

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)

SUMMARY AND MAIN TEXT

VOLUME ONE

MARCH 1995

SANYU CONSULTANTS INC.  
SUMIKO CONSULTANTS CO. LTD.

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**CURRENCY EQUIVALENTS**

(a/o 15 February 1994)

US\$1.00	= N 22	= ¥ 110
¥ 100	= N20	= US\$0.909
N 1.00	= US\$0.045	= ¥ 5

¥ ..... Japanese Yen

N..... Naira



## PREFACE

In response to a request from the Government of the Federal Republic of Nigeria, the Government of Japan decided to conduct a study on The National Water Resources Master Plan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Nigeria a study team headed by Mr. Shigeru Ito, Sanyu Consultants Inc., four times between April, 1992 and February, 1995.

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

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

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

March, 1995



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Kimio Fujita  
President

Japan International Cooperation Agency



# THE STUDY ON THE NATIONAL WATER RESOURCES MASTER PLAN

Study Period: March 1992 to March 1995

## ABSTRACT

### 1. Background

In Nigeria that is endowed with comparatively large reserves of the water resources, the nationwide water resources development came into existence in the 1970s in connection with the buoyant oil revenues and will be more promoted to meet an increasing water demand in various sectors. The Federal Ministry of Water Resources and Rural Development initiated in 1984 the preparation of a National Water Resources Master Plan with FAO assistance, but a draft plan as submitted in 1985 did not compile all the issues sectorally and comprehensively, and the FAO assistance could not stretch further to address these issues for the lack of fund and others. Under this situation, the Federal Government of Nigeria made an official request to the Government of Japan for assistance in updating the original draft by addressing its shortcomings and drawing up a complete Plan.

Review of the water resources development and management so far conducted indicates that the policy has been favored with the implementation of large-scale development with little attention to the water operations throughout a river system and also with few concern with the benefit accrual from it; on the other, the Government concerned would be generally inactive in preparation of the water resources inventory and performance of the water administration as a whole. In addition, the recent stagnation in Government spending originated from a succession of the large fiscal and external payment imbalances combined with economic recession has caused the Government to meet difficulty in giving the priority for effective and meaningful water resources program.

## **2. Objectives**

The objective of the Study is to formulate a National Water Resources Master Plan which assures the optimum water resources use and provides the appropriate development scenarios on short (year 2000) - and long (year 2020) - term basis in meeting the predicted social - economic demand for regions over a wide range of water activities including the quantitative and qualitative assessment of water resources potentials; the development and management of potential projects for water source works, irrigation and drainage, water supply and sanitation, and other related components such as hydropower generation, inland navigation and inland fisheries; the integrated management of surface and groundwater and rivers; the watershed management inclusive of gully disaster control; the water-related environmental management; and the appropriate water administration.

## **3. The Study Area**

The entire area of the Federal Republic of Nigeria which is administratively composed of 30 States and the Federal Capital Territory has been divided into eight Hydrological Areas and six Regions for the convenience of presenting the items relevant to the Plan in terms of watershed integrity and water actions being regional than local in scope. Current status of the water resources development and associated water use as evaluated are summarized in the attached table "Major Indicators in the Plan".

## **4. The Master Plan**

### **4.1 Basic Strategies**

Four strategies have been formulated putting the Plan targets on short-and long-term basis, respectively:

#### **(1) Enforcement of the 1993 Water Resources Decree:**

The establishment of a series of the regulations needed for proper enforcement of the provisions in this Decree, and the organizational



strengthening of related administration should be made as the Short-term target.

**(2) Consolidation of the Hydrological Observation Network and Continuous Monitoring:**

Consolidating the network of observing the surface and groundwater behaviors and related management system which has paid little attention should be completed as the Short-term target.

**(3) Proper Operations and Management of Existing Water Resources Projects and Facilities:**

To overcome a number of the problems identified, the Short-term target has been provided for the preparation of reservoir water operations rules, the organizational set-up of water users associations, the rehabilitation of defective and deteriorated facilities mainly due to the shortage of regular repair works, and the strengthening of operation and maintenance program for project works.

**(4) Completion of the Water Systems Downstream of Existing Reservoirs:**

At present, there are many of the incomplete water use systems and facilities for irrigation and water supply downstream of the already constructed dams; thereby, the effort to accelerate the development of these water resources projects should be realized as the Short-term target. In this occasion, the items in the above para. (3) should be applied.

**(5) Appropriate Implementation of New Water Resources Projects with the Priority Given to Small and Medium Size:**

The Plan by 2020 has established a target area for an irrigated agriculture of  $1.5 \times 10^6$  ha and a target access rate to the safe water supply at 80 percent of the predicted population ( $186 \times 10^6$ ).

In addition to consolidating existing and on-going projects as mentioned above, the Plan calls for a drastic change from the large-scale oriented to the direction to implement a series of the proposed small- and medium-scale multipurpose water resources projects to meet the water demand

anticipated in various sectors with a particular emphasis upon the effective programs of decentralization, privatisation and users participation to facilitate the greater participation and deeper involvement of local people concerned. And, the priority area should be shifted to the Middle Zone for irrigation and the Southern Zone for water supply being apart from the Northern Zone where main thrust is moving towards the promotion of more efficient water resources management programs. The JICA Team stresses that the experience and knowledge to be accumulated from positive implementation of the proposed small and medium ones for which the preparation should almost be completed by 2000 will be a great asset in complementing future development of the larger projects in more logical way.

#### **4.2 Scope of the Projects and Service Levels Involved**

In accordance with the Strategies as mentioned above, the scope of the projects and related service levels involved in the Plan by 2020 is summarized in the attached table "Major Indicators in the Plan".

#### **5. Financial Requirements for the Plan**

The costs required for implementation of the Plan are enumerated by applying the price level of February 1994 taking into account the exclusion of uncertain inflation factors, and those for the public sector projects and programs are shown dividing into each five-year period by 2000:

(Unit: 10<sup>6</sup> Naira)

	1996~2000	2001~2005	2006~2010	2011~2015	2016~2020	Total
1. Water Resources Monitoring	270	250	230	240	250	1,240
2. Water Source Works	800	7,300	9,400	10,900	13,300	41,700
Rehabilitation and Improvement	600	-	-	-	-	600
Proposed Multipurpose Dams	200	7,300	9,400	10,900	13,300	41,100
3. Public Irrigation and Drainage	7,780	7,580	6,450	7,690	8,930	38,430
Rehabilitation and Improvement	7,680	3,100	-	-	-	10,780
Proposed	100	4,480	6,450	7,690	8,930	27,650
4. Water Supply	40,780	25,610	59,590	74,260	113,540	313,780
Rehabilitation	3,400	5,160	21,020	10,050	13,260	52,890
Proposed	37,380	20,450	35,130	49,050	67,820	209,830
Reconstruction	-	-	3,430	15,160	32,460	51,050
5. Dadin Kowa Hydro Development under NEPA	600	-	-	-	-	600
6. Gully Restoration Works	-	-	-	-	-	-
Total (1. + 2. + 3.)	8,850	15,130	16,080	18,830	22,480	81,370
Total (1. ~ 6.)	-	-	-	-	-	-
<b>Total</b>	<b>53,890</b>	<b>40,740</b>	<b>75,690</b>	<b>93,090</b>	<b>136,020</b>	<b>399,410</b>

The financial feasibility for the Plan which examines a comparison between the average annual costs required and the anticipated annual budgets as calculated based upon an annual real growth rate of three percent to the current budget inclusive of the State budgets and external loans concerned, reveals that apart from the sectors of water resources monitoring and irrigation and drainage, a huge budget would be required for the water supply component to meet the Basic Human Needs. If the budgetary arrangement during the Plan period is kept at present level without any extra expansion, it may be understood that the conditions for water supply in 2020 would be in a range of the service population rate of 60 to 70 percent for urban and 30 to 40 percent for rural.

(Unit: 10<sup>9</sup> Naira)

	Average Annual Costs Required for the Plan - A -	Anticipated Annual Budgets During the Plan Period - B -	A/B
1. Water Resources Monitoring	0.005	0.036	0.2
2. Public Irrigation and Drainage	2.737	2.653	1.0
3. Water Supply	12.911	4.167	3.1
Total (1. + 2.)	2.742	2.689	1.1
<b>Total: (1. + 2. + 3.)</b>	<b>15.653</b>	<b>6.856</b>	<b>2.3</b>

## **6. Evaluation of the Plan**

It may be judged that the projects and programs as incorporated in the Plan would be economically viable and environmentally sound when the remedial measures are properly taken.

### **6.1 Project Economic Justification**

The standard practice in terms of the economic rate of return (ERR) as is internationally applied has been employed by taking only the irrigated farming benefits for the evaluation of the public irrigation and drainage projects, indicating the ERRs of around 10 percent for the Northern region, 10 to 14 percent for the Central and more than 14 percent for the Southern. For the water supply sector, the least-cost approach has been taken resulting in the water rates chargeable per cu.m for recovery of OM and replacement costs at 2 to 3 Naira for surface water and 2 to 4.5 Naira for groundwater; it may be considered that these rates would be in the acceptable range until users could attain a satisfactory level of income to bear the water rate for a full cost recovery.

### **6.2 Environmental Assessment**

The significant environmental problems have been addressed on regional and project basis including the drought and desertification; the imbalance between water resources potential and use due to improper development; the neglect of traditional water rights in wetlands; the increase of sediment, gully erosion disasters and urban flooding due to man-made watershed disturbance; the frequent occurrence of water-related diseases; the losses of fishery and wildlife resources; and so forth. The Plan calls for strict enforcement of the Environmental Impact Assessment (EIA) as an integral part of the water resources project cycle in line with the presentative of its procedures and guidelines as well as the urgent implementation of a proposed program on the EIA study and environmental monitoring for typical existing and proposed dams.

## **7. Recommendations**

Major recommendations for appropriate implementation of the Plan are given below while many suggestions and proposals are compiled in the Report:

- 1) To achieve a unitary administration and proper coordination for the enforcement of the 1993 Water Resources Decree, a competent Department of Water Administration should be created as a cornerstone of other operational Departments, the Ministry which is established in a form of enlarging and amalgamating the functions of existing Department of Hydrology and Hydrogeology that are not directly related to the public administration but to merely the technical oriented. It is also suggested to provide this Department with three Divisions such as (1) Water Use Coordination, (2) Hydrology and Hydrogeology (for Federal Administration) and (3) Environmental Management (for EIA and Watershed Management), and to strengthen the day-to-day regional water administration to be increased in work load with the establishment of four Regional Water Administration Offices. On the other hand, the technical responsibility of hydrology and hydrogeology should be concentrated in the National Water Resources Institute while strengthening the function of a National Water Resources Databank Centre and the budgetary arrangement to support the consolidation of hydrological observation network and continuous monitoring.
- 2) It is recommended to confine the responsibility of 12 River Basin Development Authorities that are presently being directed to operate as profit making commercial ventures under the 1988 Privatisation and Commercialization Decree into that for developing multipurpose water storages and conveying the raw water for the purpose of various sectors with the amount and timing needed by the downstream users at the designated points with appropriate cost arrangement, viz. the delivery point to Water Users Association for irrigation and to State Water Agency for water supply. In this respect, the cost allocation of multipurpose facilities should be put into practice. In addition, in view of the technical weakness in the State-run water resources projects, all of the water resources development even for small-scaled in the Plan should be

operated by the Authorities until such time as the engineering capability of the States is substantially upgraded.

- 3) With the strict review that the continued decline in the performance of irrigated agriculture and the inadequacy of water supply systems have brought the current top-down approach under great scrutiny, it should be understood that the promotion of decentralization, privatisation and users participation including the mobilization of social impact by women power in the water resources service area and the upgrading of users' water use technology and related efficiency be a key in achieving successful construction and sustainable management of the water resources project; therefore, it should be a pre-requisite to have the water users organize a functional water users association and request a project implementation to the Ministry in legal mode prior to the project formulation as well as participate in construction and subsequent management of the project through the Government's positive technical assistance and proper participatory arrangement. In addition, the institutional arrangement needs to be developed which would encourage the water-related Federal and State agencies to coordinate and establish mutually agreed upon priorities and policies for investment, regulation and allocation, especially for the management of river basins in term of water quality, human health and environmental consequences.
- 4) It is stressed that severe shortage of the trained manpower in quantitative and qualitative term within the Water Resources Sector may be a major constraint of implementing the Plan in a feasible manner. The Plan has also identified that the transfer and development of appropriate water resources and environmental technologies are a long and painstaking venture by the Ministry which calls for a national water resources manpower training program by the external experts to assist the National Water Resources Institute in strengthening its manpower training scheme with "Action-Learning" or "Action - Research" approach in all technical and water administrative fields. Additional leading issue is that the primary one is incentives, motivation, dedication and accountability for all staff, but particularly for middle-class officials whose performance has the most decisive impact on institutional efficiency, while the senior managers need the innovation of their mind and consciousness.

- 5) While there are more needs of the projects and programs to be assisted by international organizations or bilateral agencies where the study and preparation should be carried out upon setting clear guidelines in line with the internationally recognized standard, it is highly recommended that the top priority be given to prompt implementation of a feasibility study on the proposed Comprehensive River Basin Management Program in a particular basin with existing water resources development facilities as a pilot model for future demonstration and application to other basins. The Program intends to work out a realizable scenario on income generation and its sustainable development for the rural people's benefits through the establishment of a solid foundation for water resources development and management and also the improvement of financial accountability and relevant extension services of autonomous utilities concerned through building the proper program management system.
  
