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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
FEDERAL MINISTRY OF WATER RESOURCES  
AND RURAL DEVELOPMENT  
FEDERAL REPUBLIC OF NIGERIA

# THE STUDY ON THE NATIONAL WATER RESOURCES MASTER PLAN (NWRMP)

SECTOR REPORT

VOLUME TWO

PART 1

MARCH 1995

SANYU CONSULTANTS INC.  
SUMIKO CONSULTANTS CO., LTD.

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## COMPOSITION OF THE REPORT

The Draft Final Report on the Study on the National Water Resources Master Plan (NWRMP) for the Federal Ministry of Water Resources and Rural Development in the Federal Republic of Nigeria comprises the following volumes:

- Volume One : SUMMARY AND MAIN TEXT
- Volume Two : SECTOR REPORT

This contains 12 Chapters, each of which has been presented in an independent manner for the sub-sector designated compiling all the requirements concerned, while major findings and recommendation of each sub-sector along with inter-sub-sectoral relations and basin-wide considerations are summarized in Volume 1:

CHAPTER 1. NWRIS and SIA	Part 1
CHAPTER 2. Socio-Economy and Land Use	
CHAPTER 3. Water Resources and Management	
CHAPTER 4. Water Source Works	
CHAPTER 5. Irrigation and Drainage	
CHAPTER 6. Water Supply and Sanitation	Part 2
CHAPTER 7. Gully Erosion and Flood Control	
CHAPTER 8. Hydropower Generation	
CHAPTER 9. Inland Navigation	
CHAPTER 10. Inland Fisheries	
CHAPTER 11. Environmental Management	
CHAPTER 12. Institution and Legislation	

- Volume Three : WATER RESOURCES INVENTORY SURVEY
- Volume Four : WATER RESOURCES DATABASE MAPS
- Volume Five : SATELLITE IMAGE ANALYSIS

**This is Volume Two: SECTOR REPORT - Part 1**

It may be noted that all the findings and recommendation contained in this Report are those made by the Study Team with the members of Sanyu Consultants Inc. and Sumiko Consultants Co., Ltd. and do not imply any authorization by the Japan International Cooperation Agency or the Government of Japan.

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# CHAPTER 1: NWRIS AND SIA

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## **CHAPTER 1. NWRIS AND SIA**

### **1.1 NWRIS, 1992/93**

#### **1.1.1 Needs of a Large-Scale Survey**

The Field Work (I) of the Phase I Study (April 24 to May 13, 1992 in Abuja) clarified that the foundation of the data collection and accumulation with respect to the nation's water resources, existing development and its future potential under the overall management of the Water Resources Sector of FMWRRD were insufficient in total. And, the subsequent Home Work (I) identified in great extent the development of the water resources and related works as directly managed by the Federal and State agencies such as RBDAs, SIDs, State ADPs, SWAs and others as well as other water related agencies like FIWD, NEPA; consequently, JICA formulated the special implementing program for National Water Resources Inventory Survey (NWRIS) in a comprehensive manner and entrusted to six capable domestic consultant firms to carry out the survey during the course of Field Work(II).

#### **1.1.2 Scope of NWRIS**

The NWRIS, as the first step of the Study, was carried out to identify the problems for water use and the needs for water resources development and management in order to facilitate the project identification and preparation under successive medium- and short-term development plan of the country. Virtually, this survey was contemplated to be implemented in a form of the joint work with FMWRRD, JICA Team and domestic consultant firms; however, due to the lack of manpower in the FMWRRD and the limited number of experts in the JICA Team, majority of this Survey was entrusted to the domestic firms.

More particularly, the NWRIS entrusted to the consultant firms composed of two major items:

- to identify the actual status of water resources utilization as well as the regional needs, importance and problems for water resources development on medium and long-term basis.
- to survey the current dimensions of facilities, actual status of management and operation, and related problems with respect to irrigation, domestic and industrial water supply, hydropower, inland navigation, flood protection and others.

Aside from one consultant firm for Nationwide Socio-Economic Survey, the division of the country into five regions (NW, NE, SW, SC & SE) for the specific Technical Survey by different consultant firms was imperative as the data collection and collation had to be completed within a short period of time. The survey sector as specified in the Terms of Reference (TOR) are as given below, and a full text of the TOR is provided under Appendix 1-1:

- Nationwide Socio-Economic Inventory Survey
  - N-1 = General Socio-Economy
  - N-2 = Land Use
  - N-3 = Urban and Regional Development
  - N-4 = Hydropower Generation
  - N-5 = Inland Navigation
  - N-6 = River Basin Environment
- Regional Technical Inventory Survey
  - R-1 = Hydrology
  - R-2 = Deep Wells
  - R-3 = Water Sources
  - R-4 = Agriculture and Irrigation
  - R-5 = Water Supply and Sanitation
  - R-6 = Watershed and River Management
  - R-7 = Inland Fisheries

### 1. 1. 3 Implementation of NWRIS

The JICA's invitation documents dated August 25, 1992 were issued to eight domestic consultant firms to receive proposals in the form of "two envelop", and after evaluation and subsequent negotiations, the contracts with the following six firms were concluded on September 28, 1992 with the survey period of October 1992 through end of January 1993:



- Nationwide Socio-Economic Inventory Survey
  - Skoup & Co., Ltd., Enugu
- Regional Technical Inventory Survey
  - Enplan Group, Lagos for Northwest Region
  - Water and Dam Services Company, Lagos for Northeast Region
  - De-Crown West Africa Co., Ltd., Ibadan for Southwest Region
  - Isu Associates NIG. Ltd., Enugu for South-Central Region
  - T.C. International Associates, Ibadan later Kaduna for Southeast Region

The above-mentioned approach to the Technical Inventory Survey by dividing the country into five regions by different consultants firms as well as allocating the entire survey into one Nationwide Socio-Economic and five Technical, brought forth the need for well organized overall coordination work by the Study Team. A series of consultations were held in a form of joint workshop and through several meetings between the JICA Team and plural domestic consultant firms with a view to quickly discuss and resolve any areas of doubt to ensure quality survey. The overall coordinating work included the followings:

- ensuring proper understandings of the objectives and the approach to the NWRIS, and in ascertaining that the formats would elicit fully the information and data required by the TOR ensuring uniformity in the interpretation and adaptation of results affected by local situations, after examining the consultants' comments and alternatives.
- coordinating the format of the reports so as to facilitate consolidation of the consultants' outcomes.
- monitoring the quality of the field work and the timely implementation of the Survey as a whole through frequent site visits by the JICA Team members.

The JICA Team held joint workshop three times; (1) September 28 in Lagos, (2) November 4 and 5 in Abuja and (3) December 10 in Abuja, while each of the JICA Team members undertook individual coordination work in the respective consultant's work offices in Enugu, Lagos, Ibadan, Jibiya and Yola during the course of the field programs.

All six firms commenced their services in the beginning of October 1992, and submitted the First Progress Report in the beginning of December 1992 in line with the Contract which contained a few inventory outputs; however, the following facts had been revealed gradually:

- The most notable problem was related to the reluctance on part of the Government officials to release the data and information even with the Letter of Authority from the FMWRRD. It was said that tremendous time and effort by the consultant experts were devoted in visiting the officials concerned repeatedly to persuade them to avail the data and information, and also even when released, the procedures to procure them were cumbersome, time-consuming and expensive.
- Most of the data collection bodies are the Government agencies with the budget provided for a number of the projects and related activities. Under the financial constraints with the reduction in budget allocation, these agencies made use of the data collection and management funds for other noticeable projects; consequently these agencies have been unable to function properly for data collection.
- The consultants explained that one of the most apparent unexpected facts for the NWRIS was the negative attitude of some officials of the Government agencies. This might be a result of frustration and many other factors due to:
  - Lack of encouragement by the agency.
  - Lack of facilities such as vehicles and equipment.
  - Lack of maintenance and repair for related equipment.
  - Inadequacy and non-education of the data collection staff.
- The data procured varied in their degree of reliability, and much of the confirmatory checks and site visits were necessary. The records kept in most cases were not up-to-date, and most of the data were in their raw state. The data collected were usually incomplete and often lack of important parameters which made them inadequate for any meaningful use, and a high percentage of them were inconsistent and unreliable. The information on data item for the same parameters varied from agency to agency, and in most cases the data collected were questionable, so that the consultant experts had often been forced to extract the information by questioning the officials and by other scientific methods.

In addition to this adverse condition, the Survey encountered the long Christmas - New Year holiday which greatly hindered its progress, and it was judged impractical and meaningless to receive the Second Progress Report in the beginning of January 1993 in line with the Contract particularly for the Regional Technical Inventory Survey. The JICA Team suggested an alternative to submit the Second Progress / Draft Final Report by the end of January 1993. For the reports where there were many formats partially filled were discussed with the respective consultant firms during the period of February 9 to 19, 1993; as a result, the JICA Team had issued the following general comments in addition to the specific ones for each survey item to five consultant firms:

- A final report should form the basis for all analyses, evaluation and recommendations to be made through subsequent studies to be carried out by the JICA Team.
- The data entries and related quality so far examined have given the JICA Team serious concern for utility in these future analyses.
- There are many instances where individual data entries in the designated forms are inconsistent, inaccurate, or simply unbelievable. Although the time was pressing, there appears to be serious deficiency on the part of the consultant firm in checking their data for accuracy and usability prior to submittal.

Under this situation, it was rescheduled that aside from Skoup & Co. Ltd. for the Nationwide Socio-Economic Survey who submitted the Final Report on February 24, 1993 and the Addendum to Final Report on February 25, 1993, each consultant firm for the Regional Technical Survey was requested to submit an advance copy of the final report by the end of February for JICA's concurrence prior to the finalization of the Final Report.

#### **1.1.4 Final Reports**

The Final Reports for the Regional Technical Survey in 15 copies were submitted by March 18, 1993 which was the departure date of the JICA Team from Nigeria after completing the Field Work (II), while 10 copies of the said reports were delivered to the FMWRRD for their immediate review and future reference. List of such Final Reports are given below:

- **Nationwide Socio-Economic Inventory Survey**
  - **Skoup & Co., Ltd., Enugu**  
Final Report, Addendum to Final Report, and Base Maps
- **Regional Technical Inventory Survey**
  - **Enplan Group for the Northwest Region**  
Vol. I: The Main Report, Vol. II: The Forms, Vol. III: The Appendices (I to XIV), and Vol. IV: The Album of Drawings
  - **Water & Dam Services Company for the Northeast Region**  
Vol. I: Main Report, Vol. II: Data Forms, and Vol. III: Base Maps
  - **De-Crown West Africa Co., Ltd. for the Southwest Region**  
Vol. I: Final Report, Vol. II: Inventory Forms, and Base Maps
  - **Isu Associates NIG Ltd. for the South-Central Region**  
Vol. I: Main Report, Vol. II: Result Presentation, and Vol. III: Drawings to Main Report
  - **T.C. International Associates for the Southeast Region**  
Vol. I: Main Report, Vol. II: Data Forms, and Vol. III: Maps

In the beginning of the Home Work (II), thorough checking of all of the data compiled in these Final Reports was made for accuracy, consistency and usability for compilation of the Interim Report, and those data thus processed were subsequently incorporated in its Vol. III: "Database Summary" and Vol. IV: "Database Maps". It may be stressed that although slightly improved, there were still many problem areas inclusive of questionable and ambiguity ones.

