.2	864.0
1978	4349.3	1543.0	527.0	3332.5	1548.6	1013.0	4172.9	1761.5	688.0	3156.9	1733.4	884.0
1979	4373.7	1606.7	775.0	2992.3		1105.0	3746.9	1775.7	595.0			1014.0
1980	2670.3	1590.2	773.0	2270.8	1608.0	896.0	2843.5	1782.0	557.0	2918.3	1812.0	882.0
1981	4322.4	1538.0	556.0	3675.7	1555.7	787.0	4602.7	1751.2	556.0		1783.7	896.0
1982	4525.5	1586.3	496.0	3848.4	1553.9	720.0	4819.0		568.0		1730.3	1073.0
1983	4677.6	1593.6	424.0	3977.7	1485.6	846.0	4980.0		621.0	2809.0		584.0
AVER	4414.9	1526.1	624.4	3792.8	1553.2	880.8	4374.8	1738.7	641.1	2978.3	1728.9	913.7