- 6) It is advised that a supplemental survey of the National Water Resources Inventory which was presented during the course of the JICA Study should be promptly carried out upon overcoming the inherent defectiveness on database and inventory preparation in each Government agency, and also all of the database should be adequately incorporated into the National Water Resources Databank Centre. Moreover, the JICA Team suggests that the work to revise and upgrade the National Water Resources Master Plan as presented herewith shall be carried out every five year during its implementing period.

## MAJOR INDICATORS IN NATIONAL WATER RESOURCES MASTER PLAN

Region Hydrological Area	NW HA-I	NE HA-III	CW HA-II	CE HAs-III/IV	SW HA-VI	SE HAs-VI	Total
<b>1. Area (10<sup>3</sup> sq.km)</b>	131.6	188.0	158.1	231.9	100.5	113.7	923.8
<b>2. Population (10<sup>6</sup>)</b>							
- 1991	10.3	16.8	10.5	9.7	22.3	18.9	88.5
- 2020	17.0	28.2	25.3	24.4	49.3	41.8	186.0
- Growth Rate (% p.a.)	1.74	1.80	3.08	3.23	2.77	2.77	2.59
<b>3. Potential Water Resources</b>							
<b>3.1 Surface Water</b>							
- Annual Yield (10 <sup>9</sup> cu.m)	22.4	8.2	32.6	83.0	35.4	85.7	267.3
- Specific Yield (mm p.a.)	38	44	206	245	352	674	178
<b>3.2 Groundwater</b>							
- Annual Yield (10 <sup>9</sup> cu.m)	4.3	5.6	8.2	11.4	9.0	13.4	51.9
- Specific Yield (mm p.a.)	33	30	52	49	132	118	56
<b>4. Existing Development</b>							
<b>4.1 Water Storages</b>							
- No. of Dams	20	23	32	35	32	18	160
- Active Capacity (10 <sup>6</sup> cu.m)	13,269	5,951	7,980	2,413	1,053	2	30,668
<b>4.2 Irrigation and Drainage</b>							
- Public: Service area (10 <sup>3</sup> ha)	8	27	12	12	3	8	70
- Private: Service Area (10 <sup>3</sup> ha)	35	98	10	3	0	4	150
<b>4.3 Public Water Supply</b>	(Per capita demand: 108 lcd for Urban and 40 lcd for Rural)						
- Urban: Service Population (%)	67	58	82	44	45	35	50
- Rural: Service Population (%)	10	9	10	9	10	6	9
<b>4.4 Water Use Rate</b>							
- Surface Water (%)	2.1	14.6	1.1	0.3	0.8	0.2	1.0
- Groundwater (%)	0.5	1.1	0.2	0.1	0.9	0.5	0.5
<b>5. Proposed Development in the NWRMP</b>							
<b>5.1 Water Storages Newly Proposed</b>							
- No. of Multipurpose Dams	64	20	304	362	141	193	1,084
- Active Capacity (10 <sup>6</sup> cu.m)	950	100	4,090	4,690	1,410	1,720	12,960
<b>5.2 Irrigation and Drainage in 2020</b>							
- Public: Service Area (10 <sup>3</sup> ha)	120	95	305	305	115	180	1,120
- Private: Service Area (10 <sup>3</sup> ha)	75	190	40	45	10	20	380
<b>5.3 Public Water Supply in 2020</b>	(Per capita demand: 216 lcd for Urban and 80 lcd for Rural)						
- Service Population	← 80% for both of Urban and Rural →						
- No. of Boreholes (10 <sup>3</sup> )	36.96	59.23	38.43	49.68	44.70	57.80	286.80
Existing	4.16	5.23	3.03	2.88	3.10	3.00	21.40
Additional	32.8	54.0	35.4	46.8	41.6	54.8	265.4
<b>5.4 Water Use Rate in 2020</b>							
- Surface Water (%)	9.1	35.6	13.5	5.5	9.8	3.3	7.6
- Groundwater (%)	7.8	11.1	4.5	3.7	10.8	8.9	7.5
<b>5.5 Capital Costs Required (10<sup>6</sup> Naira) at 1994 Price Level</b>							
- Water Resources Monitoring	154	188	187	214	224	273	1,240
- Water Storage	3,000	470	11,950	14,650	5,320	6,310	41,700
BMR	300	170	50	50	20	10	600
Proposed Multipurpose Dams	2,700	300	11,900	14,600	5,300	6,300	41,100
- Irrigation and Drainage	4,734	4,122	12,013	12,127	4,499	8,735	46,230
Public BMR	48	162	72	72	18	48	420
Public Proposed	3,802	2,738	10,043	9,923	3,922	7,582	38,010
Private Proposed	884	1,222	1,898	2,132	559	1,105	7,800
- Public Water Supply	25,940	45,360	39,690	36,740	100,920	5,130	313,780
BMR	5,230	8,440	7,080	5,970	16,590	9,580	52,890
Proposed	15,800	27,180	26,870	25,020	71,400	43,560	209,830
Reconstruction	4,910	9,740	5,740	5,750	12,930	11,990	51,060



## REGIONAL DIVISIONS

For the convenience of presenting the items relevant to the NWRMP to ensure that the watershed integrity is properly maintained and strengthened and the water resources are adequately managed with a concept that these actions should be regional rather than local in scope, Nigeria has been divided into six Regions taking into account the principal geographical features and climatic-agroecological regions:

No.	Region	Hydrological Area (HA)		States
1.	North-West	HA-I	(Niger-North)	Kebbi, Sokoto, Katsina (3)
2.	North-East	HA-VIII	(Lake Chad)	Kano, Jigawa, Yobe, Borno, Buchi (5)
3.	Central West	HA-II	(Niger-Central)	Niger, Kwara, Kaduna, Kogi, Abuja ECT (5)
4.	Central East	HAs-III & IV	(Upper Benue & Lower Benue)	Adamawa, Taraba, Plateau, Benue (4)
5.	South-West	HA-VI	(Western Littoral)	Oyo, Ogun, Oshun, Lagos, Ondo, Edo, Delta (7)
6.	South-East	HAs-V & VII	(Niger South & Eastern Littoral)	Anambra, Imo Rivers, Enugu, Abia, Akwa Ibom, Cross River (7)

Since the boundary of each Region does not always coincide with those of the States included, the areas included in HA-wise and States-wise are compared:

No.	Region	Area		Hydrological Area (HA)	Area of the States Included		
		(sq.km)	(%)		(sq.km)	(sq.km)	(%)
1.	North-West	131.6	(14.2)	HA-I	131.6	129.3	(14.0)
2.	North-East	188.0	(20.3)	HA-VIII	188.0	233.5	(25.3)
3.	Central West	158.1	(17.1)	HA-II	158.1	187.2	(20.3)
4.	Central East	231.9	(25.1)	HA-III	158.9	181.4	(19.6)
				HA-IV	73.0		
5.	South-West	100.5	(10.9)	HA-VI	100.5	115.0	(12.4)
6.	South-East	113.7	(12.4)	HA-V	53.9	77.4	(8.4)
				HA-VII	59.8		
	Total	923.8	(100.0)		923.8	923.8	(100.0)

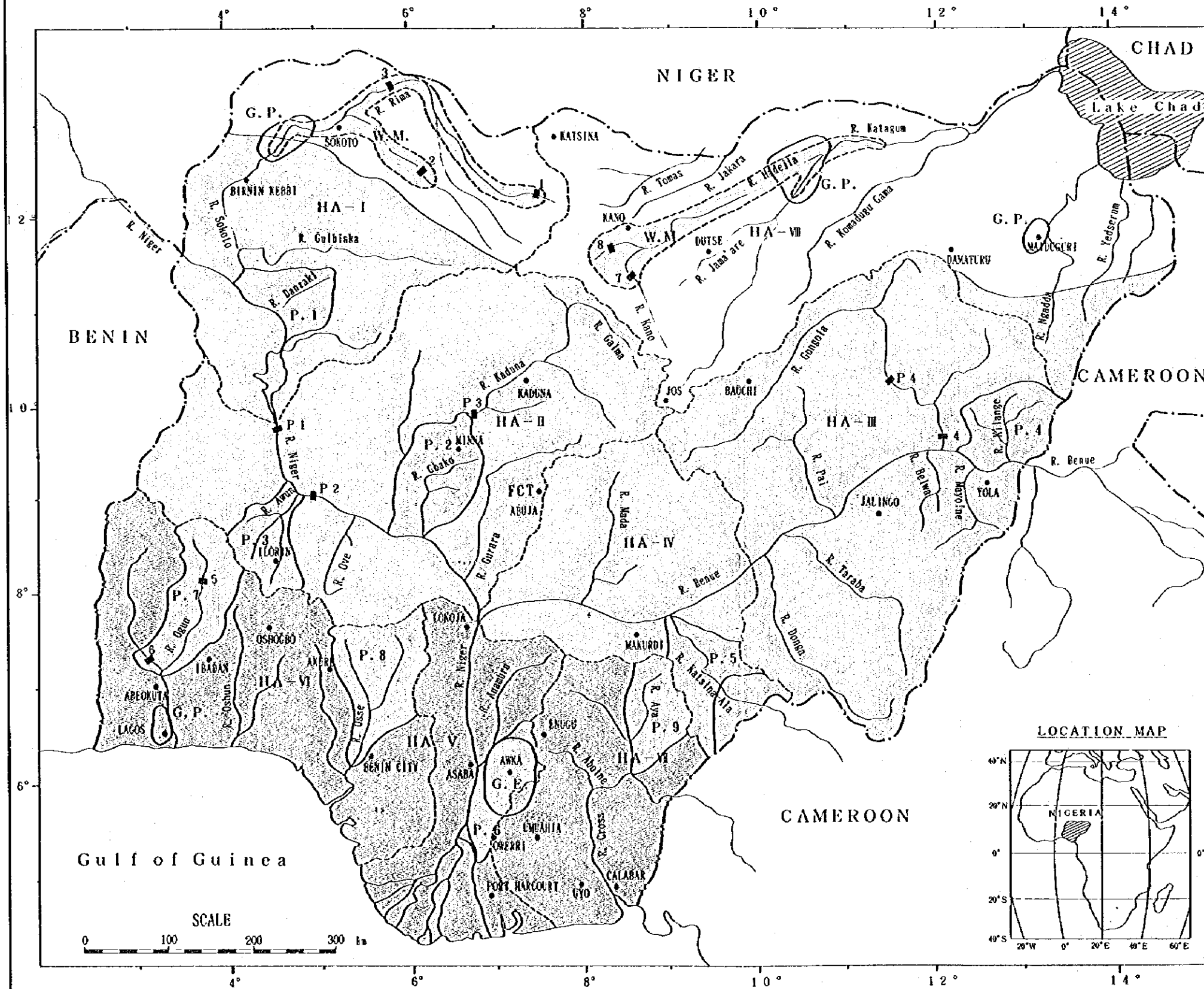
Six Regions as demarcated above has the general relationship with other presentations as applied in various publications:

<u>NWRMP Region</u>	<u>Agro- Ecological Zone</u>	<u>Climate Zone</u>
North-West North-East	Northern Grain Zone (Z-I)	Sudan Savanna
Central West Central East	Mixed Root Crop and Grain Zone (Z-II)	Guinea Savanna
South-West South-East	Southern Tree and Root Zone (Z-III)	Rain Forest

It may be noted that aside from the above-designated regional divisions, the terms of "Northern Zone", "Middle Zone" and "Southern Zone" are employed in this Report with respect to major strategies on the water resources management and development as examined in the NWRMP, and their boundaries do not coincide with those of regional divisions. For instance, the main strategy for the North Region is to strengthen the water resources management for existing water storages, but some of the sub-Hydrological Areas in its southern part are directed with the strategy on positive development of medium and small-sized water resources projects. In the Middle Zone, the water resources development in the NWRMP will be promoted with major emphasis upon public irrigation with supplemental role in public water supply, while that in the Southern Zone is vice versa.