#### **1. 1. 5 Subsequent Modifications and Implications**

Throughout the period of the Field Work (III), the Interim Report was fully discussed with and elaborately examined by the Government agencies concerned in the occasion of the National Workshop for NWRMP Study held on 7 to 9 December 1993 in general, and its Vols. Three & Four were particularly examined by the RBDAs and State agencies for the data relevant to their territory when the JICA Team members visited them for the field investigation. All of their comments on the NWRIS inclusive of full correction

and additional information as well as the field findings by the JICA members have been incorporated into the final compilation of Vol. Three: "Water Resources Inventory Summary" and Vol. Four: "Water Resources Database Maps" of this Report.

In conclusion, the JICA Team's future implications on the NWRIS are as follows:

- It may be reviewed that the implementation of the JICA - assisted NWRIS encountered serious setbacks militating proper assessment, planning and development of the nation's water resources, although the NWRIS was an important pre-requisite towards the preparation of the NWRMP.
- A major significance of the NWRIS undertaking was also to produce a massive amount of data required for an action program of the FMWRRD. Although there is insufficient foundation to prepare the baseline data, the NWRIS provides an excellent reservoir of the available knowledge on all matters related to water resources development and management. Since those data would serve a general purpose, an important follow-up activities should involve the collation of massive data nationwide, and checking and processing those as necessary. The data collated, checked and processed should be subsequently kept in the FMWRRD Data Bank for easy retrieval.
- The implications of the NWRIS are the awareness that it has brought about to the need to maintain proper record and information on all parameters of water resources activities. It is necessary to consolidate the gains of NWRIS by a continuous updating of the data and filling of gaps when data become available. It is recommended that the FMWRRD should coordinate all of the data collection activities in the country and supervise the activities of other implementing agencies by providing the guidelines and standards to be adopted.

## **1.2 SIA, 1992/93**

### **1.2.1 General**

In parallel with the activities during the Field Work (II), the Satellite Image Analysis (SIA) or the Remote Sensing was carried out by PASCO

International Inc., Japan under JICA contract during the period of October 1992 to March 1993. The subject work to support proper understanding of the nation's land and water resources and facilitate broad interpretation of the present situation on those resources was done in cooperation with the JICA Team in Nigeria with the following objectives:

- Three thematic maps at a scale of 1:1,000,000 composed of land use/vegetation, geological structure and landform classification covering the country as well as the land cover classification images at a scale of 1:250,000 covering the selected area for about 10 percent of the country are to be prepared through analysis of the Landsat Satellite Imageries together with existing topographical and geological maps.
- This outcome should subsequently contribute to a sequential analysis of the land use evaluation, watershed conditions, hydrogeological mapping, groundwater evaluation, highly potential areas for water resources development, and total water and land resources management.

The analytical work was conducted with the following five sequences:

- Selection and purchase of Landsat TM data.
- Processing of the Landsat data and printing of the Color Infrared Mosaic Images at the scale of 1:500,000.
- Field checking of land cover conditions on the Images and collection of additional data for detail analysis of Landsat data.\*
- Analysis of Land Cover, Geomorphology, Geology & Watersheds with Landsat Data and output of the Thematic Maps covering the whole area of Nigeria at the scale of 1:500,000 & 1:1,000,000.
- Analysis of Land Cover with Landsat Data in the selected area, and output of the Land Cover Maps at the scale of 1:250,000.
- \* Conducted by a representative of PASCO International Inc. during the period of his stay in Nigeria from January 5 to 24, 1993 for the nationwide ground truthing work together with the officials of the NWRI and the FDALR.

At the end of March 1993, the following products in five copies were submitted to the JICA Team:

- For Whole Country:
  - Color Infrared Mosaic : Sheets 1-9, Scale 1:500,000 (Photo Print)
  - Watersheds Map : Sheets 1-9, Scale 1:500,000 (Polyestel Base)
  - Geology Map : Sheets 1-9, Scale 1:500,000 (Polyestel Base)

Geomorphology Map : Sheets 1-9, Scale 1:500,000 (Polyestel Base)  
 Land Cover Map : Sheets 1-9, Scale 1:500,000 (Polyestel Base)  
 Watersheds Map : Sheets 1-4, Scale 1:1,000,000 (Color Paper)  
 Geology Map : Sheets 1-4, Scale 1:1,000,000 (Color Paper)  
 Geomorphology Map : Sheets 1-4, Scale 1:1,000,000 (Color Paper)  
 Land Cover Map : Sheets 1-4, Scale 1:1,000,000 (Color Paper)

- Land Cover Map for the Selected Area:

Sokoto-Rima River : 1-2 Scale 1:250,000 (Photo Print)  
 Hadejia-Jamáare-Yobe River : 1-2 Scale 1:250,000 (Photo Print)  
 Niger : 1 Scale 1:250,000 (Photo Print)  
 Benue River : 1-4 Scale 1:250,000 (Photo Print)  
 Yedeseram-Lake Chad : 1 Scale 1:250,000 (Photo Print)  
 South Eastern : 1-2 Scale 1:250,000 (Photo Print)  
 Jos Highlands : 1 Scale 1:250,000 (Photo Print)

- Report in One Volume (dated March 1993)

A full set of the products has been submitted to the FMWRRD for nationwide reference in the beginning of the Field Work (III), while another set has been equipped at the JICA Representative Office in Lagos for future technical cooperation program. And, the color-photo prints of the Maps for Geology, Geomorphology and Land Cover for the whole country at a scale of 1:2,000,000 have been incorporated into Vol. Five "Satellite Image Analysis".

### 1.2.2 Selection of Landsat Data

Landsat data used for this analysis were selected using the following criteria:

- Landsat scenes that would cover all of Nigeria. The area covered by Landsat data are defined by Path (East-West) and Row (North-South) numbers. Nigeria requires the data from paths 184 to 192 and rows 51 to 57.
- Latest data available (from the latest observation dates), but within the same season. Dates of the scenes ranged from 1986 to 1991. All the data came from the months of December, January or February.

- Good quality data with the minimum amount of cloud cover. Cloud cover of more than 30 percent makes the data impractical for interpretation because of the limited view of the land surface.

By considering these factors, a total of 44 scenes were acquired. All were approximately from the same season (2 December through 28 February), but over a six-year period. Most of the 44 scenes were cloud free with the exception of some of the Southern scenes. No data was acquired for a small amount of the Northwestern and Southeastern corner of Nigeria.

### 1. 2. 3 Production of Color-Infrared Mosaics

By pre-processing of the acquired landsat imagery, the color-infrared mosaics for the nine 1:500,000 scale map sheets were produced for the primary data source for the geomorphology, geology, and drainage basin interpretations. Band 3 was imaged as 255 intensities of blue, band 7 as 256 intensities of green, and band 4 as 256 intensities of red. Histogram matching techniques allowed adjacent scenes from two different dates to match coloration reasonably well. General color characteristics on the color-infrared images is shown in Appendix 1-2.

### 1. 2. 4 Classification of Land Cover

Land cover information was digitally extracted from each of the 44 Landsat TM scenes. This involved a three step process: the pre-processing, the grouping and editing, and the post-processing.

The DISP/TRAIN/EDIT procedures were used to extract the following informational classes from all 44 Landsat TM scenes:

- Mangrove - restricted to coastal areas. Coloration was dark red to maroon indicating the presence of surface water and heavy vegetation.
- Wetlands - restricted to coastal plain, floodplain, Niger Delta, and Lake Chad areas, always associated with lakes or rivers throughout the country, has a bright red color associated with the



heavily vegetated areas and typically associated with linear features such as rivers.

- **Tropical Rain Forest** - includes forest reserves and oil palm plantations in the Southern region. Tropical rain forests showed a distinctive homogeneous deep red texture, slightly brighter than mangrove.
- **Grassland Savanna** - areas dominated by grasslands with sparse overstory vegetation. Also, burned areas. This is the predominant land cover in the Central and Northern regions. Grassland savannas were medium to light pinks and greens in the Northern region with deep brown color in the Central region. Recently, burned areas showed up as dark blue/black areas.
- **Woodland** - includes areas with moderate/dense overstory vegetation (not tropical rain forest) in the Central and Northern regions. Includes "woody" and "scrubland" vegetation associated with rivers and hills. Woodland savanna in the Northern region consisted of thorny thickets which appeared gray. Transitional forests at the savanna/tropical forest ecotone were homogeneous red areas not associated with fluvial formations. In the Eastern highlands, the red forest areas were classified as woodlands.
- **Bareland** - includes non-vegetated areas in the mountains/hills, Northern savanna, some fallow agriculture, bare rock, and sand or mud flats associated with rivers and lakes. Occurs throughout the country. Barren areas have high reflectance and appear as white and light green. Rock outcrops without vegetation appear as dark green and were classified as bareland.
- **Water** - includes open water bodies such as large rivers and lakes (dark blue or black on the images).
- **Urban/Disturbed** - restricted to large cities showing human activity (light blue on images). Urban/disturbed areas were frequently distinguished by higher band 3 reflectance (light blues). In the tropical forest zone, these urban areas were often identified by spatial pattern and spectral response.
- **Agriculture** - occurs throughout the country including large areas often associated with floodplains and small areas occurring in cleared areas of tropical rain forest, savanna, and floodplains. Agricultural areas appeared as light to medium reds and pinks often showing a very heterogeneous spectral patterning. In more heavily vegetated savanna and tropical forest zones, cleared areas showed significantly higher contrast.

The hectares of each land cover type in each of the watersheds was enumerated by creating a union of the land cover coverage and the watershed coverage (ARC/INFO's UNION command) and reporting the hectares of land cover type by each watershed (ARC/INFO's FREQUENCY command).

### 1. 2. 5 Interpretation of Geology and Geomorphology

The geological mapping in Nigeria involved that of lithologies, structure including faults and lineaments, and foliation. The surface exposures of rocks are nearly equally divided between sedimentary and igneous/metamorphic types. Most of the rocks in West-Central and North-Central Nigeria and along the Eastern border are largely Precambrian age, igneous/metamorphic intermixtures. The remainder of the area is covered with sedimentary beds ranging in age from Cretaceous to Recent.

The igneous/metamorphic rocks are highly weathered, and outcrops are rarely continuous over large distances. The metamorphic rocks with the exception of the quartzites tend to weather rapidly and produce subdued landscapes. Some units, however, are resistant enough to permit the identification on the Satellite imagery of the regional foliation patterns. Isolated masses of igneous rocks known as inselbergs are identifiable over much of the area. The differentiation of the various Precambrian rocks is difficult. Using the 1:2,000,000 scale Geological Map of Nigeria as a guide, certain textural characteristics of a rock grouping were tentatively identified on the Landsat imagery, and attempts were made to carry these "signatures" into adjacent areas.

Invariably, polygons delineated based on the signatures identified on the imagery were not identical to the published map. In fact, there were places where the continuity of the characteristics of a rock mass was good enough to bring doubt upon the accuracy of the map. In these cases, polygon boundaries were modified from those of the published map. In moving to a different part of the country, textural characteristics associated with a rock type at the first location seemed to be identified as a different unit. This was particularly a problem with the unit, Pcm. Also, only locally could a distinction between Pcg and Pcb be reliably made (refer to Appendix 1-2). Too often there was

inadequate diagnostic information on the imagery to make judgments as to the rock type. In these instances, the published map was given precedence.