# NATIONAL WATER RESOURCES MASTER PLAN (TARGET YEAR : 2020)



### GENERAL TARGET

1. Northern Zone : ○  
Water resources management
2. Middle zone : ◐  
Medium/small-scale water resources development  
for irrigation and water supply
3. Southern Zone : ◑  
Medium/small-scale water resources development  
for water supply and irrigation

### PRIORITY BASINS FOR WATER RESOURCES DEVELOPMENT

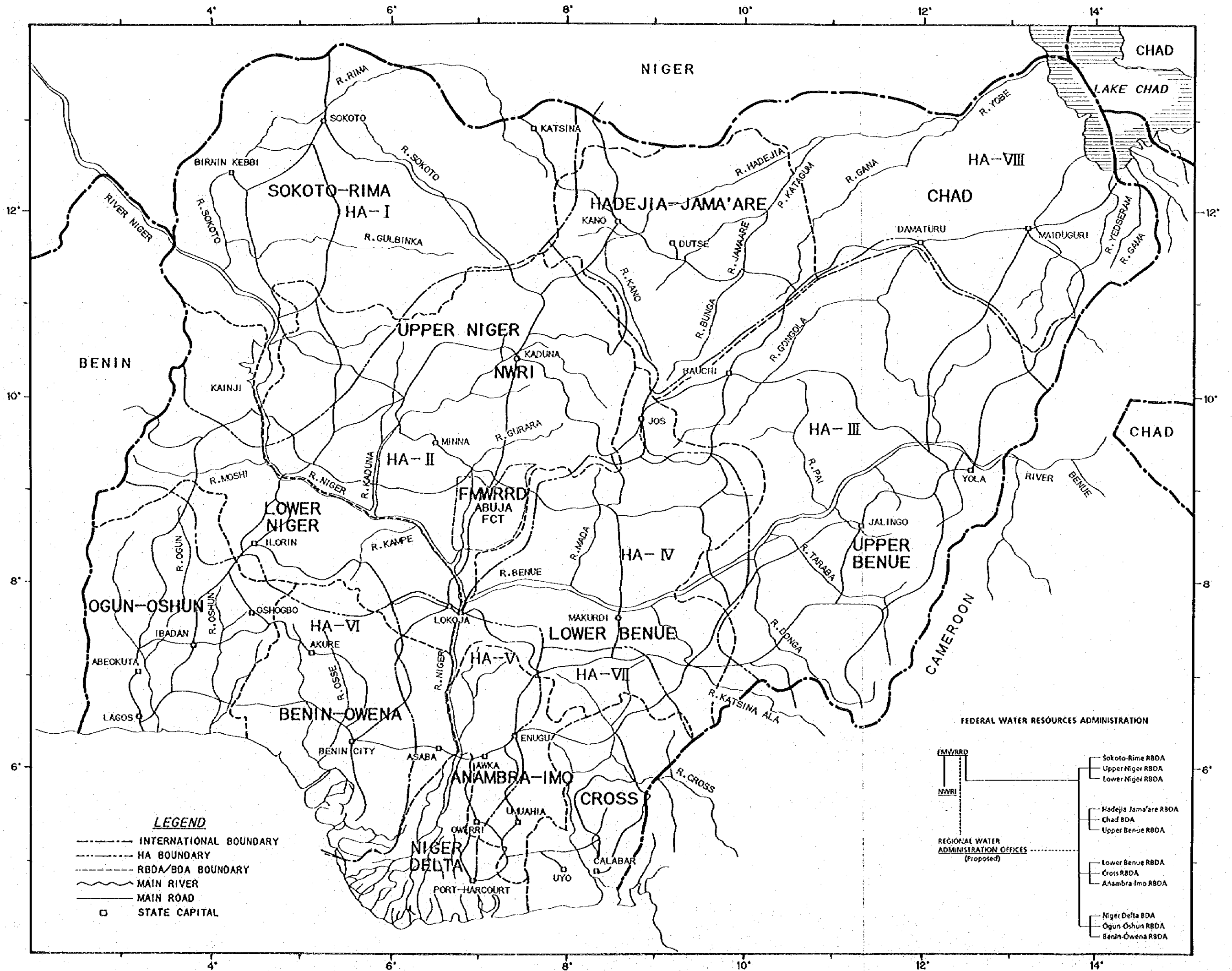
- |   |       |
|---|-------|
| 1. Danzaki (SHA 110): Sokoto-Rima RBDA            | (P.1) |
| 2. Gbako (SHA 214): Upper Niger RBDA              | (P.2) |
| 3. Awun (SHA 204): Lower Niger RBDA               | (P.3) |
| 4. Kilange (SHA 301): Upper Benue RBDA            | (P.4) |
| 5. Katsina-Ala (SSHA 4052 to 3): Lower Benue RBDA | (P.5) |
| 6. Mamu (SHA 504): Anambra-Imo RBDA               | (P.6) |
| 7. Upper Ogun (SSHA 6022 to 3): Ogun-Oshun RBDA   | (P.7) |
| 8. Osse (SHA 608): Benin-Owena RBDA               | (P.8) |
| 9. Aya (SHA 702): Cross RBDA                      | (P.9) |

### AREAS FOR SPECIAL ATTENTION

- |  |          |
|--|----------|
| 1. Water Management under Existing Reservoirs                  | : (W.M.) |
| 2. Groundwater Monitoring and Surveillance Programs<br>by 2000 | : (G.P.) |
| 3. Severe Gully Erosion Disaster                               | : (G.E.) |

### GENERAL LEGEND

- |                          |                   |
|--------------------------|-------------------|
| International Boundary   | — — — — —         |
| State Capital            | •                 |
| Major River              | ~~~~~             |
| HA-Boundary              | - - - - -         |
| Existing Major Dam       | ■                 |
| - For Irrigation General | ■                 |
| 1. Zobe                  | 5. Ikere Gorge    |
| 2. Bakolori              | 6. Oyan           |
| 3. Coronyo               | 7. Tiga           |
| 4. Kiri                  | 8. Challawa Gorge |
| - For Power Specific     | ■                 |
| P1. Kainji               | P3. Shiroro       |
| P2. Jebba                | P4. Dadin Kowa    |



## COMPOSITION OF THE REPORT

The 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	
CHAPTER 7. Gully Erosion and Flood Control	Part 2
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 One: SUMMARY AND MAIN TEXT**

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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## **ABBREVIATIONS**

<b>ACS</b>	<b>Agricultural Cooperative Society</b>
<b>AD</b>	<b>Anno Domini</b>
<b>ADP</b>	<b>Agricultural Development Project</b>
<b>AfDB</b>	<b>African Development Bank</b>
<b>APMEU</b>	<b>Agricultural Project Monitoring and Evaluation Unit, FDA</b>
<b>ARAC</b>	<b>African Regional Aquaculture Center</b>
<b>BHN</b>	<b>Basic Human Needs</b>
<b>BLP</b>	<b>Better Life Program</b>
<b>BMR</b>	<b>Balancing Modernization and Rehabilitation</b>
<b>BRCP</b>	<b>Basic Reference Control Point</b>
<b>CBDA</b>	<b>Chad Basin Development Authority</b>
<b>CBN</b>	<b>Central Bank of Nigeria</b>
<b>CCT</b>	<b>Computer Compatible Tapes</b>
<b>CPI</b>	<b>Consumer Price Index</b>
<b>CWS</b>	<b>Community Water Supply</b>
<b>DFRRI</b>	<b>Directorate of Food, Roads and Rural Infrastructure</b>
<b>DID</b>	<b>Department of Irrigation and Drainage</b>
<b>DRC</b>	<b>Domestic Resource Cost</b>
<b>DRP</b>	<b>Drought Relief Programme</b>
<b>EA</b>	<b>Environmental Assessment</b>
<b>ECOWAS</b>	<b>Economic Community of West African States</b>
<b>EEC</b>	<b>European Economic Commission</b>
<b>EFO</b>	<b>Ecological Funds Office</b>
<b>EIA</b>	<b>Environmental Impact Assessment</b>
<b>EM</b>	<b>Electro-Magnetic</b>
<b>EMP</b>	<b>Environmental Management Plan</b>
<b>EOJ</b>	<b>Embassy of Japan</b>
<b>EOSAT</b>	<b>Earth Observation Satellite Company</b>
<b>EPM</b>	<b>Environmental Protection Measures</b>
<b>ER</b>	<b>Electrical Resistivity</b>
<b>ERR</b>	<b>Economic Rate of Return</b>
<b>ERTS</b>	<b>Earth Resources Technology Satellite</b>
<b>ESAF</b>	<b>Economic Structure Adjustment Facility</b>
<b>ET</b>	<b>Evapotranspiration</b>
<b>FACU</b>	<b>Federal Agricultural Coordination Unit</b>
<b>FAO</b>	<b>Food and Agriculture Organization</b>
<b>FAO/CP</b>	<b>Food and Agriculture Organization / World Bank Cooperative Program</b>
<b>FCI</b>	<b>Federal Comprehensive Inspection</b>
<b>FCT</b>	<b>Federal Capital Territory</b>

<b>FDA</b>	<b>Federal Department of Agriculture</b>
<b>FDALR</b>	<b>Federal Department of Agricultural Land Resources</b>
<b>FDF</b>	<b>Federal Department of Forestry or Fisheries</b>
<b>FDHH</b>	<b>Federal Department of Hydrology and Hydrogeology</b>
<b>FDMS</b>	<b>Federal Department of Meteorological Services</b>
<b>FDWR</b>	<b>Federal Department of Water Resources</b>
<b>FEM</b>	<b>Foreign Exchange Market</b>
<b>FEPA</b>	<b>Federal Environmental Protection Agency</b>
<b>FGN</b>	<b>Federal Government of Nigeria</b>
<b>FGSN</b>	<b>Federal Geological Survey of Nigeria</b>
<b>FIG</b>	<b>Farmers Irrigation Group</b>
<b>FIWD</b>	<b>Federal Inland Waterways Department</b>
<b>FMANR</b>	<b>Federal Ministry of Agriculture and Natural Resources</b>
<b>FMAWRD</b>	<b>Federal Ministry of Agriculture, Water Resources and Rural Development</b>
<b>FMFED</b>	<b>Federal Ministry of Finance and Economic Development</b>
<b>FMHH</b>	<b>Federal Ministry of Health and Human Services</b>
<b>FMWH</b>	<b>Federal Ministry of Works and Housing</b>
<b>FMWR</b>	<b>Federal Ministry of Water Resources</b>
<b>FMWRRD</b>	<b>Federal Ministry of Water Resources and Rural Development</b>
<b>FOS</b>	<b>Federal Office of Statistics</b>
<b>FSN</b>	<b>Federal Surveys of Nigeria</b>
<b>FUA</b>	<b>Fadama Users Association</b>
<b>GDP</b>	<b>Gross Domestic Product</b>
<b>GIS</b>	<b>Geographical Information System</b>
<b>GNP</b>	<b>Gross National Product</b>
<b>II-NWP</b>	<b>Hadejia-Nguru Wetlands Project</b>
<b>HA</b>	<b>Hydrological Area</b> SHA : Sub-Hydrological Area SSHA : Sub-SHA
<b>ha</b>	<b>hectare</b>
<b>HGA</b>	<b>Hydrogeological Area</b>
<b>IB</b>	<b>Irrigation Block</b>
<b>ICID</b>	<b>International Commission for Irrigation and Drainage</b>
<b>ICOLD</b>	<b>International Commission on Large Dams</b>
<b>IDA</b>	<b>International Development Association</b>
<b>IDT</b>	<b>Inter-Tropical Discontinuity</b>
<b>IDWSSD</b>	<b>International Drinking Water Supply and Sanitation Decade</b>

<b>IFOV</b>	<b>Instantaneous-field-of-view</b>
<b>ILO</b>	<b>International Labor Organization</b>
<b>IITA</b>	<b>International Institute of Tropical Agriculture, Ibadan</b>
<b>IMF</b>	<b>International Monetary Fund</b>
<b>IUCN</b>	<b>International Union for the Conservation of Nature (The World Conservation Union)</b>
<b>JICA</b>	<b>Japan International Cooperation Agency</b>
<b>KLRI</b>	<b>Kainji Lake Research Institute</b>
<b>KNALDA</b>	<b>Kano State Agricultural and Rural Development Authority</b>
<b>LCBC</b>	<b>Lake Chad Basin Commission</b>
<b>LCHF</b>	<b>Laboratoire Central D'hydraulique de France</b>
<b>LG</b>	<b>Local Government</b>
<b>LGA</b>	<b>Local Government Area</b>
<b>LGC</b>	<b>Local Government Council</b>
<b>lpcd</b>	<b>litre per capita per day</b>
<b>MANR</b>	<b>Ministry of Agriculture and Natural Resources, State</b>
<b>MSS</b>	<b>Multispectral Scanner</b>
<b>MWH</b>	<b>Ministry of Works and Housing, State</b>
<b>MWR</b>	<b>Ministry of Water Resources, State</b>
<b>NACB</b>	<b>Nigerian Agricultural and Cooperative Bank</b>
<b>NAFCON</b>	<b>National Fertilizer Company of Nigeria</b>
<b>NALDA</b>	<b>National Agricultural Land Development Authority</b>
<b>NARESCON</b>	<b>Natural Resources Conservation Council of Nigeria</b>
<b>NASA</b>	<b>U.S. National Aeronautics and Space Administration</b>
<b>NBP</b>	<b>National Borehole Program</b>
<b>NCA</b>	<b>National Council for Agriculture</b>
<b>NCC</b>	<b>National Control Center</b>
<b>NCSC</b>	<b>National Committee on Soil Conservation</b>
<b>NCWR</b>	<b>National Council for Water Resources</b>
<b>NEAZDP</b>	<b>North East Arid Zone Development Program</b>
<b>NEPA</b>	<b>National Electric Power Plc.</b>
<b>NESCO</b>	<b>National Electricity Supply Corporation (NIG) Limited</b>
<b>NFAEP</b>	<b>National Fund for the Amelioration of Ecological Problems</b>
<b>NFDP</b>	<b>National Fadama Development Project</b>
<b>NGO</b>	<b>Non-Governmental Organization</b>
<b>NGWEP</b>	<b>Nigerian Guinea Worm Eradication Program</b>
<b>NIOMR</b>	<b>Nigerian Institute of Oceanography and Marine Research</b>
<b>NNJC</b>	<b>Nigeria / Niger Joint Commission</b>

NOAA	National Oceanic and Atmospheric Administration
NPC	National Planning Commission
NTCWR	National Technical Committee on Water Resources
NWRI	National Water Resources Institute
NWRIS	National Water Resources Inventory Survey
NWRMP	National Water Resources Master Plan
NWRP	National Water Rehabilitation Project
OAU	The Organization of African Unity or Obafemi Awolowo University, Ile-Ife
OM	Operation and Maintenance
OFN	Operation Feed the Nation
PHC	Primary Health Care
PRS	Planning, Research and Statistics
QOL	Quality of Life
R & D	Research and Development
RBDA	River Basin Development Authority
RBRDA	River Basin and Rural Development Authority
RBV	Return-Beam Vidicon
ROSH	Rural Oriented Small Holder
SAP	Structural Adjustment Program
SCC	Sumiko Consultants Co., Ltd.
SCI	Sanyu Consultants Inc.
SCS	Soil Conservation Services
SHA	Sub-Hydrological Area
SIA	Satellite Image Analysis
SID	State Irrigation Department
SPR	Service Population Rate
SREB	State Rural Electrification Board
SSHA	Sub. Sub. Hydrological Area
SSS	Soil Suitability Systems
SWA	State Water Agency (Water Board, Water Corporation, Public Utilities Board, etc.)
TA	Technical Assistance
TCPC	Technical Committee on Privatization and Commercialization
TEW	Technical Extension Workers
TOR	Terms of Reference
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization



<b>UNICEF</b>	<b>United Nations International Children's Emergency Fund</b>
<b>USLE</b>	<b>Universal Soil Loss Equation</b>
<b>VIP</b>	<b>Ventilated Improved Pit</b>
<b>WATSAN</b>	<b>Water and Sanitation Unit, State</b>
<b>WB</b>	<b>World Bank</b>
<b>WHO</b>	<b>World Health Organization</b>
<b>WM</b>	<b>Water Master</b>
<b>WMO</b>	<b>World Meteorological Organization</b>
<b>WRECA</b>	<b>Water Resources and Engineering Construction Agency, Kano State Ministry of Works and Survey</b>
<b>WTI</b>	<b>West Texas Intermediate</b>
<b>WUA</b>	<b>Water Users Association</b>
<b>WWF</b>	<b>World Wildlife Fund</b>



## EXECUTIVE SUMMARY

### 1. (JICA - Assisted Study)

Pursuant to the Scope of Work and the Minutes of Meetings as agreed upon between the representatives of the Government of Nigeria and the Leader of the Preparatory Study Team of the Japan International Cooperation Agency (JICA) in November 1991, the Study on the National Water Resources Master Plan (NWRMP) has been implemented by a Study Team composed of Sanyu Consultants Inc. and Sumiko Consultants Co., Ltd. since March 1992 including the 12-month field work. This is a Final Report in draft presented after completion of all the work required.

### 2. (Potential Water Resources)

The Federal Republic of Nigeria is located in West Africa with a total land area of 923,800 sq.km, being entirely in the tropics where its climate is semi-arid in the North gradually becoming humid in the South. Annual rainfall varies from over 4,000 mm in the South-East to below 250 mm in the extreme North-East and is subject to significant temporal variation. The prolonged drought as afflicted the North since the 1970s have been recognized across width of the Sahel. This is also highly seasonal with the wet season of July to September in the North lengthening to April to November further South. Potential water resources have been estimated taking into account the rainfall for the 1980s in view of the effect of Sahelian drought, viz. surface water at  $267.3 \times 10^9$  cu.m or 178 mm and groundwater at  $51.9 \times 10^9$  cu.m or 56 mm.

### 3. (Past Trend in water Resources Development)

The institutions which are responsible for water resources development in Nigeria are relatively young. The Federal Ministry of Water Resources, the Federal River Basin Development Authorities (RBDAs) and the National Water Resources Institute (NWRI) which are the principal agencies responsible for nationwide water resources development came into existence in the 1970s when the Federal Government of Nigeria (FGN) adopted the policy of "Green Revolution" in order to address the problem of food security; hence, despite the broad and wide-ranged terms of reference and mandated roles of these institutions, the primary focus has been on large-scale water resources exploitation facilitated by the oil boom for food production and, to a lesser extent, public or community water supply. Actual status indicates that the building of irrigation systems under large dams mostly in dry North, however, has proceeded more slowly mainly due to serious shortages of skilled and experienced managers and staff and partly to the downturn in oil prices in 1982 and subsequent years of financial stringency. On the other hand, despite the participation in the IDWSSD by 1990, the water supply situation appears to be deteriorating, and Nigeria is gradually becoming one of the countries at its lowest level in the world.

### 4. (JICA-Assisted NWRIS and SIA)

The JICA Study was initiated with the undertaking of a National Water Resources Inventory Survey (NWRIS) to collect the information and data available for

present water use and needs for water resources development and management, and a Satellite Image Analysis (SIA) to support proper understanding of the nation's water and land resources and facilitate broad interpretation of their present situation. Aside from the SIA that was the first attempt for nationwide coverage at a scale of 1:500,000, the NWRIS implementation has brought about serious setbacks militating against a proper assessment, planning and development of the water resources. Although there is insufficient foundation to prepare the baseline data, the NWRIS and subsequent modifications have provided an excellent reservoir of the available knowledge on all matters related to water resources development and management. It is recommended that the FMWRRD should consolidate the gains of NWRIS by continuous updating of the data and filling of gaps when data become available and also should coordinate all of the data collection activities and supervise the activities of other implementing agencies by providing them with the guidelines and standards to be adopted.

## 5. (The Problems: Constraints and Potentials)

### 5.1 - Water Resources Monitoring -

In general, the rain and evaporation gages are insufficient in quantity and quality terms, and their management for observation and data processing is in rather unfavorable situation. There is the current existence of 357 surface water gages, many of which are difficult for operations due to the breakage of equipment, river channel variations and lack of budget, and none of which is equipped with observation of water quality and sediment transport. Some 23,000 boreholes have been provided throughout the country with less attention to the groundwater quality, and there is no problem of the groundwater balance except for the local areas of Maiduguri, Sokoto, Middle IIA-VIII and Lagos.

### 5.2 - Water Source Works -

The number of dams so far completed or under construction has reached 160 with a total effective capacity of  $30.7 \times 10^9$  cu.m including Kainji, Jebba and Shiroro by NEPA, while there are many large dams for irrigation and water supply in the North region since the onset of Sahelian drought. Except for hydropower, the current water use at existing storages is quite low at 10 to 20 percent because of slow progress in downstream facilities and the lack of reservoir operations rule, while the evaporation from storages in the North region amounts to 20 to 30 percent of their capacity. Many of existing dams have safety problems, and many of small/medium dams are facing the difficulties due to the lack of technical data, equipment, access road, skilled manpower, etc. for OM.

### 5.3 - Irrigation and Drainage -

The general consensus is that the food and nutrition insecurity is a serious and growing problem in Nigeria, and an emphasis is being placed on irrigation development for growth in farm production. There are two modes: (1) public schemes under FMWRRD - RBDAs and State Ministries, and (2) private schemes for farmer-owned and -operated irrigation in wetlands under FMANR-State ADPs. To date, the upstream storage construction of the public schemes has completed for irrigable area of  $320 \times 10^3$  ha while the downstream construction to on-farm level has reached  $70 \times 10^3$  ha; on the other hand, the private program has been identified by the FGn as a key source of agricultural growth

with a positive support of the World Bank and already achieved irrigation practice for over  $150 \times 10^3$  ha. Many problems facing existing public schemes have been demonstrated along with a number of technical, financial, institutional, and human resource weakness, with particular attention paid to the land tenure strategy, WUA's activity and coordination with the State ADPs for agricultural extension service.

#### 5.4 - Water Supply and Sanitation -

The current situation examined indicates that the service population rate of public water supply is 50 percent for urban and 9 percent for rural. Virtually, inadequate water supply remains as one of the major problems in urban centres, in fact, the supply of improved water can be said to be adequate in none of them. Despite a number of boreholes already sunk, many of the rural communities served have not derived the maximum benefits because of inadequate supply, technical problems and peoples' ignorance. Poor water supply coverage is closely linked to improper targeting of the resources in planning, inadequacy of skilled labor management and optimization, insufficient billing and collection of water revenue and inadequate monitoring and evaluation of the performance. On sanitation, there is no clear-cut policy which has always been regarded as household affair, and the domestic water waste disposal practice is unregulated and underdeveloped in most areas of Nigeria resulting in gradual contamination of both surface and groundwater quality. It may be noted that Nigeria has no national water quality standards.

#### 5.5 - Watershed / River Management and Gully Erosion Disaster -

As with most problems involving the environmental degradation, different manifestations of related deterioration are not distinct but inter-related resulting from common causes. Several categories of severe watershed management problems in Nigeria fall into this pattern; these include soil degradation, deforestation, soil erosion, wildlife and fisheries losses and local flooding. The main Federal institutions concerned with the watershed management program are the FMANR and FEPA, while prior to promulgation of the 1993 Water Resources Decree, there was no single agency who is responsible for an integrated river management on use and conservation of the water resources and river systems. As for the gully erosion that is the most frightful type of soil erosion, the most catastrophic gullyings which can start off suddenly in a rainy night with subsequent rapid expansion can be seen in the South-East region particularly in the States of Anambra and Enugu. It may be defined that the gulying is largely man-made in view of poor sense of these problems by local people, road construction without careful attention to the provision of drains and ill-designed channelization of heavy runoff in built-up areas. Anti-erosion measures have been taken up from public education campaign to legislative provisions; however, the present situation has not yet gone out of hand. There are many technical problems in gully control works mainly made by RBDAs including inadequate consideration of geology, hydrology and hydraulics in engineering, insufficient budget allocation, lack of post-control maintenance for drainage system, and so forth.

## **5.6 - Other Water-Related Components -**

### **5.6.1 Hydropower Generation:**

*A total aggregate of the present capacity installed at power plants under NEPA is 6,000 MW (1,900 of hydro and 4,100 of thermal) with the nationwide power grid system being apart from those of NESCO, SREBs and the private companies and individuals. Out of the 6,000 MW capacity, barely 2,500 MW would be available because of major breakdowns in plant machinery and equipment, and most of the distribution networks are overloaded resulting in frequent breakdowns and outages. Out of three major hydro plants under NEPA, 1,490 MW is functional, and the Kainji and Jebba on the Niger River are suffering the decrease of reservoir inflow due to effect of the Sahelian drought and anticipated use of the Niger water by upstream countries under NBC, as well as the invasion of water hyacinth.*

### **5.6.2 Inland Navigation:**

*The FIWD established in 1956 had in the past provided the main communication routes and access from coast to hinterland in accounting for over 30 percent of the product transport; however, the civil war caused a complete change in river traffic by more cost-effective road transport from existing ports at Lagos, Port Harcourt and Calabar. In the meantime, the flow patterns and conditions along the rivers of Niger and Benue have recently been deteriorated with more eroded sediments from watersheds and flow reduction by upstream withdrawal. To improve these adverse conditions, significant modification by capital and maintenance dredgings is required by FIWD; however, the lack of fund to meet the huge cost and of technical capability to cope with these difficult works has hampered the improvement. From the historical point of view, the FGN has entrusted the FIWD with the responsibility of conservancy for major rivers including the maintenance and improvement of river channels and the hydrological monitoring. With promulgation of the Water Resources Decree, it is recommended that a considerable part of the FIWD responsibilities be transferred to the FMWRRD together with proper adjustment on contradiction between the 1988 Navigable Waterways Decree.*

### **5.6.3 Inland Fisheries:**

*Current level of per capita annual fish consumption is around 4 kg that is lower than the Africa's average of 9 kg and the minimum requirement of 11.5 kg as recommended by FAO, while there is an increasing contribution from import and the domestic production has proportionately decreased. Nigeria is generally endowed with very large bodies of the natural water in wetlands, rivers and lakes. In the effort towards the water resources development, little or no attention has been paid to the important living aquatic resources. To date, many of the large and medium rivers have been dammed up without regard to such resources both up and downstream, viz. there is no fish ladders at existing hydraulic structures across the rivers, and there has been no pre-impoundment study to protect the ecology of a newly inundated reservoir bottom. It has been indicated by various analyses that the desire for self-sufficiency in fish production may only be realized through development of the aquaculture in close tie-up with the water resources development.*

## 5.7 - Regional Constraints and Problems -

### 5.7.1 Water Use Rate at Present:

Important factors on water use and balance for each of surface and groundwater resources are summarized at regional level:

(Unit: 10<sup>9</sup> cu.m)

	NW HA-1	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total or Average
<b>1. Surface Water</b>							
(1) Potential	22.40	8.20	32.60	83.00	35.40	85.70	267.30
(2) Water Use	0.47	1.20	0.36	0.21	0.28	0.19	2.71
Public Irrigation	0.08	0.26	0.14	0.15	0.04	0.11	0.78
Private Irrigation	0.32	0.88	0.07	0.02	0	0.02	1.31
Public Water Supply	0.07	0.06	0.15	0.04	0.24	0.06	0.62
(3) Water Use Rate (%): (2)/(1)	2.1	14.6	1.1	0.3	0.8	0.2	1.0
<b>2. Groundwater</b>							
(1) Potential	4.34	5.68	8.18	11.38	9.02	13.43	51.93
(2) Water Use	0.02	0.06	0.02	0.01	0.08	0.07	0.26
Public Water Supply	0.02	0.06	0.02	0.01	0.08	0.07	0.26
(3) Water Use Rate (%): (2)/(1)	0.5	1.1	0.2	0.1	0.9	0.5	0.5

It has been understood that there would be the most severe problems on water resources management over the Lake Chad basin (North-East region or HA-VIII) where advanced water resources undertakings have taken place in Nigeria; thus, the most careful and judicious considerations have been given to this problem basin.

### 5.7.2 Lake Chad Basin (HA-VIII):

This Basin extends over Sahel and Sudan Savannah zones discharging into a fresh water Lake Chad where there are severe hydrological problems such as downward trend of basin rainfall and Lake drying-up. The construction of large storages at Tiga and Challawa Gorge has restricted the extent of flooding and groundwater recharge for vast Hadejia-Yobe wetlands, for which the IUCN-funded Hadejia-Nguru Wetland Conservation Project is taking a central role in encouraging the open debate on the present and future water management issues that are critical to the effective conservation of existing biodiversity. The basin study has pointed out several issues on constraints and potentials including (1) defects in water resources development in upper Hadejia basin, (2) freezing of the proposed Kafin Zaki dam, (3) careful considerations on functions of the Hadejia-Yobe wetlands, (4) problems in Maiduguri water supply, and (5) communication problems between two RBDAs. It is expected that the findings to be obtained through current implementation of the Master Plan for development and environmentally sound management of the natural resources of the Lake Chad conventional basin as presented by LCBC in June 1992 would strengthen this NWRMP.