The sedimentary rocks are more realistically mappable, particularly north of the Benue River. South of the Benue River where vegetation is more dense and unfortunately the Landsat image quality is in places inferior, the published map was the guide. North of the Benue River in areas where topographic expression is good, the sedimentary boundaries are mappable in considerable detail. Structural deformation in the sedimentary section is relatively gentle except locally in beds associated with the Benue Trough. Here, beds have been deformed into pronounced folds. Where mappable, fold axes are shown with a solid circle indicating an anticline and an open circle for synclines. Faults are mapped with a bold solid line. Foliation is shown as a line of small, interconnected crosses. Lineaments are thin solid lines, and lithological boundaries are even thinner lines.

The geomorphic analysis was based upon a photo-interpretation of the nine 1:500,000 scale map sheets and followed standard analysis conventions using a combination of tonal and textural indicators. This photo-geomorphic analysis was aided by reference to previous land use, soil, geomorphic and geologic mapping of Nigeria (FDALR-Soils Map of Nigeria at 1:1,000,000 scale; Afrika - Kartenwerk, Geomorphologic Maps of Nigeria at 1:1,000,000 scale; FDF, Nigeria - Land Systems of Nigeria at 1:500,000 scale; Geological Survey of Nigeria - Geology Series at 1:250,000 scale).

The geomorphic interpretations were drawn directly on clearfilm mylar overlays to the 1:500,000 scale map sheets with permanent ink pens. These interpretations were then hand-digitized into an ARC/INFO system, and test plots were generated to check for inaccuracies. These edited test plots were then used to make the necessary corrections, and final plots were produced.

The classification of the terrains is as follows:

- (M) **Mountains.** Land masses that rise rather abruptly above the surrounding area by 300 m or more.
- (H) **Hills.** Hummocky, irregular terrain; includes many inselbergs. Locally, where there is a substantial area of mixture of classes a combined symbol, Mountains/Hills (M/H) is used.

- (P) Plains.** Smooth, rolling topography with few abrupt changes in relief.
- (P/H, H/P)** Mixture of two classes where the occurrences are too intermixed to justify separation of classes. The first-listed class in the predominant category.
- (UP) Uplands.** Those high plateau areas that are, at least in part, separated from the lower surrounding terrain by near vertical escarpments.
- (D) Dunes.** Predominantly sheet sands, although locally can be several m thick. This class is restricted to the extreme northeastern part of Nigeria. Where the sands are thin (estimated to be one m or less, this class is identified with the Plains class, i.e., P/D. Much of the surface around Lake Chad is covered with sand, partially wind blown and partially lakebed deposits. These are mapped either as D/LB or LB/D.
- (LB) Lakebeds.** These are occurrences of fine-grained elastic sediments deposited in ancient lakebeds.
- (S) Shoreline.** Ancient shorelines or beach ridges associated with periods of stable high-water level of Lake Chad.
- (FP) Floodplains.** This class is restricted to the courses of the major drainage systems. In relief, they are usually only a few meters above water level and are subject to periodic flooding.
- (CP) Coastal Plains.** This is low sandy terrain restricted to the area adjacent to the ocean shoreline. In Nigeria, they are covered with a mixture of tropical vegetation.
- (ND) Niger Delta.** Over geologic time, sediments from the outflow of the Niger River have built a large, low, fan-shaped deposit of gravels, sands and clay. This large feature is distinguishable from the adjacent Plains category, thus the unique name. The seaward side of the delta is topographically low and extends for a large distance under the ocean. Tidal fluctuations have produced a zone of complex patterned estuary channels.
- (MS) Mangrove Swamps.** The estuary channels and low adjacent landmasses are covered with a single predominant plant species, the Mangrove tree. This tree dominates the areas, thus, the name of this class. It could have been labeled as Estuarian Coastal Area.

- (L) **Natural Levees.** Where a river floodplain widens and the flood-water velocity slows accordingly, some of the sediment load is dropped. This usually occurs most prominently near the stream channel, forming a berm or low ridge parallel to the channel that is topographically higher than the floodplain further removed from the channel. There appear to be very few of these features in Nigeria based upon the Landsat imagery. Some were mapped along the upper portion of the Niger River, but it is questionable that these are true levees.

### 1.2.6 Delineation of Drainage Basins

The existing drainage basin delineation was modified based upon the detail discernible on the Landsat TM imagery. In most cases, the existing delineations were accurate, but where the base map detail was erroneous, modifications were made. Image quality varies greatly across the study area. In some instances, the drainage divides were not accurately discernible. In these cases, the existing drainage divide maps were used as the authority for positioning.

### 1.2.7 Area Calculations

Hectares of geomorphology, geology and land cover per watershed were calculated in ARC/INFO. Unions of these three cover types were made with the watersheds (ARC/INFO's UNION command), and ARC/INFO's FREQUENCY command was used to create the hectares by watershed. The following areas were given:

- Watershed : HAs, sub-HAs (SHAs) and sub-SHAs.
- Land Cover : By nine classifications on the basis of HAs, sub-HAs and sub-SHAs.
- Land Cover : By nine classifications on state level.
- Geomorphology: By 18 classifications on the basis of HAs, sub-HAs and sub-SHAs.
- Geology : By 40 classifications on the basis of HAs, sub-HAs and sub-SHAs.

### 1.2.8 Production of Land Cover for Selected Fadamas and Soil Erosion Areas

For seven selected areas, more detailed land cover analysis was provided, and the land cover classification was printed as raster images at a scale of 1:250,000. The seven areas primarily major fadamas are named as follows:

1) Sokoto-Rima River (Goronyo Dam/Bakolori Dam → Niger Confluence)	745,251 ha
2) Hadejia - Jamáare - Yobe River Wudil/Faggo/Dambam → Lake Chad)	1,949,395 ha
3) Niger River (Jebba Dam → Lokoja → Onitsha)	776,577 ha
4) Benue River (Int'l Boundary/Dadin Kowa → Lokoja)	1,608,530 ha
5) Yedesarem - Lake Chad (Bama → Lake Chad)	795,264 ha
6) South Eastern Area (Kogi, Benue, Enugu, Anambra, Imo & Abia States)	2,236,010 ha
7) Jos Highland	625,401 ha
Total	8,736,428 ha

The classification procedure is identical to the procedures used for the nationwide land cover analysis. However, during the "Grouping and Editing" step, additional land cover classes were defined. Listed below are the land cover classes used for these selected areas:

- River - those rivers detectable on the Landsat scenes.
- Open Water - all visible water bodies other than rivers.
- Low Intensity Agriculture - small, scattered subsistence agriculture dominated by savanna, woodland or barren areas.
- Medium Intensity Agriculture - small, clustered farmland areas within savanna, woodland or barren areas.
- High Intensity Agriculture - large, managed farmland areas which dominate the landscape.
- Oil Palm - managed oil palm plantations within the tropical rain forest zone.
- Riverbed (Gravel Bars) - barren areas located within and immediately surrounding rivers.

- Bare Soil - some fallow agriculture and desert areas in the Northern region.
- Bare Rock - exposed bedrock, usually occurring in the Northern region.
- Mangrove - as defined for nationwide work.
- Tropical Rain Forest - as defined for nationwide work.
- Grassland Savanna - as defined for nationwide work.
- Woodland - as defined for nationwide work.
- Wetlands - as defined for nationwide work.
- Urban/Disturbed - as defined for nationwide work.

For each of the seven areas, image maps showing the classification just for the area within the study area have been created. Each image contains the title of the image, the scale bar, latitude and longitude ties along the neat line, and a legend. The legend for each map shows which color depicts each of the land cover classes, and the hectares of that feature which appears on the map are placed adjacent to the legend. Each of the seven study areas was printed at a scale of 1:250,000 on one sheet of photographic paper. Three of the study areas, Sokoto-River, Hadejia-Jamáare-Yobe River, and South Eastern were too large to fit on one sheet and were printed on two sheets. The Benue River area was printed on 4 sheets. Twenty-eight Landsat TM scenes were processed to create the detailed land cover information for these seven areas.





## **APPENDIX 1 - 1 TERMS OF REFERENCE FOR NWRIS**

### **1. Objective**

The objective of the National Water Resources Master Plan Study is to assist the Federal Government of Nigeria in preparation of a comprehensive and up-to-date plan for the maximum development and use of the water resources of the country providing a framework for project selection, planning and investment decisions. As the first step of the Study, the National Water Resources Inventory Survey will be carried out to identify the problems of water use and the needs for water resources development in order to facilitate the project identification and preparation under successive medium- and short-term development plan of the country.

The Inventory Survey which will be entrusted to the Nigerian domestic consultant firm(s) to a greater extent and be completed by the end of January 1993 is composed of the following two items:

- to identify the actual status of water resources utilization, as well as the regional needs, importance and problems for water resources development on medium- and long-term basis, for which the water use survey will be carried out by means of questionnaire, interview and others in direct contact with the water resources related agencies; and
- to survey the current dimensions of facilities, actual status of management and operation, and related problems with respect to irrigation, domestic and industrial water supply, hydropower, inland navigation, flood protection and so on.

### **2. Subdivision of the Survey**

The National Water Resources Inventory Survey which identifies the problems of water use and the needs for water resources development is scheduled to be entrusted to and carried out by the domestic consultant firm(s) to a greater extent under the overall coordination and close supervision by the JICA Team. Aside from one consultant firm for nationwide socio-economic survey, the division of the country into five regions (NW, NE, SW, SC & SE) for the specific technical survey by different consultant firms is imperative because

this will enable the data collection and collation to be completed within the short time given.

As a matter of fact, this approach to the technical inventory survey by dividing the country into five regions by different consultant firms as well as to allocate the entire survey into one nationwide socio-economic and five technical, would bring forth the need for and the importance of an overall coordination work. It is intended that there would be the need for consultations to be held in a form of joint workshops and several meetings between the JICA Team and plural domestic consultant firms with a view to quickly discuss and resolve any areas of doubt.

### **3. Scope of Work**

The National Water Resources Inventory Survey to be carried out by several domestic consultant firms is expected to be completed in four months from October, 1992 to January, 1993.

The subdivision of the Inventory Survey into five regions for specific technical survey by different consultant firms is mapped out as attached herewith, which also compiles the boundaries by 30 states and Abuja FCT, 11 River Basin Development Authorities (RBDAs), 8 Hydrological Area (HAs) and the Regional Technical Inventory Surveys.

### **4. Terms of Reference for the Nationwide Socio-economic Inventory Survey**

One domestic consultant firm shall carry out the Water Resources Inventory survey for the nationwide socio-economic sector as described in the following items on the basis of collection and collation of the data and information at state and/or LGA level with the field observation and measurement to a minimum extent:

#### **(1) General Socio-Economy**

1) Overall socio-economic development policy for short (2000) and long (2020)-term basis including the sectoral development for agriculture and irrigation, industry, urban and region and other water-related activities, in deliberate comparison with the current development status. (Form N-1.1)

**(2) Land Use**

- 1) Present land use on state basis classifying the farmland, forest land, grazing land, residential area, lake and swamp area, and so forth. (Form N-2.1)
- 2) Land use plan for the years of 2000 and 2020 including the potential development area for farmland, forest land, grazing land, residential and industrial area, and so forth. (Form N-2.2)

**(3) Urban and Regional Development**

- 1) Urban development plan for the years of 2000 and 2020 with the items of area expansion, population increase, major social infrastructure, public establishment, water supply, waste disposal and sewerage system and so forth. (Form N-3.1)
- 2) Regional development plan for the years of 2000 and 2020 on the basis of land categories as provided in Form N-2.2. (Form N-3.2)
- 3) Present situation of the industrial zone and related activities including location, area occupied, industrial component, product and value and so forth, as well as the industrial potential development area in view of available water resources. (Form N-3.3)

**(4) Hydropower Generation**

- 1) Current situation of the power demand-supply relations on the national and regional basis. (Form N-4.1)
- 2) Power demand projection for the years of 2000 and 2020, and hydropower supply program for the above demand including the allowable cost of capital investment per kw and generation per kWh for potential hydropower development sites. (Form N-4.2)
- 3) Summary of the hydropower development plan proposed by NEPA with the following items;

- Project name, location, and reservoir area, showing on 1:1,000,000 map.