## 5.8 - Environmental Aspects -

The most complex and overriding causes of serious environmental degradation throughout the country would be poor management and the lack of information on quantity and quality of the resources, resulting in unsound decisions regarding the use and renewal of resources. As a matter of fact, many water resources development activities reflect the

tenet that "one action causes many types of problems" in the environmental resources sector. The environmental problems in water resources sector. The environmental problems in water resources sector include (1) drought and desertification, (2) reduced flow availability in downstream area of rivers, (3) watershed management, (4) water pollution, water hyacinth and eutrophication, (5) water-related diseases, (6) socio-economic impacts, and (7) lack of EIA for water-related projects. The experience obtained through JICA-NWRIS indicates that little specific information are available, and the primary reasons for this include (1) no priority for monitoring and collection on this type of information, (2) few coordinated data collection program in several FGN Departments dealing with water-related problems, and (3) unreliable recording and record-keeping.

## 6. (Principles and Strategies Involved in the NWRMP)

### 6.1 - General Principles -

A scenario of the NWRMP towards 2020 has been presented on the basis of water availability and current problems and constraints as well as of the FGN goals as provisionally described in "A Pre-Plan Vision Documents towards A Perspective Development Plan (by 2010)" as circulated by NPC in December 1992. Based upon the gains from previous Development Plans and on-going SAP, a framework of the Plan calls for the undertaking of new initiative in quest by all levels of the societies to ensure overall well-being of the people. The overriding objective of the Plan well-interpreted as a Human-Centred Development Plan requires a renewed commitment to developing the country's human resources through investment in health, education, nutrition and food security, job creation and other social services, with emphasis on improvement in decision-making capability at grass roots level. The sectoral strategies incorporated into the Plan include (1) agricultural development for smallholder private production effectively backed by market-oriented agricultural policies and also for agriculture-cum-informal sector centred orientation, and (2) infrastructure development where existing public services of poor quality and low capacity utilization are upgraded with a concept of the Balancing Modernization and Rehabilitation (BMR).

### 6.2 - Specific Strategies -

In compliance with the above-stated requirements and inputs, the NWRMP has delineated a basic framework with its overall objective that is comprehensive, realistic and integrated development and management of the water resources leading to the maximum utilization of all other resources throughout the country and being oriented to have a more direct effect on more people than any other features of the current national planning. Three strategies have been incorporated into establishment of the NWRMP:

#### - Enforcement of the Water Resources Decree, No.101 of 1993:

This legislation permits FMWRRD to undertake its mandated responsibility for efficient management of the nation's water resources, more particularly to resolve the issues of competing demands among domestic users, remove inter-state rivalries over water allocations, help resolve international water right issues in Lake Chad and Niger/Benue basins and to ensure due attention is paid to hydro and inland navigation needs and overall environmental conservation programs including watershed management. As a matter of fact, the Decree gives FMWRRD a basic foundation to perform public administration of the



water resources management; thereby, a series of the regulations needed for proper enforcement of the provisions in this Decree should be established at the earliest practical date ensuring appropriate standards and techniques for due management and administration of renewable water resources.

- **Proper Operations and Management of Existing Water Resources Project Facilities:**

This should include two items: (1) full utilization of existing water storages with solution of dam safety problems, and (2) BMR works and OM upgrading of existing water resources infrastructural facilities. In order to harvest with anticipated potential benefits the previous huge investment, this should be, with the top priority, materialized with possible solutions on inadequate planning, insufficient relevant manpower, haphazard implementation, social issues, environment as well as funding and water rating and cost recovery.

- **Appropriate Implementation of Water Resources Projects with Priority Given to Medium and Small Size:**

With a view to mobilizing the water resources as called for by the National Perspective Plan, the NWRMP should be directed to implement a series of the proposed medium and small-scale multipurpose water resources development projects to meet water demand anticipated in various sectors concerned in such manner as (1) self-reliance, (2) human-centred approach and (3) focus on household production unit in informal sector on the basis of the maintenance of environmental protection as well as the improvement in implementing capability of the government agencies and the strengthening of institutions to facilitate more effective cooperation and greater participation of the local people concerned. It may be noted that the history of irrigation in Nigeria has been that smaller-scale and decentralized schemes have been more successful from the cost-benefit and environmental standpoints than larger schemes. Keeping these requirements in mind, the proposed projects mainly for irrigation and water supply and partly for mini-hydro and aquaculture should be located over the tributary basins. In addition, the priority area should be shifted to the Middle Zone with emphasis on irrigation and to the Southern Zone on water supply as are shown in a frontispiece Map, being apart from the Northern Zone where main thrust is moving towards promotion of more effective water resources management program.

**7. (The NWRMP)**

**7.1 - Water Resources Monitoring Program -**

Monitoring programs of the surface and groundwater resources in quantitative and qualitative term are the pre-requisite for appropriate implementation of the proposed NWRMP including enforcement of the Water Resources Decree and implementation of the BMR works for existing projects and of the newly proposed water resources development schemes. During the early period of NWRMP, the monitoring of climate and surface water will be realized at 78 sites for rainfall, 66 for evaporation, 434 for river runoff and 123 for water quality and sediment. Strict attention should be paid to continuous observation and also to frequent updating of rating curves for runoff observation. For the groundwater, pre-pumping tests and groundwater withdrawal from production wells will be monitored, and proper surveillance programs over the problem areas for groundwater overdrafting will be launched for control of aquifer hydraulic parameters. In addition, there is the need for

provision of shallow-groundwater monitoring networks to ensure the proposed expansion of private irrigation schemes. For this, the NWRMP has organized to install monitoring wells for aquifers at 68 sites and those for private irrigation at 300. All of the data observed will be promptly sent to NWRI for processing and storage as well as publication of year books under the supervision of FMWRRD.

### 7.2 - Water Source Works -

A comprehensive BMR works for existing water storages should be urgently implemented to ensure the downstream release of  $5.1 \times 10^9$  cu.m including the preparation of reservoir operations rules and the rehabilitation of dam structures, with particular emphasis on artificial flood release from upstream storages for Hadejia-Yobe and Sokoto-Rima wetlands. In line with the strategies involved, the NWRMP is directed to provide medium to small-size water storages at 1,084 sites in response to the demand predicted for irrigation and water supply. These sites have been studied on the 1:50,000 FSN maps with short visits over some tributary basins with an area of  $2$  to  $5 \times 10^3$  sq.km where a sufficient coverage of immediate downstream wetlands is seen for gravity irrigation. These multipurpose dams mainly of earth-fill type would be constructed by RBDA on force account basis for small and on domestic contracting for medium, and relevant joint costs will be allocated among the responsible agencies concerned by applying "Separable Costs-Remaining Benefit Method". As for the inter-basin water transfer schemes, it has been reviewed that since the feasibility of all proposed plans would be questionable in economic and environmental term; any scheme is not in a position to be included in the NWRMP, and it may be suggested that more elaborate study on a Hawal scheme to the Lake Chad basin be made at the end of the NWRMP period taking into account future trend of the Sahelian drought.

### 7.3 - Irrigation and Drainage -

An irrigation growth scenario has been prepared with reference to the World Bank publications concerned with agricultural sector keeping in mind the perspective of food demand and supply in the FGN drive for attainment of self-sufficiency, and a target area for an irrigated agriculture mostly for rice, maize and vegetables by 2020 has been taken at  $1.50 \times 10^6$  ha ( $1.12 \times 10^6$  ha for public and  $0.38 \times 10^6$  ha for private) in view of the available resources such as water source works and potential service areas. The private irrigation program that is effective under FMANR-State ADPs will be expanded at an assumed rate of  $20$  to  $30 \times 10^3$  ha per year, and most of this service area will be later converted for inclusion into the proposed public schemes. For the public schemes, urgent BMR works for currently irrigated area of  $70 \times 10^3$  ha will be made with strengthening of the agro-allied services, and additional development of  $230 \times 10^3$  ha for incomplete schemes will be promoted in line with the BMR for water storages particularly with the preparation of feasibility study for large projects. Proposed 1,100 public schemes mainly composed of small-scale less than 500 ha and medium to 3,000 ha covering wetlands in tributary basins in the mode with storage and also in pump and creek type have been included in the NWRMP. To ensure successful performance of public schemes, it is suggested that when a project is identified, the Government campaign should take place for farmers in line with land tenure strategy suitable for development, and their representatives

will file a petition requesting the FMWRRD for implementation. All the projects will be constructed and managed by RBDAs upto farm turnouts into terminal service networks in a standard size of 30 ha each. Provision and OM of the terminal blocks will be the responsibility of WUA in line with the agro-allied services to be carried out by the State ADPs. In this respect, it is critically important that close linkages are developed and established between RBDAs and ADPs under the Federal inter-Ministrial coordination.

#### **7.4 - Water Supply and Sanitation -**

The poor record in terms of this sub-sector underscores the need to reorient the FGN policy to ensure that the sustainable improvement in quality of living standards as BHN for vast majority of the population is achieved during the NWRMP period. The water demand required for public water supply schemes in 2020 has been projected on the basis of an access rate to the safe water at 80 percent of the predicted population ( $186 \times 10^6$ ) with reference to the National Perspective Plan. As a matter of fact, this target may be optimistic, but would be of a challenging task. Since there are many portions of the deteriorated and defective waterworks and boreholes with current availability at 50 to 70 percent of design capacity, urgent BMR works should be carried out for restoration to a maximum level along with an extension line of on-going National Water Rehabilitation Project and others. Per capita water demand in 2020 is taken at 213 lcd at intake point and 150 lcd at consumption level for urban on a national average and at 80 lcd at intake and 60 lcd at consumption for rural; thus, a total supply capacity of  $7.38 \times 10^9$  cu.m in 2020 will be equivalent to 5.5 times as large as the present capacity after BMR. For the sanitation for urban area where the population density is more than  $5 \times 10^3$  per sq.km, it is suggested to provide a public sewerage system to be connected to the households, private undertakings and public facilities with an end-treatment for waste water. Many entities are currently involved in this sub-sector including FGN, State and LG institutions and external agencies, and it appears that these institutions employ their own implementation strategies and there is no clear leadership; therefore, it is strongly recommended for FMWRRD to take an appropriate central role with detailed guidelines on design of water supply and sanitation installations and also on community involvement from inception as well as the water quality standard and related monitoring.

#### **7.5 - Control and Prevention of Gully Erosion -**

The NWRMP on gully disaster has been divided into two: (1) gully erosion restoration works and (2) gully erosion prevention measures:

- The restoration works may include the primary remedial short-term measures through gully infill operations with appropriate drainage works and the full-scale restoration works for gullies expanded in size. The former should be undertaken with the prior preparedness of required materials and equipment under LG Councils concerned. For the latter, the guidelines on planning, design, construction and post-control surveillance at master plan level have been presented with attention to the Sabo works for river course downstream.

- Because of non-productive investment for gully disaster control works, it is imperative to implement appropriate preventive measures for gully occurrence in an exhaustive manner including the construction control and guidelines on public and private works

project. The NWRMP has, for due reference, presented a gully erosion hazard map and outlined the forecasting and warning systems and education and campaign programs. The Department of Soil Erosion and Flood Control, FEPA would be responsible for the policy action of gully preventive measures in close coordination with FMWRRD who has the mandatory responsibility to enforce the Water Resources Decree in terms of coordination of watershed management program.

## **7.6 - Other Water-Related Components -**

### **7.6.1 Hydropower Generation:**

Aside from urgent BMR works on existing power units and immediate countermeasures on human and organizational factors with substantial influence on OM and reliability of the power systems, it would be difficult for new hydro sites to become competitive as baseload units against cheaper gas-fuelled combined cycles. The NWRMP has paid attention to major hydro sites proposed at Zungeru (950 MW) and Mambilla (2,600 MW). The former with problems of huge resettlement requirement and cost reduction in multipurpose nature would not be commissioned before 2010, and the latter has too many issues to be clarified for inclusion by 2020. It is suggested that four hydro plants at RBDA dams should be amalgamated into the NEPA system including urgent installation of electro-mechanical turbines and generators (34 MW) at Dadin Kowa with a change of its main objective from irrigation to power. In connection with a series of multipurpose medium and small dams proposed, any potential mini-hydro site will be identified for isolated rural electrification involving SRBBS under coordination of NEPA. In addition, five multipurpose large-scale dams projects have been preliminarily screened out on the left side of the Benue River, for which pre-feasibility study is included in the later stage of NWRMP.

### **7.6.2 Inland Navigation:**

A proposal to provide the barrage(s) in the lower Niger has been examined for navigable improvement; however, it would be too early to organize a multipurpose water resources project with a focus on the proposed barrages and associated environmental impacts. It is suggested for FIWD that the programs and projects currently being undertaken would be continued without any expansion within foreseeable future, and improvement of the Niger navigability would be carried out in two steps: (1) river channel management including hydrological and morphological observation and study to a limited extent for the dredging of local critical parts and bed-regulation by groynes, training-walls and bank stabilization for difficult crossings and flats, and (2) probable discharge regulations by Jebba and Shiroro in cooperation with NEPA under coordination of FMWRRD. From historical point of view, the FIWD is in charge of the hydrological monitoring works for the rivers of Niger and Benue. In accordance with enforcement of the Water Resources Decree, current FIWD gages at 14 sites would be transferred to FMWRRD as BRCPs.