- Hydrological condition at dam site:

- catchment area, monthly rainfall and evaporation
- monthly runoff and runoff yield
- maximum and minimum discharge
- sediment transport

- Reservoir and Dam dimensions:

**Reservoir Dimension:**

- Reservoir surface area at full and maximum water level
- Total, active and dead reservoir capacity
- High, full and dead water level
- Reservoir length, width and depth
- Annual available water on average and dry years, if available by the study report

**Dam and Appurtenant Structure:**

- Type of dam
- Height, length and crest width
- Dam volume for fill and concrete dam
- Type of spillway and designed flood capacity
- Outlet type and outlet design discharge capacity

- Estimated power output (MW) and annual product (NWH).

- Approximate capital cost.

- Possibility of developing for multi-purpose use.

(Form N-4.3)

4) Idea of the mini-hydropower schemes for the localized isolated power network on the State basis, including, if possible, the development plan as provided in Form N-4.3. (Form N-4.4)

**(5) Inland Navigation**

**1) Historical and present situations of the inland navigational activities including:**

- Name of river, river reaches, river length, width and depth related to navigation.
  - Number of ship and cargo volume on each river basis.
  - Navigation period (month) in accordance with river depth.
  - Cargo loading and unloading ports.
  - River dredging activity including the following items:
    - Dredging volume (m<sup>3</sup>/day and m<sup>3</sup>/year)
    - River reaches under dredging
- (Form N-5.1)

**2) Current conditions of the river morphology for navigational course including:**

- River cross section and slope.
- River bed fluctuation by sediment accumulation.
- Consideration and amelioration of the adverse effects of water development on other resources,
- Consideration of the public health implications of water resources development projects such as reservoirs and irrigation schemes,
- Establishment of the adequate control to prevent contamination and depletion of the water resources,
- Conservation and improvement of the water quality conditions and related ecological systems in the water bodies for fishes and other fauna and flora.
- Establishment of the adequate control of point and non-point sources of the water pollution along the river courses.

**1) General situation of the problem areas concerned with river courses and existing water resources projects as mentioned above which may be identified through initial discussions with the Federal Departments and universities concerned on the nationwide basis. It is scheduled that this Inventory Survey**

work would be implemented together with the representative(s) of JICA Study Team. (Form N-6.1)

2) Current situation of the problem areas concerned with river courses and existing water resources projects as well as of the probable problems in future projects which may be discussed in detail with the State Government Agencies and universities concerned on the State level; to this end, to compile the location of problem areas, the nature of problems to be interpreted from socio-economic and technical point of view, and possible countermeasures. It is expected that this Inventory Survey work should be carried out in close cooperation with those to be implemented by other consultant firms for the Regional Inventory Survey. (Form N-6.2)

#### **(7) Preparation of the Base Maps**

The base maps are to be prepared showing the location and type of any important items as stipulated in TOR on the given 1:1,000,000 maps or a map at any more appropriate scale for detail when necessary.

#### **5. Subdivision of the Survey**

The Water Resources Inventory Survey for the specific technical sector as stipulated in the following items shall be carried out by the domestic consulting firms subdividing the country into five regions on the basis of collection and collation of the data and information from the Government agencies concerned with field observation and measurement to a minimum extent:

##### **(1) Hydrology**

1) Demarcation of the catchment boundaries for sub-areas in the already designated Hydrological Areas (HAs) taking into account the location of major hydro-gaging stations and damsites, with the measurements of catchment areas. (Form R-1.1)

2) Collection of the hydrological data observed at major hydro-gaging stations and damsites:

- Type of the hydro-gages with the installation date, and present situation on the operational adequacy.
- Rainfall, evaporation and run-off on monthly basis, together with the water level-discharge rating curve and its historical significance due to the channel changes.
- Maximum high and minimum low water levels on annual basis.
- All of the sediment discharges and water quality data together with these synchronized river discharges. (Form R-1.2)

## **(2) Deep Wells**

- 1) Location of all productive deep wells on LGA basis compiling number of wells drilled by agency, well dimensions and facilities, water level with drawdown and its seasonal fluctuation, functional degree, problems and so forth. (Form R-2.1)
- 2) Development plan of deep wells for the years of 2000 and 2020 including rehabilitation and new installation on LGA basis including number of wells to be replaced or newly provided, well dimensions and facilities, service population and so forth. (Form R-2.2)

## **(3) Water Sources**

- 1) Present situation of existing reservoir dams and diversion dams indicating location, executing agency, construction period, hydrological information, reservoir dimensions, dam structural design, problem areas (structural & operational), service purpose and area and so forth. (Form R-3.1)
- 2) Development plan of new reservoir dams and diversion dams indicating location, executing agency, study stage, objective, outline of the hydrology, reservoir, dam structure, construction cost and so forth. (Form R-3.2)

## **(4) Agriculture and Irrigation**

- 1) Current condition of the irrigation area development under existing projects including executing agency, location, water source works, study level, total planned and actual irrigated areas by crop season, irrigation mode and water requirement, on-farm facilities, farmers group, irrigation fee, extension

services and so on. For small-scale irrigation projects, such information may be limited to executing agency, location, service area, farmers organization, degree of irrigation development, bottlenecks for full development, problem areas and so forth. (Form R-4.1)

2) Development plan of irrigation command area on the basis of proposed irrigation projects for the years of 2000 and 2020 including those of para. 4.1, taking into consideration the position in overall framework of the agricultural development plan, soil classification and socio-economic background of the framers involved. (Form R-4.2)

3) Current condition of existing fadama irrigation schemes on each group basis indicating location, service area, executing agency, number and dimensions of lift pumps and tube wells, irrigation mode and water requirement, framers organization, extension services, problem areas and so on. (Form R-4.3)

4) Development plan of fadama irrigation schemes on each group basis for the years of 2000 and 2020 including location, service area, executing agency, water facilities, recharge potential and so forth. (Form R-4.4)

#### (5) Water Supply and Sanitation

1) Present situation of existing urban and semi-urban water supply schemes (systems) compiling location and coverage, executing agency, water source work, service population, projected water demand and current water supply, major water conveyance and distribution facilities, treatment plant and its process, water quality before and after treatment, construction cost, completion year, O & M cost, water charge, problem areas and so forth. (Form R-5.1)

2) Present situation of existing rural water supply schemes on LGA basis summarizing the items similar to 5.1 in connection with para. 2 "Deep Wells". (Form R-5.2)

3) Proposed plan of the development for new urban and semi-urban water supply schemes (systems) and of the major rehabilitation for existing ones for the years of 2000 and 2020 compiling the items similar to 5.1 as deemed relevant. (Form R-5.3)



4) Proposed plan of the development for new rural water supply schemes and of the major rehabilitation for existing ones for the years of 2000 and 2020 compiling the items similar to 5.2 in connection with para. 2 "Deep Wells".  
(Form R-5.4)

**(6) Watershed and River Management**

1) Present situation of the land degradation over the watershed on the basis of sub-HAs demarcating the total problem area into that of each degradation type together with the current social conditions as well as the countermeasures already taken, the basic data of which may be taken on LGA or State level.  
(Form R-6.1)

2) Current need of the river channel improvement works to improve flow downstream of major hydraulic structures, prevent flooding, protect or reclaim land showing the extent of problem areas on the 1:1,000,000 maps by different categories given in river morphological term.  
(Form R-6.2)

**(7) Inland Fisheries**

1) Current condition of the inland fisheries including (1) traditional capture ones in the fresh and brackish water along major rivers and (2) culture ones in the man-made reservoirs and ponds, with the information of species, quantity and value of fish catches and relevant trend, availability and fingerling supply of the existing hatcheries, problem areas encountered and so on.  
(Form R-7.1)

2) Proposed inland fisheries development plan to guarantee the minimum flow in the downstream of major hydraulic structures, to provide such structures with fish ladder, to promote the fish culture and so on, indicating the scheme location, related investment, executing agency, anticipated benefits and the like.  
(Form R-7.2)

## **(8) Preparation of the Base Maps**

The base maps are to be prepared showing the location and type of gaging stations, damsites and reservoirs, as well as the delineation of sub HAs and other items as stipulated in TOR on the given 1:1,000,000 scale maps or a map at any more appropriate scale for detail when necessary.

## **6. Reporting and Review**

Each of the domestic consultant firms shall submit a) Progress Report (1) by the end of November 1992, b) Progress Report (2) by the end of December 1992, and (C) Final Report by the end of January 1993. The Progress Report (1) & (2) in 10 copies each shall contain a) the record of survey activities, b) the outcome of the Inventory Survey for the designated areas by using the various Forms, c) the list of collected data and maps as well as of available reference materials, and d) the photos taken at important sites during the reporting period, as well as the detailed work schedule for next reporting period. The Final Report in 15 copies shall contain all the items as incorporated in the Progress Reports for the full scope of work as well as a set of computer diskettes available for data storage and retrieval system of the FDWR Data Bank in future.

The consultant firms' work will be subject to overall review and verification of certain points where there are doubts or ambiguity at tripartite review meetings attended by representatives of FDWR, JICA Study Team and consultant firm(s). Such reviews are expected three times at the specified date immediately after each of the Reports is submitted to the Study Team in Abuja to examine the consultant specific outputs.

## **APPENDIX 1 - 2 EXPLANATORY NOTES ON SIA**

### **1. Landsat System Characteristics and Image Products**

#### **(1) Characteristics of Landsat System**

The Landsat satellite (formerly called ERTS, Earth Resources Technology Satellite) is a land remote sensing satellite system, which began as an experimental program conducted by U.S. National Aeronautics and Space Administration (NASA). Landsat 1 launched on July 23, 1972 was expected to function for about one year and finally ceased operating in 1978 after nearly five years of continuous operation. During that time, it returned digital data for some 300,000 images of the Earth's surface. The Landsat system was declared an operational system in 1983 and turned over to the U.S. Commerce Department's National Oceanic and Atmospheric Administration (NOAA). In 1984, the Land Remote Sensing Commercialization Act was established to transfer the commercial operation of the Landsat program to the private sector. Earth Observation Satellite Company (EOSAT) was selected as the commercial operator for the Landsat Program.

Landsat 1 through 3 satellites had two sensors. The Return-Beam Vidicon (RBV) sensor, which is similar to the television camera, recorded red, green and infrared energy reflected from the surface of the Earth. The Multispectral Scanner (MSS) was the main instrument carried on Landsat 1 through 3 satellites and is still operating on the Landsat 4 and 5 satellites. The MSS sensor collects data by scanning the Earth from west to east with an oscillating mirror. Radiation from four different spectral bands (green, red, and two in the near infrared) is recorded. The radiation is transferred by fiber optics to filters that permit only certain wavelengths of radiation to strike the sensor's detectors. The picture element (pixel) sampled by the MSS is about 79 m by 56 m. Landsat 2 and 3 satellites ceased operating in 1983. Landsat 1 through 3 satellites orbited the Earth at 900 km and provided repeat coverage for any location on earth every 18 days.