### **7.6.3 Inland Fisheries:**

Three aspects such as (1) wetland fisheries, (2) reservoir fish farming, and (3) aquaculture in the water resources projects should be included with the effort to be made along with the FGN policy of achieving self-sufficiency in fish production. The NWRMP has incorporated a plan to build a series of medium and small dams for multipurpose including fisheries

immediately upstream of the inland valleys in tributary basins. In this occasion, the FMWRRD should pay a special attention to release minimum maintenance flow to mitigate adverse impacts to its downstream riverine ecosystem where the fish ladders and other passage ways for fish movement up and down the stream are taken into account for attachment to hydraulic structures. The aquacultural ventures in multipurpose medium and small dams should be given with the priority including reservoir fishing as well as the fish pond operations by a cooperative or private entity within the irrigation service area. In order to promote the fisheries components, the DOF should be assigned to all stages in their project cycles to be carried out by FMWRRD.

## 7.7 - Regional Development and Management -

### 7.7.1 Water Use Rate in 2020:

The NWRMP of each component has been translated into basin-wide management issues:

(Unit: 10<sup>9</sup> cu.m)

	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total or Average
<b>1. Surface Water</b>							
(1) Potential	22.40	8.20	32.60	83.00	35.40	85.70	267.30
(2) Water Use	2.03	2.92	4.41	4.56	3.47	2.82	20.21
Public Irrigation	1.16	0.91	3.48	3.82	1.63	2.41	13.47
Private Irrigation	0.69	1.71	0.30	0.40	0.07	0.11	3.28
Public Water Supply	0.18	0.30	0.63	0.34	1.72	0.29	3.46
(3) Water Use Rate (%): (2)/(1)	9.1	35.6	13.5	5.5	9.8	3.3	7.6
<b>2. Groundwater</b>							
(1) Potential	4.34	5.58	8.18	11.38	9.02	13.43	51.93
(2) Water Use	0.35	0.62	0.36	0.43	0.97	1.20	3.93
Public Water Supply	0.35	0.62	0.36	0.43	0.97	1.20	3.93
(3) Water Use Rate (%): (2)/(1)	8.1	11.1	4.4	3.8	10.8	8.9	7.6

The undertaking of water resources projects and programs proposed by 2020 will increase the water use from  $2.97 \times 10^9$  cu.m at present to  $24.14 \times 10^9$  cu.m or 8.1 times. Attention should be paid to higher rates of 35.6 percent in HIA-VIII for surface water and of 11 percent in both HIAs-VIII and VI for groundwater, and these higher rates require the strengthening of water resources monitoring and more deliberate water operations of the water resources projects within water use rights to be granted under the Water Resources Decree.

### 7.7.2 Lake Chad Basin (HA-VIII):

Aside from a proposal to provide small water source works that are limited to the tributary basins with surplus potential, the NWRMP intends to achieve a full function of many water source works already completed with large capacities through the reservoir operations studies in connection with the demarcation of potential service area for additional public irrigation and water supply. On top of this, one of the highlights to be recommended is to make artificial flood releases for Hadejia-Yobe wetlands from existing large storages at Tiga and Challawa Gorge, and this urgent program will contribute in the preparation of a nationwide model for recovery of other wetland functions. Attention is also paid to the Maiduguri water supply where the aquifer behaviors should critically be surveillant with the provision of a series of groundwater monitoring wells in close relation with the reservoir

operations at Alau dam. It is to take note in view of a critical state in Borno water resources that research effort by the University of Maiduguri to develop an effective use of many natural depressions which are flooded during rains and never utilized should be much appreciated.

#### **7.8 - Environmental Management -**

The present situation on environmental degradation demands that the agencies responsible for the water resources management and development take a proactive rather than a reactive role in the management of environmental resources. In view of the present FEPA capacity that appears to be unprepared to assume a leadership role in water resources-related environmental management, it is recommended that the FMWRRD be prepared to take a unilateral action to ensure that the watershed integrity is strengthened and the water resources are protected. One of two primary approaches is the watershed management programs that consider the requirements and implications of entire watershed when formulating and implementing the development planning and policies, and the Water Resources Decree has given FMWRRD significant powers to coordinate the measures and control of the activities for proper watershed management and resources protection. Another approach is the use of EIA as an integral part of the environmental resources planning and water resources project cycle on the basis of the 1992 EIA Decree. For this, the FMWRRD is to be involved to develop, working with other Ministries, the detailed procedures as appropriate to be applied by all levels of the government and private developers.

#### **7.9 - Organization and Manpower -**

##### **7.9.1 Federal Organization:**

It is suggested that the activities of NCWR/NTCWR in the highest water resources policy formulating position should be more strengthened in all aspects including the FEPA, FMWH, FMOH and NPC in compliance with the NWRMP. In line with promulgation of the Water Resources Decree, major responsibility to be given to FMWRRD is to coordinate with a central authorization the development and management of both surface and groundwater in a well-defined manner, and taking into account future role and work load for enforcing the Decree, it is suggested to create newly a competent Department of Water Administration in a form of enlarging and amalgamating the functions of existing Department of Hydrology and Hydrogeology. Serious attention has been paid at the policy level to forge the strong collaborative links between various organizations involved in one way or another in the development of all aspects in the field of irrigation with the FMANR and water supply with FMOH, FMWH, SWAs and SEPCs. It is also proposed to strengthen the day-to-day regional water resources administration to be largely increased in work load with the establishment of four Regional Water Administration Offices to be managed at Director level with additional responsibility on monitoring of RBDAs, liaison with State Governments and undertaking of water resources monitoring work. The NWRI will be substantially upgraded as a main body for technical research and services with the transfer of main technical functions in Dept. of Hydrology and Hydrogeology and Water Resources Databank Centre, Abuja. It seems that the general performance of RBDAs, Federal parastatals would be mixed and their reform package program on partial

commercialization under TCPC since 1988 to remedy several shortcomings is in progress. It is suggested that RBDA be responsible for developing multipurpose storages and conveying water for various users with amount and timing as required by them at designated points with appropriate cost arrangement, and since State Governments are not equipped with sufficient manpower, all of the projects even for small-scale be carried out by RBDA in a consistent FMWRRD policy.

#### **7.9.2 Manpower:**

Because of no statistics on nationwide manpower of the water resources sector, a comprehensive manpower inventory survey has been implemented by FMWRRD in 1993 by using the questionnaire to all public and private organizations numbered at 220 with only 119 sets retrieved. This has revealed that some 24,000 staff are currently available throughout the country, of which only 8.9 percent is in senior-level engineering related disciplines and about 10 percent is in FMWRRD. It appears that the institutions concerned typically suffer from serious shortages of skilled and experienced staff, an excessive number of untrained staff, inadequate wages and salaries, and a counterproductive policy environment. There should be the need to improve the public administrative structure that is imperative for appropriate implementation of the NWRMP proposed, including improvement and upgrading of the training programs for Government personnel as well as changing the organization and procedures of public agencies to improve efficiency, generate more timely and accurate information and make the agencies more responsive to their public. The NWRMP has identified that the transfer and development of appropriate water resources and environmental technologies with a greater effort to train more skilled in-house manpower are a long and painstaking venture to be involved in the NWRMP which calls for the National Water Resources Manpower Training Program by external agency(s).

### **8. (The NWRMP Implementation Program)**

#### **8.1 - Implementing Strategy -**

An implementing mode proposed for a long-range scenario of the NWRMP towards 2020 as presented in line with the specific strategies in para. 6.2 has been delineated largely dividing into two: (1) the establishment of basic foundations for public administration of the nation's water resources and the BMR and perfect completion works of existing and on-going projects, both of which would be executed during the National Water Master Action Plan period by 2000, and (2) full implementation of the proposed medium and small water resources programs, taking into account the current FGN constraints on financial management that may be continued by the end of this century. In order to achieve this implementing strategy, a centre of the great attention has been paid to the strengthening of the government institutions including the training of managers and staff to enhance their technical and managerial capabilities.

#### **8.2 - Costs Needed by 2020 -**

##### **8.2.1 Financial Requirements at 1994 Price Level:**

Cost estimate at master plan level indicates  $1.24 \times 10^9$  Naira for water resources monitoring,  $41.70 \times 10^9$  Naira for water storages (before allocation),  $46.23 \times 10^9$  Naira for irrigation and drainage,  $313.78 \times 10^9$  Naira for water supply, and  $3.66 \times 10^9$  Naira for

*gully restoration. These figures have been compared with the current financial situations in a preliminary manner, viz. (1) almost same level for water resources monitoring, water storages and irrigation, and (2) 2.8 times as high as the current required for water supply in ambitious goal. It may be noted that the gully inevitably increases with time in number and size; hence, quick restoration works should be undertaken putting great emphasis in allocating the Federal Ecological Funds and State Government budgets. In view of the present situation that the FGN budgeting is in a critical state with large stock of external debt despite the huge reserves of petroleum and natural gas, and the need for further restraints on the FGN spending in connection with the economic reform program inclusive of the on-going SAP and subsequent application of the ESAF will be continued in a foreseeable future, rather moderate outlook of the FGN budgeting inclusive of the resource inflow could be expected beyond 2000, and this perspective may correspond to the implementing mode proposed in the NWRMP. As far as water supply is concerned, each of the State Governments will have to reinstitute his budgetary and development priorities including manpower training if significant progress is to be achieved, and the FMWRRD would continue to guarantee and coordinate the loans and grants on genuine basis and also to receive additional financial support for the States from external agencies.*

#### **8.2.2 Project Economic Justification:**

*Newly proposed medium and small public irrigation and drainage projects have been examined from economic aspect. Only the irrigated farming benefits inclusive of rice, maize and vegetables have been incorporated, and the computed ERRs indicate about 10 percent for the North region, 10 to 15 percent for Central and more than 15 percent for South, which may be referred to the World Bank general guide of 12 percent. For the water supply schemes which may be customarily measured by the consumers' willingness to pay as reflected by the prices charged for public services, the least-cost approach to issues of the predetermined physical or cost standards for services has been applied due to the lack of data for measuring the increase in consumers' surplus under the project.*

#### **8.3 - National Water Master Action Plan by 2000 -**

##### **8.3.1 Scope of Work:**

*The subject Plan to be implemented during the five-year plan period of 1996 to 2000 has been worked out in more operational mode with major components including (1) the institutional building to enforce the Water Resources Decree, (2) the accomplishment of proper operations and management of existing and on-going water resources projects and facilities, and (3) the preparation of medium and small water resources projects over nine Priority Basins to establish a solid foundation for successful implementation from 2001, with particular emphasis on the institutional development and manpower capacity building through the introduction of a proposed TA "National Water Resources Manpower Training Program" by external agency(s).*

##### **8.3.2 Priority Basins for water Resources Development:**

*The NWRMP has included a plan of 260 potential sites for medium dams and 820 for small dams, and subsequent pre-feasibility study for identification and full-scale feasibility study for preparation will be required for orderly implementation. In this occasion, a basinwide*



approach is a pre-requisite for the preparation of appropriate medium and small dams package program after verifying well-balanced use of the water resources and mitigation of the environmental impacts in a particular basin with the priority sub-project rating. The first step to be taken for this long-range implementation is to carry out a pilot study in some representative basins where fundamental technology for selection and planning of potential sub-projects should be developed. The NWRMP has selected nine Priority Basins for model studies (one for each of RBDAs concerned) as shown in a frontispiece Map, and all of these studies will be led by FMWRRD with positive participation of SWAs for water supply, NEPA and SREBs for mini-hydro and DOF and related Stated agencies for fisheries.

### **8.3.3 Projects and Programs for Consideration by External Agencies:**

Careful examination has been made of the needs and categories to be assisted by external agencies. A tentative list of these projects and programs proposed is introduced below:

- (1) **National Water Resources Manpower Training Program**
  - Institutional development and manpower capacity building.
  - Agencies : FMWRRD (lead), NWRI, RBDAs, FEPA and State Governments.
  - Period : Five years (1966 to 2000)
- (2) **Water Resources Management Program in Upper Hadejia**
  - Artificial flood releases from Tiga and Challawa Gorge dams for Hadejia-Yobe wetlands.
  - Agencies : FMWRRD (lead), RBDAs, NWRI, FMANR and State Governments concerned.
  - Period : Three years (1996 to 1998)
- (3) **Preparation of Medium and Small Dams Package Programs**
  - Pre-feasibility and feasibility studies for preparation in sector financing for three Priority Basins such as Awun, Kilange and Aya.
  - Agencies : FMWRRD (lead), RBDAs, NWRI, FMANR, FEPA and State Governments concerned.
  - Period : Two years (mid-1997 to mid-1999)
- (4) **EIA Study and Environmental Monitoring Program for Dam Projects**
  - Guidelines for EIA study and environmental management plan in line with EIA and monitoring of related parameters for five existing and five proposed.
  - Agencies : FMWRRD (lead), NWRI, RBDAs, NEPA, FEPA, FMANR and State Governments concerned.
  - Period : Two years (mid-1998 to mid-2000)
- (5) **Hydropower Development Project at Dadin Kowa Dam**
  - Preparation of a project implementation program for installation of turbines and generators at 34 MW and subsequent connection to the NEPA national power grid system, and installation of the equipment by external financing.
  - Agencies : NEPA in cooperation with FMWRRD
  - Period : Three years

It may be noted that every effort should be made by the FGN for realization of these projects and programs to be assisted by external agencies on schedule for subsequent smooth implementation of the NWRMP towards 2020.



## **CHAPTER 1. INTRODUCTION**

### **1.1 BACKGROUND**

In Nigeria, organizing the water resources development for agriculture and other uses has been a late starter. Until 1955 when the World Bank pointed out the need for an organized approach towards harnessing the water resources, the water use for agriculture had all along been left in the hands of farmers. Although there were some attempts to quantify the nation's water resources to meet some sectoral demands, the preparation of a National Water Resources Master Plan (NWRMP) remained for too long in the background and was initiated in 1984 with FAO assistance. A draft plan as submitted in 1985 did not, however, compile all the issues sectorally and comprehensively, and the FAO assistance could not stretch further to address these issues.