Landsat 4 and 5 satellites were launched in 1982 and 1984, respectively. Landsat 4 is used sparingly because of an electrical problem that developed shortly after its launch. As of January 1992, Landsat 5 is still operating. Landsat 4 and 5 satellites circle the Earth every 98.9 minutes in a

near polar orbit of 705 km. Each satellite provides repeat coverage for any area every 16 days, at the same local time of day. Landsat 4 and 5 satellites each weigh nearly 2,000 kg and carry the MSS sensor and the Thematic Mapper (TM) sensor. The TM sensor has excellent capabilities for meeting the data needs of many GIS applications for large regions. Along each orbital path, the TM and MSS sensors can continually scan a swath 185 km wide. The scanned data are systematically divided into an area termed a "Landsat Scene", which encompasses approximately 185 km by 170 km. Each scene covers approximately 3.2 million hectares. Users of Landsat data can purchase data from an existing archive maintained by EOSAT or can schedule the collection of data for any site. The images from the TM sensor on Landsat 4 and 5 satellites have significantly better geometric quality than images from sensors on earlier Landsat missions due to engineering enhancements to the spacecraft. This has facilitated geodetic rectifications of the images.

The TM sensor provides significant improvements in spatial, spectral and radiometric resolution compared to the MSS. The instantaneous-field-of-view (IFOV) of the TM is square and results in a ground resolution cell and image pixel of approximately 30 m on a side. The TM measures the intensity of reflected radiation in six spectral bands; three in the visible wave lengths, blue (0.45-0.52  $\mu\text{m}$ ), green (0.52-0.60  $\mu\text{m}$ ), red (0.63-0.69  $\mu\text{m}$ ), one in the near infrared (0.76-0.90  $\mu\text{m}$ ), and two in the shortwave infrared (1.55-1.75, 2.08-2.35  $\mu\text{m}$ ). The TM also measures emitted thermal radiation (10.4-12.5  $\mu\text{m}$ ) although the IFOV for this spectral band is 120 m on a side. The greater radiometric resolution of the TM is achieved by the analog-to-digital conversion of the electrical signal to 8 bits or 256 gray levels compared to the 64 gray levels of the MSS on the first three Landsat satellites. Landsat 6 is scheduled to be launched late in 1993.

Overpass time for all the Landsat satellites is approximately 9:45 a.m. local time, although perturbations in the orbit have caused small variations in the time. An early morning sun-synchronous orbit was selected to take advantage of clear morning skies and to ensure repeatable illumination. Consistency in illumination is important for constructing image mosaics and in comparing changes through time. In addition, the moderately low sun angle at the time of overpass, particularly in the higher latitudes and during the winter months, enhances detail caused by relief differences.

## **(2) Computer Processing of Landsat TM Data**

The Landsat TM data is delivered on magnetic tapes called CCTs (Computer Compatible Tapes). From these data tapes, Landsat Images are produced by assigning various combinations of bands to the colors of blue, green and red. An interactive computer system is used for viewing and selecting the various bands for processing. The algorithms within the processing package can be divided into two broad types: "pre-processing" and "image processing".

## **(3) Pre-Processing**

The Landsat TM data contains some noise and distortions (such as band dropouts). Therefore, pre-processing of the data is necessary before the images can be created. The pre-processing consisted of:

- 1) Viewing the images and replacing any dropped lines.
- 2) Geocoding the image to insure that the imagery will register to published maps.
- 3) Histogram matching the imagery with adjacent scenes to reduce the variation between consecutive scenes in an image mosaic.
- 4) Mosaicking all satellite scenes required to cover each map sheet. Ten or more Landsat scenes are required to cover one full 1:500,000 map sheet.

## **(4) Color-Infrared Composite Image**

The color-infrared composite images for the nine map sheets were created by recording film bands 3, 7 and 4 to the colors of blue, green and red, respectively. Various band combinations were examined interactively on a display screen, but this combination of bands produced the best images throughout all of Nigeria. From this band combination, land cover, geomorphology, geology and cultural features could readily be interpreted.

Each of the nine map sheets covers 4.5 degrees of longitude and 3.5 degrees of latitude. Printing these images at a scale of 1:500,000, the resultant image maps measures approximately 39 inches by 43 inches. The map number, latitude and longitude extent, and the map name for the nine 1:500,000 scale image maps covering all of Nigeria are shown below:

Upper Left Corner			Lower Right Corner		
Map	Long	Lat	Long	Lat	Name
1	1.5E	14.0N	6.0E	10.5N	Kebbi
2	6.0E	14.0N	10.5E	10.5N	Kano
3	10.5E	14.0N	15.0E	10.5N	Borno
4	1.5E	10.5N	6.0E	7.0N	Oyo
5	6.0E	10.5N	10.5E	7.0N	Plateau
6	10.5E	10.5N	15.0E	7.0N	Adamawa
7	1.5E	7.0N	6.0E	3.5N	Lagos
8	6.0E	7.0N	10.5E	3.5N	Enugu
9	10.5E	7.0N	15.0E	3.5N	Taraba

These images were registered to the UTM projection using zone 32 and the International 1924/Hayford 1909 spheroid. Major cities were annotated and the most recent state maps were digitized. The state boundaries and their names are displayed on the image maps.

## 2. Landsat TM Scenes

Path/Row	Date	Path/Row	Date
192/54	01/01/90	188/53	01/04/87
191/51	01/09/87	188/54	04/04/87
191/52	12/27/90	188/55	01/04/87
191/53	12/27/90	188/56	01/07/91
191/54	12/27/90	188/57	01/09/91
191/55	12/27/90	187/51	12/10/91
191/56	12/27/90	187/52	01/29/87
190/51	01/29/88	187/53	12/31/90
190/52	01/05/91	187/54	12/31/90
190/53	01/05/91	187/55	01/13/87
190/54	01/05/91	187/56	01/29/87
190/55	01/05/91	187/57	12/12/86
190/56	01/05/91	186/51	12/02/88
189/51	01/28/90	186/52	12/16/90
189/52	02/28/90	186/53	12/16/90
189/53	02/28/90	186/54	12/16/90
189/54	02/12/90	186/55	02/07/87
189/55	01/11/87	185/51	12/04/91
189/56	01/06/88	185/52	12/04/91
189/57	01/17/87	185/53	12/04/91
189/51	01/04/87	185/54	02/27/88
189/52	01/04/87	185/52	01/08/87

## 3. Color Characteristics on the Color Infrared Images

Colors of color-infrared imagery are greatly different from the actual colors as seen to the ground. General characteristics of typical and cover classification based on the color-infrared imagery are as follows;

- **Forest:** Usually red to dark red. Fine texture for dense forest; coarse texture for sparse forest. When trees are sparse, undergrowths are seen in bright red (grass) mixed with gray white

(earth). Coniferous trees appear darker in red than deciduous trees. In the typical climates of tropical rain forests and savanna, the dry season can be reflected in reddish brown but there is little change in color tone between dry and wet seasons. Whereas in the temperate climate zone, low temperature seasons appear reddish brown to brown mixed with gray white (earth) for under-growths seen through bare trees.

- **Grassland/Bushland:** Generally bright red - red. Brighter than forests. Red dots are dense or coarse depending on the density of bushes. In the tropical rain forest climate zone and the savanna climate zone, the wet season is reflected in bright red, low temperature periods in reddish brown, and the dry season in reddish brown, possibly mixed with gray white (dry earth) - dark grayish blue (wet earth).
- **Agricultural land:** Color tones of agricultural land on the imagery differ widely according to the growth stages of crops. At the sowing stage, it appears gray white (dry earth) - dark grayish blue (wet earth) and, as crops grow with leaves, bright red - red. Grains right after harvesting appear in orange - yellowish brown. There is little difference in color tone between grassland and crops in the growing stage, so that artificial segmentations, water Channels, or topography like slopes are sought as surrogates to differentiate them in interpretation.
- **Town:** Generally bright blue. Dark blue where there are many tall structures. Parks appear red reflecting trees and white for roads. Towns and villages with few buildings show a mixture of light blue and red for agricultural land and gray white for open land, making it difficult to delineate their boundaries.
- **Bareland:** Generally in irregular expense appearing gray white. Very similar to those of agricultural land after harvesting and grassland during the dry season. During the wet season, it appears in dark gray-dark grayish blue reflecting the wetness, making it clearly different from bright red grassland. In the dry or semi-dry zones, there is little vegetation cover so that bare land can be observed extensively. Rock outcrops if any are reflected in brownish colors in various shades with coarse texture while areas covered with weathered sand range from gray white to dark brown but uniformly smooth in texture making it relatively easy to interpret.
- **Waters:** Generally black or dark blue. Deep clear water in black and shallow turbid water in blue. In the tropical rain forest climate zone and the savanna climate zone, rivers flood during the wet season and water remains in the flood plain. It is turbid and

appears blue in color. Original river channels can be traced from riparian vegetation on both banks of the rivers appearing in red dots meandering in two parallel lines. The river channels are dark blue during the dry season and the flood plains white gray white and, when wet, grayish blue.

Wetlands have typically riparian vegetation growths which appear on the imagery as a mixture of blue for water and red for vegetation, with red varying depending on the density of vegetation.

Dams and reservoirs are represented in black-dark blue. It is easier to monitor changes in water levels during the wet and dry seasons. Water conduits can be recognized as black-dark blue straight lines.



#### 4. Geology Legend

Q U A T E R N A R Y	{	Meander Belt, Back and Fresh Swamps	Qa	Alluvium	
		Mangrove Swamps	Qs	Sands, clays and clay	
		Abandoned Beach Ridges	Qm	Sands, clays, and mangrove swamps	
		Sombreiro Deltaic Plain	Qbr	Sands and pebbles	
		Coastal Plains Sands	Qsd	Sands, clays, and mangrove swamps	
		Chad Formation	Qp	Sands and clays	
T E R T I A R Y	{	Tertiary to Recent Volcanics	T-Qr	Basalts, trachyte, rhyolite. Newer basalts of Jos Plateau	
		Ilaro Formation	Ti	Sands, clays, shales	
		Lignite Formation	Tl	Clays, sandstone, lignite, and shale	
		Bende Ameki Group	Tb	Clays, clayey sands, and shale	
		Gwandu Formation	Tg	Calys and grits	
		Ewekoro Formation	Te	Shales and limestone	
		Imo Clay-Shale Group	Tm	Clays and shales with limestone	
		Kerri-Kerri Formation	Tkk	Grits, sands and clays	
		Sokoto Group	Ts	Clay and shale	
		C R E T A C E O U S	{	Abeokuta Formation	Kb
False-bedded Sandstone and Upper Coal Measures	Kuc			False-bedded sandstones, coals and shale	
Lower Coal Measures	Klc			Coal, sandstone and shale	
Nkporo Group	Kro			Shale and mudstone	
Cretaceous Intrusion	Ki			Basic and intermediate intrusion	
Awagu-Ndeaboth Shale Group	Kwn			Shale and limestone	
Eze Aku Shale Group	Kea			Black shale and siltstone	
Asu River Group	Kar			Shale and limetone	
Gombe Sandstone	Kg			Sandstone, siltstone, shale and ironstone	
Pandiga Formation	Kp			Shale and liemstone	
Yola Formation	Ky			Med. and coarse grained felspathic sandstone	
Bima-Yola Formation	Kbo				
Bima Sandstone and Yolde Formation	Kby			Felspathic sandstone, sandclays, shale calcareous sandstone and shelly limestone	
Rima Group	{			Kr	Sandstone and mudstone
Nupe Sandstones				Kn	Felspathic sandstone and siltstone
Illo Formation				Kl	Pisolitic clays and grits
Gundumi Formation		Km	Clays and grits with pebble beds		
J U R A S S I C	{	Younger Granite	Jyg	Syentie and gabbro, etc.	
			Jyr	Rhyolite	
P R E C A M B R I A N  U P P E R	{	Basement Complex	Pcg	Older Granite	
			Pcs	Ibadan quartzite, schist complex	
			Pcq	Quartzites	
			Pcm	Undifferentiated meta-sediments	
			Pcb	Undifferentiated gneiss-migmatite	

## **CHAPTER 2. SOCIO-ECONOMY AND LAND USE**

## CHAPTER 2: SOCIO-ECONOMY AND LAND USE

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## **CHAPTER 2. SOCIO-ECONOMY AND LAND USE**

### **2.1 STATE ADMINISTRATION**

#### **2.1.1 Establishment of New State and LGA**

Province formed the basic administrative units until three region - East, North and West were created in 1951. In 1963, the Mid-Western Region was carved out from the Western Region, and the four regions subsisted until May 1967, when 12 States, namely North-Western, North-Central, Kano, North-Eastern, Benue, Plateau, Lagos, Western, Mid-Western, East-Central, South-Eastern and Rivers States emerged.

In February 1976, seven more States were added, and the States were no longer described by reference to geographical points such as North, and South, East or West. The total 19 States were Kaduna, Bendel, Cross river, Ogun, Ondo, Oyo, Lagos, Kwara, Niger, Imo, Benue, Plateau, Bauchi, Borno, Gongola, Kano, Anambra, Sokoto and Rivers. In September 1987, two additional States Katsina and Akwa-Ibom were created from former Kaduna and Cross River States, respectively.

Nine new States emerged in August 1991, which are: Abia State from Imo State; Anambra State with its headquarters at Awka by dividing the former Anambra State into Anambra and Enugu States; Kebbi State out of Sokoto State; Kogi State out of Benue and Kwara States; Delta State by dividing old Bendel State into Delta and Edo States; Oshun State out of Oyo State; Taraba State by dividing old Gongola State into Taraba and Adamawa States; Jigawa State from Kano State; and Yobe State out of Borno State.

In parallel with increased number of State, number of Local Government Area (LGA) increased substantially for the purpose of modifying the structural imbalances in the Federal structure.

Table 2-1 summarizes the changes in Federal structure before and after August 1991.

## 2. 1. 2 Nigeria's Administrative Structure

Reference is made to the last paragraph of Chapter 1, Main Text.

Code	Name	Code	Name
01 LA	<u>LAGOS STATE</u>	0308	IFELOJU
	LGA	0309	IREPO
0101	AGEGE	0310	ISEYIN
0102	BADAGRY	0311	KAJOLA
0103	EPE	0312	LAGELU
0104	ETI-OSA	0313	OGBOMOSHO NORTH
0105	IBEJU-LEKKI	0314	OGBOMOSHO SOUTH
0106	IKEJA	0315	OGO-OLUWA
0107	ALIMOSHO	0316	OLUYOLE
0108	IKORODU	0317	ONA-ARA
0109	LAGOS-ISLAND	0318	ORELOPE
0110	LOGOS MAINLAND	0319	ORIRE
0111	SURULERE	0320	OYO
0112	MUSHIN	0321	SURULERE
0113	OSHODI/SOLO	0322	IBADAN NORTH EAST
0114	OJO	0323	IBADAN SOUTH EAST
0115	SHOMOLU	0324	IBADAN SOUTH WEST
		0325	IBADAN NORTH
02 OG	<u>OGUN STATE</u>	04 OS	<u>OSHUN STATE</u>
	LGA		LGA
0201	ABEOKUTA NORTH	0401	AYADADE
0202	ABEOKUTA SOUTH	0402	AYEDIRE
0203	ADO-ODO/OTA	0403	ATAKUNMOSA
0204	EGBADO NORTH	0404	BORIPPE
0205	EGBADO SOUTH	0405	EDE
0206	I/O	0406	ECBEDORE
0207	IJEBU-EAST	0407	EJIGBO
0208	IJEBU-NORTH	0408	IFELODUN
0209	IJEBU-ODE	0409	IFE CENTRAL
0210	ODOGBOLU	0410	IFE NORTH
0211	OBAFEMI/OWODE	0411	IFE SOUTH
0212	ODEDA	0412	ILA
0213	OGUN WATERSIDE	0413	IFEDAYO
0214	IKENNE	0414	ILESHA
0215	SHAGAMU	0415	IREWOLE
03 OY	<u>OYO STATE</u>	0416	IREPODUN
	LGA	0417	IWO
0301	AFIJO	0418	OBOKUN
0302	AKINYELE	0419	ODO-OTIN
0303	EGBEDA	0420	OLA-OLUWA
0304	IBADAN NORTH EAST	0421	OLORUNDA
0305	IBARAPA	0422	ORIADE
0306	IDO	0423	OSOGBO
0307	IFEDAPO		



Code	Name	Code	Name
05 OD	<u>ONDO STATE</u>	07 DT	<u>DELTA STATE</u>
	LGA		LGA
0501	ADO-EKITI	0701	ANIOCHA SOUTH
0502	AKOKO NORTH	0702	BOMADI
0503	AKOKO SOUTH	0703	BURUTU
0504	AKURE	0704	ETHIOPE EAST
0505	EKITI EAST	0705	IKA SOUTH
0506	EKITI SOUTH-WEST	0706	ISOKO SOUTH
0507	EKITI WEST	0707	NDOKWA WEST
0508	IDANRE	0708	OKPE
0509	IDO/OSI	0709	OSHIMILI
0510	ODIGBO	0710	SAPELE
0511	IJERO	0711	UGHELLI NORTH
0512	OKITIPUPA	0712	WARRI SOUTH
0513	IKERE	0713	WARRI NORTH
0514	IKOLE	0714	ETHIOPE WEST
0515	ILAJE/ESE-ODO	0715	DOKWA EAST
0516	IREPODUN/IFELODUN	0716	UGHELLI SOUTH
0517	EMURE/ISE/ORUN	0717	IKA NORTH EAST
0518	MOBA	0718	ANIOCHA NORTH
0519	ONDO	0719	ISOKO NORTH
0520	OSE		
0521	OWO	08 RV	<u>RIVERS STATE</u>
0522	OYE		LGA
0523	ILE-OLUJI-OKEIGBO	0801	AHOADA
0524	IFEDORE	0802	ASARI-TORU
0525	IRELE	0803	BONNY
0526	AKOKO NORTH-WEST	0804	BRASS
		0805	OGBIA
06 ED	<u>EDO STATE</u>	0806	DEGEMA
	LGA	0707	ETCHE
0601	ESAN SOUTH EAST	0808	TAI-E.EME
0602	AKOKO-EDO	0809	IKWERE
0603	ETSAKO WEST	0810	KHANA
0604	ESAN WEST	0811	OYIBO
0605	OREDO	0812	OBIO/AKPOR
0606	ORHIONMWON	0813	OKRIKA
0607	UIHUNNWONDE	0814	PORT-HARCOURT
0608	OVIASOUTH WEST	0815	SAGBAMA
0609	OWAN EAST	0816	NORTHERN IJAW/SOUTHERN IJAW
0610	OWAN WEST	0817	OGBA/EGBEMA/NDONI
0611	ESAN CENTRAL	0818	ABUAL/ODUAL
0612	ESAN NORTH EAST	0819	SOUTHERN IJAW
0613	ETSAKO EAST	0820	AKUKUTORU
0614	OVIASOUTH EAST	0821	EKEREMOR
		0822	EMUOHA
		0823	ANDONO/OPOBO
		0824	GOKANA

Code	Name	Code	Name
09 AK	<u>AKWA IBOM STATE</u>	11 IM	<u>IMO STATE</u>
	LGA		LGA
0901	ABAK	1101	ABOH-MBAISE
0902	EKET	1102	AHIAZU-MBAISE
0903	EKPE-ATAI	1103	EHIME-MBANO
0904	ESSIEN-UDIM	1104	EZINIHITE
0905	ETINAM	1105	IDEATO NORTH
0906	IKONO	1106	IHITE-UBOMA
0907	IKOT-ABASI	1107	IKEDURU
0908	IKOT-EKPENE	1108	ISIALA-MBANO
0909	ITU	1109	ISE
0910	MBO	1110	MBAITOLI
0911	MKPAT-ENIN	1111	NGOR-OKPALA
0912	NSIT-UBIUM	1112	NKWERE
0913	OKOBO	1113	OBOWO
0914	ONNA	1114	OHAI/EGEMA
0915	ORON	1115	OKIGWE
0916	ORUK-ANAM	1116	ORLU
0917	UKANAFUN	1117	ORU
0918	UQUO-IBENO	1118	OWERRI
0919	URUAN	1119	OGUTA
0920	UYO	1120	ORSU
0921	ETIM EKPO	1121	IDEATO SOUTH
0922	NSIT IBOM		
0923	INI	12 AB	<u>ABIA STATE</u>
0924	URUE OFFONG/ORUKO		LGA
10 CR	<u>CROSS RIVER STATE</u>	1201	ABA NORTH
	LGA	1202	ABA SOUTH
1001	AKANKPA	1203	AFIKPO
1002	CALABAR MUNC	1204	AROCHUKWU
1003	IKOM	1205	BENDE
1004	OBUBRA	1206	IKWUANO
1005	OBUDU	1207	ISIALA NGWA
1006	ODUKPANI	1208	ISIKWUATO
1007	OGOJA	1209	OBIOMA NGWA
1008	UGEPO SOUTH	1210	OHAFIA
1009	BIASE	1211	OHAOZARA
1010	BOKI	1212	ONICHA
1011	YALA	1213	UKWA
1012	OBANLIKU	1214	UMUAHIA
1013	AKPABUYO	1215	AFIKPO SOUTH
1014	UGEPO NORTH	1216	UKWA EAST
		1217	ISIALA NGWA SOUTH

Code	Name	Code	Name
13 AN	<u>ANAMBRA STATE</u>	1505	GADA
	LGA	1506	GORONYO
1301	AGUATA	1507	GUNMI
1302	ANAMBRA	1508	BUKKUYUM
1303	ANAOCHA	1509	GUSAU
1304	AWKA SOUTH	1510	GWADABAWA
1305	IDEMILI	1511	ILLELA
1306	IHIALA	1512	ISA
1307	NJIKOKA	1513	KAURA NAMODA
1308	NNEWI NORTH	1514	KWARE
1309	OGBARU	1515	MARADUN
1310	ONITSHA NORTH	1516	RABAH
1311	ONITSHA SOUTH	1517	SABON BIRNI
1312	ORUMBA SOUTH	1518	SILAME
1313	OYI	1519	SOKOTO
1314	AWKA NORTH	1520	TALATA MAFARA
1315	ORUMBA NORTH	1521	TAMBUWAL
1316	NNEWI SOUTH	1522	TANGAZA
		1523	TSAFE
14 EN	<u>ENUGU STATE</u>	1524	WAMAKKO
	LGA	1525	WURNO
1401	ABAKALIKI	1226	YABO
1402	AWGU	1527	ZURMI
1403	ENUGU NORTH	1528	BINJI
1404	ENUGU SOUTH	1529	BAKURA
1405	EZEAGU		
1406	EZZA	16 KB	<u>KEBBI STATE</u>
1407	IGBO-ETITI		LGA
1408	IGBO-EZE NORTH	1601	AREWA/DANDI
1409	IGBO-EZE SOUTH	1602	ARGUNGU
1410	IKWO	1603	BAGUDO
1411	ISHIELU	1604	BIRNI-KEBBI
1412	ISI-UZO	1605	BUNZA
1413	IZZI	1606	JEGA
1414	NKANU	1607	MAIYAA
1415	NSUKKA	1608	SAKABA
1416	OHAUKWU	1609	WASAGU
1417	OJI-RIVER	1610	SURU
1418	UDI	1611	YAURI
1419	UZO-UWANI	1612	ZURU
		1613	DANDI
15 SO	<u>SOKOTO STATE</u>	1614	NGASKI
	LGA	1615	GWANDU
1501	ANKA	1616	KOKO-BESSE
1502	BODINGA		
1503	BUNGUDU		
1504	DANGE SHUNI		

Code	Name	Code	Name
17 KW	<u>KWARA STATE</u>	1916	BUKURU
	LGA	1917	GWERRI WEST
1701	ASA	1918	UKUM
1702	EDU		
1703	IFELODUN	20 NG	<u>NIGER STATE</u>
1704	ILORIN EAST		LGA
1705	ILORIN WEST	2001	AGAIE
1706	IREPODUN	2002	CHANCHAGA
1707	EKITI	2003	GBAKO
1708	KAIAMA	2004	LAPAI
1709	MORO	2005	LAVUN
1710	OYUN	2006	MAGAMA
1711	BARUTEN	2007	MARIGA
1712	OFFA	2008	RAFI
		2009	SHIRORO
18 KG	<u>KOGI STATE</u>	2010	SULEJA
	LGA	2011	WUSHISHI
1801	ANKPA	2012	RIJAU
1802	BASSA	2013	BORGU
1803	DEKINA	2014	AGWARA
1804	IDAH	2015	BIDA
1805	OKEHI	2016	PAIKORO
1806	OKENE	2017	BOSSO
1807	OYI	2018	GURARA
1808	OFU	2019	MOKWA
1809	YAGBA EAST		
1810	OLAMABORO	21 PL	<u>PLATEAU STATE</u>
1811	KOGI		LGA
1812	ADAVI	2101	ADWANGA
1813	AJAOKUTA	2102	NASARAWO-EGON
1814	IJUMU	2103	AWE
1815	YAGBA WEST	2104	BARIKIN-LADI
1816	KONTOKARFE	2105	BASSA
		2106	LANTANG SOUTH
19 BN	<u>BENUUE STATE</u>	2107	JOS NORTH
	LGA	2108	JOSNORTH
1901	ADO	2109	KANAM
1902	GBOKO	2110	KEFPI
1903	GUMA	2111	KARU
1904	GWERRI EAST	2112	LARIA
1905	KATSINA-ALA	2113	OBI
1906	KONSHISHA	2114	LANTANG NORTH
1907	KWANDE	2115	MANGU
1908	MAKURDI	2116	BOKKOS
1909	OJU	2117	NASSARAWA
1910	OKPOKWU	2118	TOTO
1911	OTURKPO	2119	PANKSHIN
1912	USHONGO	2120	QUAN-PAN
1913	VANDEIKYA	2121	SHENDAM
1914	OGBADIBO	2122	WASE
1915	APA	2123	DOMA

Code	Name	Code	Name
22 KD	<u>KADUNA STATE</u>	2321	MASHI
	LGA	2322	MUSAWA
2201	BIRNIN GWARI	2323	MATAZU
2202	CHIKUN	2324	RIMI
2203	IGABI	2325	SAFANA
2204	IKARA	2326	ZANGO
2205	JAMA'A		
2206	KACHIA	24 TB	<u>TARABA STATE</u>
2207	KADUNA		LGA
2208	KAURA	2401	BALI
2209	KAURU	2402	GASHAKA
2210	LERE	2403	JALINGO
2211	SOBA	2404	KARIM/LAMIDO
2212	ZANGON-KATAF	2405	SARDAUNA
2213	ZARIA	2406	TAKUM
2214	MAKARFI	2407	WUKARI
2215	SABON-GARI	2408	YORRO
2216	JABA	2409	ZING
2217	GIWA	2410	DONGA
2218	TUDUN WADA/MAKERA	2411	IBI
		2412	LAU
23 KT	<u>KATSINA STATE</u>	25 AD	<u>ADAMAWA STATE</u>
	LGA		LGA
2301	BAKORI	2501	FUFURE
2302	DANJA	2502	GANYE
2303	BATSARI	2503	GOMBI
2304	BINDAWA	2504	GUYUK
2305	DAURA	2505	HONG
2306	MARIADUWA	2506	MAHIA
2307	DUTSIN-MA	2507	MAYO-BELWA
2308	KURFI	2508	MICHIKA
2309	FASKARI	2509	MUBI
2310	FUNTUA	2510	NUMAN
2311	INGAWA	2511	DEMSA
2312	JIBIA	2512	SONG
2313	KAITA	2513	YOLA
2314	KANKARA	2514	JADA
2315	KANKIA	2515	MADAGALI
2316	KATSINA	2516	SHELLENG
2317	BATAGARAWA		
2318	MALUNFASHI		
2319	KAFUR		
2320	MANI		

Code	Name	Code	Name
26 BA	<u>BAUCHI STATE</u>	2716	KABO
	LGA	2717	KANO
2601	AKKO	2718	KARAYE
2602	ALKALERI	2719	KUMBOTSO
2603	BALANGA	2720	KURA
2604	BAUCHI	2721	MODOBI
2605	BILLIRI	2722	MINJIBIR
2606	DARAZO	2723	NASSARAWA
2607	DASS	2724	RANO
2608	DUKKU	2725	RIMIN-GADO
2609	GAMAWA	2726	TOFA
2610	GOMBE	2727	SHANONO
2611	ITAS/GADAU	2728	SUMALIA
2612	JAMA'ARE	2729	TAKAI
2613	KATAGUM	2730	TSANYAWA
2614	MISAU	2731	TUDUN-WADA
2615	NAFADA	2732	DOGUWA
2616	NINGI	2733	UNGOGO
2617	SHIRA	2734	WUDIL
2618	TAFAWA-BALEWA		
2619	TORO	28 JI	<u>JIGAWA STATE</u>
2620	YAMALTU/DEBA		LGA
2621	KALTUNGO	2801	BABURA
2622	GANJUWA	2802	BIRNIWA
2623	ZAKI	2803	BIRNIN-KUDU
		2804	DUTSE
27 KN	<u>KANO STATE</u>	2805	GARKI
	LGA	2806	GUMEL
2701	ALBASU	2807	SULETANKAR-KAR
2702	BAGWAI	2808	GWARAM
2703	BEBEJE	2809	HADEJIA
2704	KIRU	2810	JAHUM
2705	BICHI	2811	KAFIN-HAUSA
2706	BUNKURE	2812	KAZAURE
2707	DALA	2813	KIRIKASAMA
2708	DAMBATTA	2814	KIYAWA
2709	DAWAKIN-KUDU	2815	MAIGATARI
2710	WARAWA	2816	SULETANKAR-KAR
2711	DAWAKIN-TOFA	2817	MALAM-MADURI
2712	GABASAWA	2818	KAUGAMA
2713	GAYA	2819	RINGIM
2714	GEZAWA	2820	TAURA
2715	GWARZO	2821	RONI
		2822	GWIWA

Code	Name	Code	Name
29 YB	<u>YOBE STATE</u>	3006	DIKWA
	LGA	3007	GWOZA
2901	BADE	3008	KAGA
2902	JARUSKO	3009	MAGUMERI
2903	DAMATURU/DAPCHI	3010	KONDUNGA
2904	BORSARI	3011	MAFA
2905	FIKA	3012	KUKAWA
2906	FUNE	3013	GANZAI
2907	GEIDAM	3014	MAIDUGURI
2908	GUJBA	3015	MOBBAR
2909	YUSUFARI/MACHINA	3016	GUBIO
2910	NANGERE	3017	MONGUNO
2911	NGURU	3018	MARTE
2912	YUNUSARI	3019	NGALA
		3020	SHANI
30 BO	<u>BORNO STATE</u>	3021	HAWUL
	LGA		
3001	ASKIRA-UBA	31 FC	<u>ABUJA FCT</u>
3002	BAMA		LGA
3003	BIU	3101	ABAJI
3004	KWAYA-KUSAR	3102	ABUJA MUNICIPAL
3005	DAMBOA	3103	GWAGWALADA
		3104	KUJE

It may be noted that the local (Nigerian) news in February and March 1993 reported that 11 new LGAs would be added in near future due to the political reasons and also the imbalance in revenue allocation.

### 2.1.3 Administration Base Map

In order to exhibit various socio-economic condition of the Study Area, a base map has been arranged on the basis of the Administration Map (10th edition) with scale of 1/1,000,000 prepared by Federal Survey Department.

## 2.2 NATIONAL ECONOMY

### 2.2.1 General Economic Performance

#### (1) Overview

The steady growth in real output observed since 1987 continued in 1992 although at a lower rate. The aggregate domestic output, as measured by the Gross Domestic Product (GDP) at 1984 constant factor cost stood at 98.42 billion Naira, showing an increase of 4.1 percent, compared with 4.6 and 8.3 percent in 1991 and 1990, respectively.

All the sectors reflected the increase, except mining and quarrying (excluding petroleum) where output stagnated at the 1991 level (See Table 2-2). Agricultural output recorded appreciable growth which, as in the past years, was attributable mainly to favourable weather conditions, improved supply of farm inputs and effective pest control measures. Industrial production recorded a modest increase traceable to the petroleum and manufacturing sub-sectors.

However, GDP per capita expressed in US dollar showed sharp declining trend from US\$991 in 1984 to US\$368 in 1991 due mainly to the floating system in the foreign exchange market in Nigeria, which has brought about substantial devaluation of Nigerian currency against US Dollar. Although the Nigerian economy would show expanding trend in terms of Naira in future, it could be obviously forecasted that GDP per capita in terms of US dollar would continuously decrease taking into account the prevailing sharp devaluation of Naira in the foreign exchange market in Nigeria.

Unemployment rates compiled by the Federal Office of Statistics (FOS), showed that the unemployment rate in the urban centres rose from 4.4 percent in 1991 to 5.8 percent while the rural rate remained at 2.6 percent. Industrial relations were further strained during the year as the number of trade disputes declared increased by 8.3 percent while the number of strikes rose by 6.0 percent.

The pressure on domestic prices further intensified during the year. Data from the FOS showed that the average all-items consumer price index for



1992 stood at 478.4 (1985 = 100), indicating an inflation rate of 44.6 percent compared with 13.0 percent in 1991.

The activities of the Directorate of Food, Roads and Rural Infrastructure (DFRRI) and the Better Life Program (BLP) continued to positively influence the pace of rural development, while notable achievements were recorded in the area of social services.

## (2) Gross Domestic Product

Agricultural sector comprising crops, livestock, forestry and fishery contributed 37.9 billion Naira or 38.5 percent of the GDP. While crops production alone accounted for 29.4 billion Naira or 29.9 percent, livestock, forestry and fishery accounted for 5.4, 1.3 and 1.9 percent, respectively. The share of industrial sector (crude petroleum, mining and quarrying, and manufacturing) was 21.5 billion Naira or 21.8 percent of the GDP. Crude petroleum and Manufacturing accounted for 12.9 and 6.4 percent of the total GDP, respectively. Wholesale and Retail trade, Finance and Insurance, Producers of Government Services contributed 12.3, 8.5 and 8.9 percent, respectively (Table 2-2).

Analysis of real domestic output by expenditure approach showed that private consumption expenditure and government final consumption expenditure accounted for 64.3 billion Naira or 65.2 percent and 8.5 billion Naira or 8.6 percent of the total expenditure, respectively. Gross capital formation and export of goods and non-factor services accounted for 6.2 and 24.2 percent of the total while import of goods and non-factor services accounted for 4.5 percent of the total, respectively. All the expenditure components recorded steady increases in the past four years. A breakdown of the GDP by income approach showed that National Income amounted to 93.8 billion Naira or 95.1 percent of the GDP while net factor income from abroad amounted to 1.9 billion Naira and accounted for 1.1 percent of the GDP.

### 2.2.2 SAP and Related Issues

Nigeria is endowed with large reserves of petroleum and natural gas, receipts from which still dominate foreign exchange earnings and Government

receipts, although the gas subsector remains largely undeveloped. The Nigerian economy recorded a boom in the 1970s when overall real GDP grew at an annual average rate of five percent, reflecting primarily increases in the volume and world price of crude petroleum. Between 1974 and 1980, the FGN took advantage of the sharp rise in petroleum receipts to implement large public sector investments in infrastructure and to increase outlays for social development along with rapid expansion of the provision for Government services.

The contraction in overall economic growth that accompanied the stagnation in the volume of oil exports during the first half of the 1980s was aggravated by the collapse of world oil prices in 1986. Accordingly, an average real GDP recorded no growth during the period of 1981 - 86. The heavy dependence on oil sector created serious adjustment problems after 1980, as the decline in oil receipts imposed a tight external resource constraint on the economy and precipitated a succession of large fiscal and external payments imbalances combined with recession.

By the end of 1985, it had become clear that the belt tightening alone would not solve the more fundamental problems of the economy; as the approach to economic management had to change, the economic structure had to be overhauled in order to promote development of the agricultural sector, the industries that would depend more on local resources had to be curtailed, the enterprising spirit of Nigerian societies and people had to be reawakened and galvanized to build a more self-reliant economy within a realistic global situation. It was also clear that in order to achieve the needed readjustment, various administrative controls in the system had to be removed to minimize the large areas of distortions and bottlenecks in the system and so free it to move along its sustainable and more resilient growth path consistent with the natural endowments.

Accordingly, the FGN made sweeping policy changes with the introduction of its Structural Adjustment Program (SAP) under the IMF and the World Bank in mid-1986 with a view to removing several areas of administrative controls and adopting a free market-oriented economy that would encourage private enterprises and more efficient use of the resources. The objectives of the SAP include:

- Restructuring and diversifying the productive base of the economy to reduce its dependence on the oil sector and imports.
- Achieving in the short to medium-term fiscal and balance of payments viability.
- Laying the basis for sustainable non-inflationary growth.
- Reducing the dominance of unproductive investment in the public sector, improving that sector's efficiency and enhancing the potential of the private sector.

One of the main instruments for achieving those objectives was to alter the system of determining the exchange rate of Naira currency with the open bidding system. This approach which aims at redressing the imbalance in external sector was expected to reduce the demand for imported goods, discourage import-oriented assembling industries, promote agricultural production and encourage non-oil exports. Other key instruments that were adopted under the SAP included the progressive trade and payments liberalization, adoption of appropriate pricing policies for public enterprises and rationalization (i.e. commercialization and privatisation) of public sector enterprises; reduction of Government deficit financing and pursuit of tight monetary and fiscal policies.

At its inception, the SAP was intended to last from July 1986 to June 1988. Among key measures taken immediately upon commencement of the SAP were to establish the Second-Tier Foreign Exchange Market (SFEM); to abrogate the import licensing scheme; to abolish the Commodity Market Board System; and to establish the DFRRRI to pursue a program to open up the rural areas and ameliorate the social and economic infrastructural gap between the urban and the rural. The Technical Committee on Privatization and Commercialization (TCPC) was also established to implement the policy of reorganizing and restructuring public enterprises in order to rationalize the Government's interests in them.

The FGN has taken steps under the SAP to privatize or commercialize some of the Government-owned parastatals and companies in order to rid itself of largely inefficient and wasteful public enterprises embarked upon during oil boom primarily due to the absence of adequate entrepreneurship in the private sector. At this stage, the FGN is doing just that in respect of appropriate public enterprises while those that perform the social functions are being restructured

to be self-sustaining under the commercialization guidelines. A number of the Government parastatals including the RBDA have been commercialized, and the tariffs for the services provided by such parastatals are largely related to their cost of operations. The process has enhanced the revenues of some of the parastatals and raised the levels of their operations and the quality of their services. While the FGN is convinced of the need to eliminate unwarranted subsidies through the adoption of appropriate pricing policy for public services and goods and to rationalize the demand for and consumption of such services and goods to the resources available for procurement, the FGN should continue to monitor the impact of these policies on economy and social environment.

"A Pre-Plan Vision Document Towards A Perspective Development Plan for the Federal Republic of Nigeria" (December 1993) as presented by the NPC depicts that the two most important ingredients in the development process are the availability of resources either endowed, created or acquired from others and the ability to efficiently manage such resources or translate them into goods and services in pursuance of the development objectives. The NPC document further stresses that all of the various constraints on development process may boil down to the absence of needed management capacity to transform the country's enormous resource potentials into real wealth. It follows that the first major constraint on the country's resources management capacity may be closely related with the country's complex ethnic and religious plurality which constantly pitches the micro-nationalistic interests against the national goals and objectives, and this often lead to enormous wastage in the resource utilization and difficulty in enforcing the accountability and curbing the distortionary effects of nepotism and corruption at all levels of the resource management. Next is the nature of the FGN which since independence has made for political instability and lack of continuity being by large substituted the military discipline for planning, and this has meant that each incoming administration has had to design its own programs without much recourse to achievements of the preceding administration.

The timing of SAP was rather inauspicious as the economic austerity that accompanied the sharp decline in world oil prices in early 1986 undermined the public support for the Program, and from the start, it was recognized that the SAP would produce some painful effects. As a matter of fact, the SAP during the seven years since 1986 has suffered from serious policy reverses. The GDP increased in real terms by 5.6 percent in 1987 - 92

compared with 2.5 percent in 1984 - 86 and - 2.9 percent in 1981 - 83. However, since 1991, the economic growth has faltered as its rate has halved from 8.5 percent in 1988 - 90 to 4.4 percent in 1991 - 92. The rapid decline in the exchange rate from US\$1.0 = Naira 0.75 in 1983 to Naira 19.76 at end 1992 reduced the Nigeria's real income to one of the lowest in the world as per capita income dropped from US\$886 in 1983 to US\$310 in 1992. It would appear that, contrary to its objectives, the SAP has increased the dependence of the Nigerian economy on the petroleum sector, and the manufacturing sector has declined from 9.5 to 6.1 percent as of GDP being characterized by low private sector investment, low capacity utilization and high structural unemployment, although there has been some growth in agricultural production.

It seems that the SAP policies of trade liberalization and exchange rate have not produced a sustained positive response in non-oil investment and output. In February 1994, the FGN tightened its grip on the economic regulation to restore discipline and order, hence appropriate monitoring mechanism as an alternative to the SAP with major feature of the economic deregulation. And also, in January 1994, the FGN pegged the exchange rate at US\$1.0 = Naira 22 and ordered that all foreign exchange earnings in the private and public sectors of the economy be paid into a national foreign exchange account, in order to create the right environment for the strengthening of Naira with the recognition of the Naira low-exchange rate as the fundamental factor that has complicated the nation's economic crisis.

As of October 1993, total outstanding external debt was US\$28.72  $\times$  10<sup>9</sup> (Naira 631.84  $\times$  10<sup>9</sup>) made up of multilateral debt (US\$3.72  $\times$  10<sup>9</sup> or 13 percent), bilateral or Paris Club debt (US\$15  $\times$  10<sup>9</sup> or 52 percent), London Club of Commercial Banks (US\$2  $\times$  10<sup>9</sup> or 7 percent) and promissory notes and other private lenders (US\$8  $\times$  10<sup>9</sup> or 28 percent). It is scheduled in the 1994 FGN budget that US\$1.8  $\times$  10<sup>9</sup> (Naira 39.6  $\times$  10<sup>9</sup>) out of the Naira 10.2  $\times$  10<sup>9</sup> budget in total will be spent on debt servicing while the 1994 total debt service due is US\$4.4  $\times$  10<sup>9</sup> (Naira 96.7  $\times$  10<sup>9</sup>). The FGN receipt of funds from the international financial institutions in 1994 is estimated at US\$899.97  $\times$  10<sup>6</sup> (Naira 19.8  $\times$  10<sup>9</sup>) comprising 49 percent from the World Bank group, 14 percent from AfDP, 7 percent from ECOWAS fund, 23 percent from the Paris Club and 7 percent from other bilateral sources (The Guardians, Jan. 12, 1994).

It is reported that no new debt relief was concluded in 1993 due principally to the protracted and inconclusive negotiations with the World Bank and the IMF on the envisaged Medium Term Economic Program and some unsolved economic obligations. The FGN plans to look forward a package of debt relief measures including rescheduling of the Paris Club debt and debt cancellation and inflow of concessional resources on both the Enhanced Structural Adjustment Facility (ESAF) and the International Development Assistance (IDA) terms.

### 2.2.3 Federal and State Budget Allocation

In the National Rolling Plan 1992 - 94, the total budget allocated is amounting to  $45.4 \times 10^9$  Naira, out of which about 55 percent or  $25.0 \times 10^9$  Naira is allocated to the FGN and the rest  $20.4 \times 10^9$  Naira to the State Governments. While about 23 percent or  $5.9 \times 10^9$  Naira is allocated to the agricultural sector including  $0.6 \times 10^9$  Naira for the water resources sector in the Federal budget, about 15 percent or  $3.0 \times 10^9$  Naira to the agricultural sector including almost nil (only  $10 \times 10^6$  Naira in Imo State) to the water resources sector in the State budget.

In connection with the budget allocated to the agricultural sector, while the crop/fertilizer sub-sector occupies about 66 percent or  $3.84 \times 10^9$  Naira, followed by the NALDA (National Land Development Authority) with 15 percent or  $0.90 \times 10^9$  Naira and 11 percent or  $0.62 \times 10^9$  to the water resources sector in the Federal budget, the crop/fertilizer does about 72 percent or  $2.18 \times 10^9$  Naira, followed by the forestry with 13 percent or  $0.38 \times 10^9$  Naira and the livestock sector with 9 percent or  $0.28 \times 10^9$  Naira (See Table 2-3).

When combining the water supply sector with the water resources sector in the State budget allocation, 20 percent or  $0.28 \times 10^9$  Naira is allocated to Niger State, followed by 12 percent or  $0.17 \times 10^9$  Naira to Lagos State, on the other hand, those states of Oyo, Edo, Delta, Cross River, Plateau, Taraba, Jigawa, Borno and Yobe are allocated with nil or very minimal amount.