Early in 1989, the Federal Ministry of Water Resources reactivated the NWRMP Study taking into account the priority the Federal Government of Nigeria (FGN) attached to coordinated water resources development for a viable national economy. The Ministry approached international organizations and bilateral bodies for assistance in updating the original draft by addressing its shortcomings or drawing up a complete NWRMP. In response to the request of the FGN, the Government of Japan decided to implement the NWRMP Study, and the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation program under the Government of Japan dispatched the Preparatory Study Team during the period of October 28 to November 18, 1991 and concluded "The Scope of Work for the Study on the National Water Resources Master Plan in the Federal Republic of Nigeria" on November 8, 1991 after a series of discussions with the Nigerian representatives.

The JICA has entrusted on March 31, 1992 the preparation of the NWRMP to the Study Team in association with Sanyu Consultants Inc. (Nagoya, Japan) and Sumiko Consultants Co., Ltd. (Tokyo, Japan) comprising 13 experts and also organized the Advisory Committee composed of five members to give necessary technical advice to the Study Team for smooth and effective implementation of the subject Study. On the other hand, the Federal

Ministry of Water Resources has established the Steering Committee at the policy-making level and the Technical Committee for the day-to-day technical consideration for efficient implementation of the Study. Scope of the Study and related work conducted and all of the names of the members of the JICA Study Team and three committees are described respectively, in para. 1.5 of this Chapter and in Appendix A.

## 1.2 OVERVIEW: THE NATIONAL SETTING

The Federal Republic of Nigeria is located in West Africa between latitudes 4° and 14° north and longitudes 2° and 15° east, with a total land area of  $923.8 \times 10^3$  sq.km bordered on the east by Chad and Cameroon, on the north by Niger, on the west by Benin and on the south by the Gulf of Guinea. The principal geographic feature is the Niger River which with its left bank tributary of the Benue River drains 60 percent of the country and forms an extensive delta at the mouth. Overall relief is very gentle, there being a gradual loss of height from about 500m in the north to the coast.

Nigeria is situated entirely in the tropics where its climate is semi-arid in the north gradually becoming humid in the south. Annual rainfall varies from over 4,000 mm in the south-east to below 250 mm in the extreme north-east. It is also highly seasonal with the wet season of July to September in the north lengthening to April to November in the south. Annual rainfall is also subject to significant temporal variation, and the prolonged drought which has afflicted the north since the 1970s has been recognized across the width of the Sahel.

Since 1991, Nigeria is divided into 30 states, plus the Federal Capital Territory (FCT) which have been administratively divided into 589 Local Government Areas (LGAs). The 1991 population census figure of 88.5 million which is still provisional indicates that the average population density is 96 per sq.km. Nigeria is the most populous country in Africa, one African in four being a Nigerian. According to the JICA Team's projection, the national population in 2020 will reach 186 million or 2.1 times of the 1991 figure:

Region Hydrological Area	NW HA-I	NE HA-VIII	CW HA-II	CE HA-III/IV	SW HA-VI	SE HA-V/VII	Total
1. Area (10 <sup>3</sup> km <sup>2</sup> )	131.6	188.0	158.1	231.9	100.5	113.7	923.8
2. 1991 Population (10 <sup>6</sup> )	10.3	16.8	10.5	9.7	22.3	18.9	88.5
Density (per km <sup>2</sup> )	78	89	66	41	222	166	96
3. 2020 Population (10 <sup>6</sup> )	17.0	28.2	25.4	24.4	49.3	41.8	186.0
Density (per km <sup>2</sup> )	129	150	160	105	491	368	201
4. Annual Growth Rate (%) (1991/2020)	1.74	1.80	3.08	3.23	2.77	2.77	2.59

Nigeria is endowed with large reserves of petroleum and natural gas, receipts from which still dominate foreign exchange earnings and Government receipts, despite a substantial reduction in oil export prices since 1980. The gas subsector remains largely underdeveloped. At this stage, the primary sector (petroleum plus agriculture) still accounts for some 50 percent of the GDP, while the manufacturing sector accounts for less than 10 percent. Agriculture constitutes the most important economic sector in Nigeria, accounting for 38 percent of the GDP and providing employment for major section of the population, the bulk of which is engaged in subsistence farming as small-holders.

Until 1980, buoyant oil revenues led to massive increases in the Government spending and the import of manufactured goods and foodstuffs. During the 1980s, global oil oversupply and falling prices imposed a tight external resource constraint on the economy and precipitated a succession of large fiscal and external payments imbalances combined with recession. To arrest the situation, the Federal Government of Nigeria (FGN) initiated the IMF/World Bank "Structural Adjustment Program" (SAP) with major policy implications aimed at improving fiscal and monetary financial viability which included the Naira devaluation, trade liberalization, privatization of most parastatals, and so forth.

Economic performance under the SAP has been mixed; in particular, the 1994 Federal Budget has been examined for reversing the market-oriented reforms pursued vigorously since 1986. A success of the economic reform program would lie on the extent to which the resource outflow can be curtailed on account of the external debt service. The latter in turn depends upon the degree of control and management on external debt, the outstanding stock of which was US\$28.7 billion by October 1993. It is clear that the Nigerian

economy could only achieve sustained real growth with a program of accommodation with external creditors. A package of debt relief measures may include a rescheduling of the Paris club debts, and the debt cancellation and concessional resource inflow on both the Enhanced Structural Adjustment Facility (ESAF) and International Development Assistance (IDA) terms. According to the IMF source, a debt relief from the international creditors may not materialize before 1997 being subject to the degree of achievement of the SAP. The implication of these recent trends may suggest the need for further restraint on the Government spending in the foreseeable future, but a long-term outlook beyond the year 2000 would be rather moderate.

### 1.3 PHYSICAL ASPECTS OF WATER RESOURCES

#### 1.3.1 Rainfall and Evaporation

##### (1) Rainfall

Apart from the general trend described in para. 1.2, the annual rainfall in representative points for each Region is shown being classified into that of the annual average before 1979 and that of the 1980s identifying mainly the degree of recent Sahelian drought throughout the country:

(Unit: mm per year)

Region	Station	Average Rainfall before 1979	Average Rainfall in the 1980s	Decreasing Rate (%)
NW	Sokoto	706	535	24
NE	Kano	839	684	18
NE	Maiduguri	672	455	32
CW	Kaduna	1,290	1,155	10
CE	Jos	1,378	1,273	8
SW	Ikeja	1,625	1,372	16
SE	Enugu	1,795	1,593	11
SE	Calabar	2,823	2,765	2

##### (2) Evaporation

The Class A pan evaporation observed amounts to 3,000 to 3,500 mm per year in the north, 2,000 to 2,500 mm in the central and 1,500 to 2,000 mm in the south. In the Lake Chad Basin (HA-VIII), there are some areas with the

annual evaporation of more than 4,000 mm. Extremely high rate of the evaporation in the north has brought an extraordinarily excessive water loss from the large reservoir areas and surface water development facilities so far provided as compared with the limited water resources potential, and this may imply the selection of appropriate mode to be taken for the water resources development during the NWRMP period.

### 1.3.2 Surface Water Resources

#### (1) River Systems

There are four principal river basins in Nigeria: the Niger, the Lake Chad Basin, the rivers of Cross and Imo, and the Western littoral.

The Niger and its principal tributary the Benue flow through the territory of nine countries which have raised many international issues for development and management. There are many of the major tributaries in the Niger River Basin in view of the great potential for water resources development. These include the Sokoto-Rima, the Kaduna, the Gbako and the Gurara along the Niger River upto the confluence of the Benue at Lokoja and the Gongola, the Taraba, the Donga, the Katsina-Ala and the Mada along the Benue River.

In the Lake Chad Basin located in the North-East Region of Nigeria which occupies 20 percent of the nation's land, the rivers of Hadejia and Jama'are are originated from its west high lands, pass through a vast wetland in the middle course, and are discharged into Lake Chad as the Komadugu-Yobe River along the international boundary of Niger where the river discharge is reduced to a minimum extent. In addition, there are some independent river systems called the Yedseram, the Ngadda and so on which are originated from the south highlands in this Lake Chad Basin. The Lake Chad is land-locked with no surface outlet consisting of Nigeria, Niger, Cameroon and Chad and also featured "the largest shallow and fresh water lake in Africa". The Lake itself has, in the recent past, ranged in areal dimension of  $26 \times 10^3$  sq.km in 1962 to  $1.5 \times 10^3$  sq.km being currently dried up in connection with the prolonged Sahelian drought and recent withdrawal of the lake water and river inflow for development.

In the South-East Region, the Cross River rises in the Cameroon Highlands where it is said that the annual rainfall exceeds 4,000 mm and the catchment is covered by dense rain forest. The Western littoral consisting of a number of small basins such as the Ogun, the Oshun, the Owena and the Osse drains the south-west of the country between the Niger watershed and the Gulf of Guinea and has a feature of the coastal lagoons.

## (2) Drainage Basin Delineation

As a basic foundation of the NWRMP Study, the country has been delineated, with help of the JICA-Satellite Image Analysis (SIA), into eight Hydrological Area (HAs), 90 Sub-HAs (SHAs) and further 202 Sub-SHAs (SSHAs):

	HAs								Total
	I	II	III	IV	V	VI	VII	VIII	
1. Drainage Area Within Nigeria									
(10 <sup>3</sup> km <sup>2</sup> )	131.6	158.1	158.9	73.0	53.9	100.5	59.8	188.0	923.8
(%)	(14)	(17)	(17)	(8)	(6)	(11)	(7)	(20)	(100)
2. Drainage Area Outside Nigeria									
(10 <sup>3</sup> km <sup>2</sup> )	461.6	-	98.0	8.3	-	-	13.4	-	581.3
3. Total Drainage Area									
(10 <sup>3</sup> km <sup>2</sup> )	593.2	158.1	256.9	81.3	53.9	100.5	73.2	188.0	1,505.1
4. No. of SHAs	14	16	14	9	5	10	7	15	90
5. No. of SSHAs	34	34	25	29	10	18	19	33	202

## (3) Surface Water Resources Potential

Out of 358 gages provided nationwide, the data at 90 gages where the observation of river discharge is made were collected for processing. Since these data are not uniformly distributed throughout the country and also some are of less accuracy, a comprehensive review of the data reliability and a correlation analysis with the available rainfall data have been carried out to estimate the annual runoff for each of 90 SHAs. The annual runoff thus estimated for both of the 1970s and 1980s at the representative gages which are important for the NWRMP Study is shown below:



Representative Station	Drainage Area (km <sup>2</sup> )	Annual Runoff (10 <sup>9</sup> m <sup>3</sup> )		Specific Runoff Yield (mm/year)		Decreasing Rate (%)
		1970s	1980s	1970s	1980s	
<b>1. Upper Niger Basin</b>						
Jiddere Bode (Niger)	525.5	34.10	25.10	64	47	26
Kainji Outflow (Niger)	593.0	34.00	22.40	57	37	24
Baró (Niger)	730.7	57.10	43.30	78	59	24
Goronyó Dam (Rima)	21.5	0.72	0.65	34	30	10
Wamako (Rima)	40.2	1.27	1.14	32	35	10
Bakolori Dam (Sokoto)	4.8	0.84	0.60	174	125	28
<b>2. Benue Basin</b>						
Yola (Benue)	108.4	22.70	14.20	209	130	37
Makurdi (Benue)	305.5	88.80	75.10	291	245	15
Katsina-Ala (Katsina-Ala)	16.8	24.49	21.210	1,458	1,263	13
<b>3. Lower Niger Basin</b>						
Lokoja (Niger)	1,089.5	165.80	137.90	152	127	17
Onitsha (Niger)	1,100.8	168.00	141.90	153	129	16
<b>4. Cross Basin</b>						
Ikom (Cross)	16.9	27.70	26.80	1,639	1,586	3
Ikot Okpara (Cross)	48.3	54.30	51.00	1,124	1,056	6
<b>5. Lake Chad Basin</b>						
Tiga Dam (Kano)	6.5	0.92	0.70	141	107	24
Challawa Bridge (Challawa)	6.9	0.83	0.60	120	88	27
Bunga Bridge (Bunga)	7.4	1.83	1.27	247	171	31
Gashua (Yobe)	55.7	1.00	0.81	18	15	18

Taking into account the effect of Sahelian drought currently prevailing, the annual river runoff for the 1980s as may be assumed to follow a similar trend during the NWRMP period has been taken at the amount of potential surface water resources that should be the basic foundation for the NWRMP Study, from which those for each of eight HAs are summarized below:

	HAs								Total
	I	II	III	IV	V	VI	VII	VIII	
Drainage Area (10 <sup>5</sup> km <sup>2</sup> )	593.2	168.1	256.9	81.3	53.9	100.5	73.2	188.0	1,505.1
Annual Runoff (10 <sup>9</sup> m <sup>3</sup> )	22.4	32.6	55.0	28.0	20.0	35.4	65.7	8.2	267.3
Specific Runoff Yield (mm per year)	38	206	214	344	371	352	898	44	178

### 1.3.3 Groundwater Resources

General geology in Nigeria may be largely divided into two major unitary areas, viz. (1) the crystalline rock area referred to as the Basement Complex and (2) the Sedimentary Deposit. The former area is geological-blockwisely extended mainly in the north-central, south-central and eastern parts with a total area of  $442.9 \times 10^3$  sq.km (48 percent), while the latter is

distributed forming the large basins in the north-western, north-eastern and central-southern parts and also the interjacent piles among the Basement Complex areas with a total area of  $480.9 \times 10^3$  sq.km (52 percent).

In general, the Basement Complex is equally divided into sedimentary and igneous/metamorphic types, and the groundwater potential is small except for the area where the faults and fissures are well-developed and the weathering is experienced towards deeper part. On the other hand, the groundwater in confined or semi-confined sediment layers and highly cemented sedimentary rocks with cracks and fractures of the Sedimentary Deposit area is expected to be of higher yield. Taking into consideration the hydrogeological structures, pumping record of existing wells, recharge potential from the rainfall, and extractable coefficient for development, the potential groundwater resources that are defined at extractable groundwater reserves for the NWRMP are shown by HA for the sake of river basin planning:

	HAs								Total	(%)
	I	II	III	IV	V	VI	VII	VIII		
<b>1. Basement Complex Area</b>										
Drainage Area ( $10^3$ km <sup>2</sup> )	68.5	121.9	89.5	35.2	5.9	59.7	11.1	53.7	442.9	(46)
Potential Groundwater ( $10^9$ m <sup>3</sup> )	1.66	5.13	3.60	1.64	0.27	3.08	0.65	1.21	17.23	(33)
Groundwater Yield ( $10^3$ m <sup>3</sup> /km <sup>2</sup> )	25	42	40	47	51	52	59	23	39	)
<b>2. Sedimentary Area</b>										
Drainage Area ( $10^3$ km <sup>2</sup> )	65.1	36.2	69.4	37.8	43.6	40.8	48.7	134.3	480.9	(52)
Potential Groundwater ( $10^9$ m <sup>3</sup> )	2.68	3.05	3.40	2.75	6.58	5.94	5.63	4.37	34.70	(67)
Groundwater Yield ( $10^3$ m <sup>3</sup> /km <sup>2</sup> )	41	64	49	73	142	146	116	33	72	
<b>3. Total Area</b>										
Drainage Area ( $10^3$ km <sup>2</sup> )	133.6	158.1	158.9	73.0	53.9	100.5	59.8	188.0	923.8	(100)
Potential Groundwater ( $10^9$ m <sup>3</sup> )	4.34	8.18	6.99	4.39	7.15	9.02	6.28	5.58	51.93	(100)
Groundwater Yield ( $10^3$ m <sup>3</sup> /km <sup>2</sup> )	33	52	44	60	133	99	105	30	56	

#### 1.4 RELATION WITH OTHER RESOURCES

The principal objectives of the NWRMP to increase the availability of water resources and promote their rational utilization including environmental and socio-economic assessment of the proposed water projects would depend upon the focus on renewable and partially renewable natural resources such as soil, renewable energy (firewood), plant and animal life. Sustainable management of the water resources competes with other priorities where attention should be paid to the inter-relationships among people, resources and environment in the quest for sustainable development.

The most valuable national resources is the human resources base; consequently, the protection and enhancement of the people's health and well-being constitute one of the major responsibility in the NWRMP. By their individual and collective behaviors, humans make significant positive or negative impact on the water and other renewable resources and non-human environment of the country.

In this NWRMP Study, a special attention has been paid to the land resources management which is in the position parallel to the water resources sector. The first attempt was the classification of nationwide land cover by the JICA-Satellite Image Analysis (SIA):

(Unit : 10<sup>3</sup>sq.km)

Classification	IIAs								Total	(%)
	I	II	III	IV	V	VI	VII	VIII		
1. Forestland	2.8	27.4	13.3	14.7	14.8	44.2	13.7	5.9	136.8	(15)
2. Grassland	46.6	59.7	75.9	13.9	3.8	4.7	0.8	75.7	281.1	(30)
3. Farmland	69.5	67.0	46.3	39.3	14.3	41.0	38.6	76.3	392.3	(42)
4. Wetland	0.9	0.8	1.2	1.5	11.2	6.7	0.8	2.0	25.1	(3)
5. Others	11.7	3.2	22.2	3.6	9.9	3.9	5.9	28.1	88.5	(10)
<b>Total</b>	<b>131.5</b>	<b>158.1</b>	<b>158.9</b>	<b>73.0</b>	<b>54.0</b>	<b>100.5</b>	<b>59.8</b>	<b>188.0</b>	<b>923.8</b>	<b>(100)</b>

Notes: (1) Forestland includes woodland, tropical rain forest and mangrove.  
 (2) Others include urban disturbed, bareland and water.

The forest land covers only 15 percent of the entire Nigeria, which is quite below the so-called dangerous level of 30 percent. In particular, the North Region occupies 2.2 percent giving a serious effect on the micro-climate and water retention to its river basins in addition to the direct damage made by the Sahelian drought. The vegetation closely parallels the ecology ranging from sparse tree and shrub savanna in the north to coastal tropical rain forest.

The estimated total potential cultivable area is  $710 \times 10^3$  sq.km according to the draft soil map of Nigeria, of which  $392 \times 10^3$  sq.km are under cultivation including the fallow. The high population growth rate has serious implications for traditional methods of soil fertility restoration based on fallow, and any expansion should be at the expense of the fallow period. And, this will result in declining yields under the current practices, because the inorganic sources of plant nutrients are not readily available in the crop rooting zone due to widespread sandy textured surface horizons and the soils are dominated by clays that do not provide a reservoir of available nutrients. It appears that appropriate technology for halting this process is not yet adapted to the present smallholders' capabilities. In spite of the country's vast size, the national

population at 90 million already exceeds the carrying capacity of its land resources when farmed at low level of technology, and with the population likely to reach 186 million by 2020, the imbalance will become more and more serious in the future.

A comparative analysis on 1991 population density for cropping land could provide some remarks on the present land use as follows: the South Region has high population density of 5.0 persons per ha, followed by the North's 1.8 and the Central's 1.3. It can be said that the Central Region has still large potential for promotion of agricultural development regardless of the present land productivity, and there seems much potential for new water resources development in the eastern portion of this Region.

The main consequence of a combination of population pressure, fragile land resources and a slow uptake of appropriate technology is the land resource degradation: (1) soil erosion in its various forms from insidious sheet erosion to visible gullying, (2) pervasive declines in soil fertility as fallow periods become shorter, (3) reductions in vegetative cover and in the nutritive value of the grazing areas, and (4) destruction of forest and woodlands which exceeds their capacity for natural revegetation and contributes to a decline in the diversity of plant and animal life. Attempts to address the problems of land resources degradation have been made by farmers and the Government. The scale on which these remedies have been applied, however, has so far been small in relation to the immensity of these problems. If anything has been gained, it has been largely off-set by the effects of the Government policies and programs to place more weight upon achieving the rapid increase in economic growth rather than upon the resources conservation.

Apart from the area-specific gully erosion problems which are examined as one of the sectors included in the NWRMP, a wide range of technologies exist both indigenous and introduced, which offer prospects to reduce the various forms of land degradation. Those that hold the greatest promise for widespread application are adjustments to farming practices aimed at reducing runoff, fertility decline and the degradation of soil structure. Cultivation along the contour, adjustments of cropping patterns to maintain the maximum soil cover throughout the year, maximizing the applications of organic manure and compost, and increasing levels of appropriate inorganic fertilizer inputs could all contribute to the more sustainable use of farmland,

and given their relatively low cost - apart from inorganic fertilizers - most of these essentially agronomic approaches to conservation are likely to be financially attractive to farmers.

There is apparently no mandatory requirement under the present policies to make a review of urban development proposals. Although the issues of communications, urban water need and energy supply dominate these decisions, they should be made with regard to the land quality involved, to the risks of disasters and to the change in rural land use that will follow. It is in the national interest to prevent most forms of highly damaging land use such as (1) the contamination from industrial effluents, solid and liquid wastes and storm water, (2) the gully erosion by concentrated runoff from built-up areas or roads and (3) the river flooding over low-lying land partly due to local siltation of eroded sediments. It may be noted that the FGN may consider it right to adopt a policy which calls for the nation's land resources to be used in a sustainable manner, and this should be closely related with a proper implementation of the NWRMP.

## **1.5 OBJECTIVES AND SCOPE OF THE STUDY**

### **1.5.1 Objectives**

The objective of the JICA-assisted Study is to formulate a National Water Resources Master Plan (NWRMP) which assures the optimum water resources use and provides appropriate development alternatives on short (year 2000) - and long (year 2020) - term basis. For the implementation of Study, the JICA has taken the following measures:

- To dispatch, at its own expense, the Study Team to Nigeria.
- To pursue the technology transfer to the Nigerian counterpart personnel in the course of the Study.

### **1. 5. 2 The Study Area**

The Study covers the whole area of the Federal Republic of Nigeria.

### **1. 5. 3 Scope of Work**

The Study has been carried out comprising of the following two Phases in accordance with the Scope of Work and the Minutes of Meetings on the subject Study as agreed upon between the representatives of the Government of Nigeria and the Leader of the Preparatory Study Team of the Japan International Cooperation Agency (JICA) on November 8, 1991:

**Phase I: Review of Available Information and Preparation of Study Program**  
(Period : March to July, 1992)

This phase included the review and analysis of existing studies such as the draft provisional national water resources master plan (August 1985), and data & information relevant to the Study, and the execution of initial field survey. The findings of the review and subsequent analysis led to the formulation of a Study program in detail for the work in Phase II.

**Phase II: Main Work for the National Water Resources Master Plan**  
(Period : August, 1992 to March, 1995)

This main part of the Study included comprehensive assessment, planning, development, conservation, management and other aspects of the nation's water resources which were subsequently crystallized into the NWRMP. In the Study, due attention has been paid to the watershed management and other environmental issues.

Lists of the experts in the JICA Study Team, members of the JICA Advisory Committee, composition of the FGN Steering Committee and members of the FMWRRD Technical Committee as well as a list of the vehicles and equipment as brought into Nigeria by JICA for use of the Study are given under Appendix A of this report.

During the course of the Study from March 1992 to March 1995, the following field work was conducted in Nigeria:

- Phase I : Field Work (I) ... April 20, 1992 to May 19, 1992
- Phase II: Field Work (II) ... August 24, 1992 to March 21, 1993
- Field Work (III) ... November 8, 1993 to February 21, 1994
- Field Work (IV) ... January 30, 1995 to February 28, 1995

#### **1.5.4 Important Activities Involved in Phase II Study**

##### **(1) National Water Resources Inventory Survey (NWRIS)**

The information and data available for the present water use and needs for water resources development and management were collected by means of NWRIS. The JICA's invitation documents dated August 25, 1992 were dispatched to eight domestic consultant firms for their "two-envelop" styled proposals, and after selection and subsequent negotiations, the contracts with following six firms were finalized on September 28, 1992 with the implementation period of October 1992 through 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 the South-Central Region
  - TC International Associates, Ibadan for the Southeast Region

The Final Reports for the NWRIS in 15 copies were submitted by March 18, 1993 that 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. And, the important information and database which had been refined by the JICA Team through subsequent field visits and reconnaissance and are the basic foundation for preparation of the NWRMP are compiled in Vol. Three

"Water Resources Inventory Survey" and Vol. Four "Water Resources Database Maps".

(2) Satellite Image Analysis (SIA)

In parallel with the activities during the Field Work (II), the Satellite Image Analysis (SIA) or the so-called remote sensing covering the entire area of Nigeria was carried out in Japan under the contract with PASCO International Inc., Tokyo as duly selected by JICA during the period of October 1992 to March 1993. The subject work to support proper understanding of the nation's land and water resources through analysis of the Landsat Satellite Imageries and facilitate broad interpretation of the present situation on those resources was done in cooperation with the JICA Team in Nigeria.

At the end of March 1993, the following products 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 (Ployestel Base)
Geology Map	: Sheets 1-9, Scale 1:500,000 (Ployestel Base)
Geomorphology Map	: Sheets 1-9, Scale 1:500,000 (Ployestel Base)
Land Cover Map	: Sheets 1-9, Scale 1:500,000 (Ployestel 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 areas:

Sokoto-Rima River	: 1-2 Scale 1:250,000 (Photo Print)
Hadejia-Mamáare-Yobe River	: 1-2 Scale 1:250,000 (Photo Print)
Niger River	: 1 Scale 1:250,000 (Photo Print)
Benue River	: 1-4 Scale 1:250,000 (Photo Print)
Ydeseram-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 (March 1993)

A full set of the products was submitted to the FMWRRD for nationwide reference in the beginning of the Field Work (III), while



another set was equipped at the JICA Representative Office, 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".

**(3) The National Workshop for the NWRMP**

The National Workshop on the Preparation of a National Water Resources Master Plan organized by the FMWRRD in collaboration with JICA, FAO, UNDP and World Bank was held in Abuja during the period of December 6 to 8, 1993 on the basis of the JICA Interim Report. The Workshop with the participation of some 200 experts from the Government and private organizations and international institutions consisted of the Plenary Session (Dec. 6), the six Committee Session (Dec. 7) divided into Hydrology and Hydrogeology, Dams and Reservoir Operations, Irrigation and Drainage, Water Supply and Sanitation, Gully Erosion and Flood Control, and River Management and Organization, and the Final Plenary Session (Dec. 8).

**(4) Water Resources Decree, No.101 of 1993**

The Water Resources Decree, No.101 of 1993 was promulgated on August 23, 1993 and its copy was delivered to the JICA Team at the end of January 1994.

**(5) National Manpower Inventory Survey in the Water Resources Sector**

The National Manpower Inventory Survey in the Water Resources Sector was conducted by the FMWRRD entrusting this work to Skoup & Co. Ltd., Enugu, and its report was distributed to the JICA Team at the end of January 1994.

**1.5.5 Reports Submitted**

The JICA Team has prepared and submitted the following reports in English to the Government of Nigeria: