FEDERAL REPUBLIC OF NIGERIA

FEDERAL MINISTRY OF WATER RESOURCES (FMWR)

THE PROJECT FOR REVIEW AND UPDATE OF NIGERIA NATIONAL WATER RESOURCES MASTER PLAN

VOLUME 2

SUMMARY REPORT

JANUARY 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
SANYU CONSULTANTS INC.

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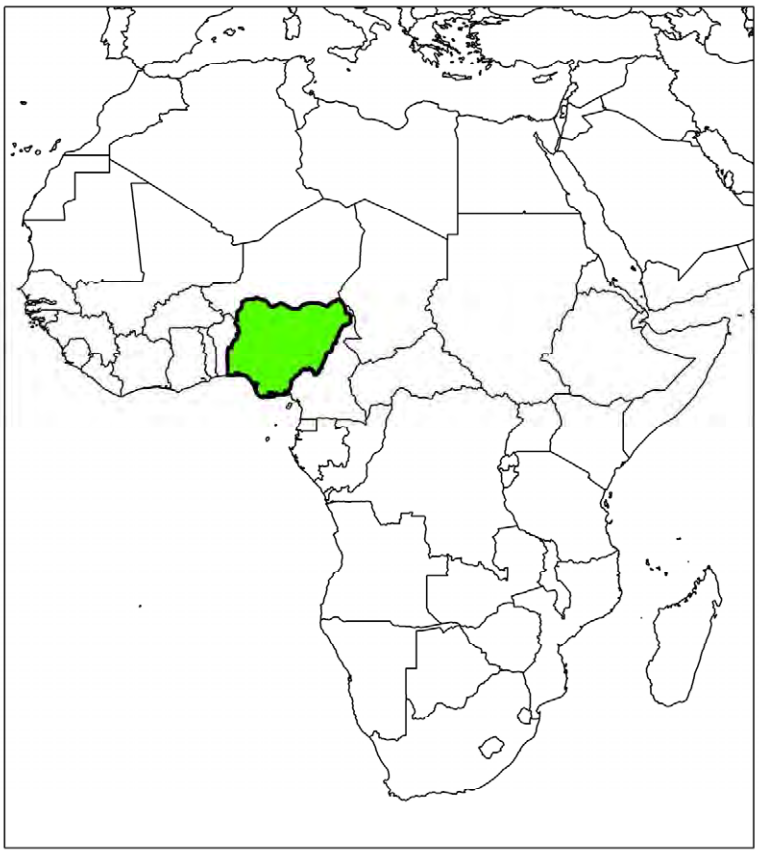
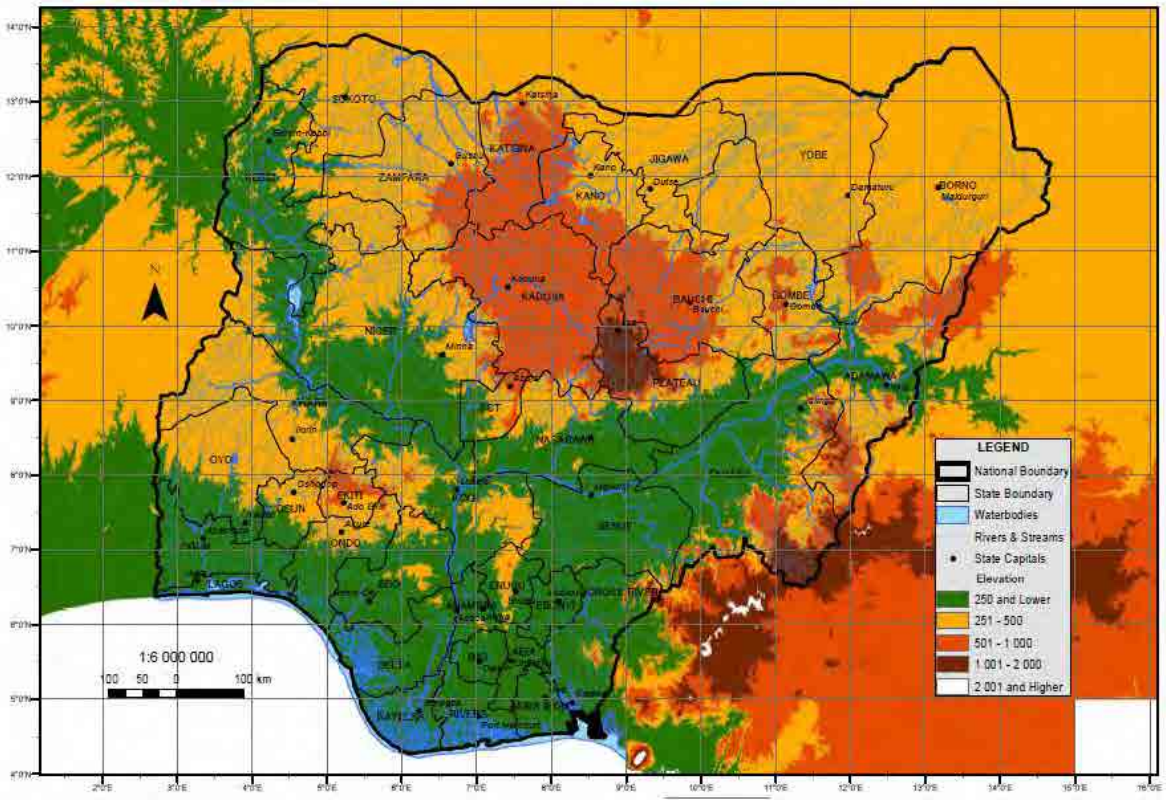


Location of the Federal Republic of Nigeria



Map of Project Area

Contents

Page

Map of Project Area
Contents ....(1)
Tables and Figures ....(2)
Abbreviations....(6)

VOLUME 2 SUMMARY REPORT

SUMMARY OF THE PROJECT .... (1)

CHAPTER 1 OUTLINE OF THE PROJECT 1-1

1.1 Outline of the Project.... 1-1
1.2 Project Management.... 1-2

CHAPTER 2 NATIONAL WATER RESOURCES MASTER PLAN 2013.... 2-1

2.1 Review of Existing National Water Resources Master Plan 1995.... 2-1
2.2 Concepts of National Water Resources Master Plan 2013 (M/P2013).... 2-5
2.3 Projection of Future Water Demand.... 2-10
2.4 Evaluation of Water Resources Potential.... 2-23
2.5 Water Balance between Demand and Supply.... 2-30
2.6 Water Sources Development Plan.... 2-37
2.7 Water Resources Sub-sector Development Plan.... 2-50
2.8 Water Resources Management Plan.... 2-61
2.9 Implementation Program.... 2-73
2.10 Evaluation of National Water Resources Master Plan 2013.... 2-78
2.11 Recommendations.... 2-84

CHAPTER 3 DRAFT CATCHMENT MANAGEMENT PLAN.... 3-1

3.1 Current Situation of Project Area.... 3-1
3.2 Framework of Catchment Management Plan.... 3-2
3.3 Projection of Future Water Demand.... 3-5
3.4 Evaluation of Water Resources Potential.... 3-6
3.5 Water Balance between Demand and Supply.... 3-8
3.6 Water Sources Development Plan.... 3-10
3.7 Water Resources Sub-sector Development Plan.... 3-12
3.8 Water Resources Management Plan.... 3-15
3.9 Implementation Program.... 3-17
3.10 Evaluation of Catchment Management Plan.... 3-21
3.11 Recommendations.... 3-24

Tables and Figures

Table

Table 1-1 Schedule of Project 1-2
Table 1-2 Member of Japanese Side 1-3
Table 1-3 Members of Steering Committee 1-3
Table 1-4 Member of Technical Advisory Committee 1-4
Table 1-5 Members of Counterpart 1-4
Table 1-6 Main Meetings 1-4
Table 1-7 Schedule of Workshops in Abuja 1-5
Table 1-8 Outline of Workshops in Eight Hydrological Areas 1-5
Table 1-9 Schedule and Outline of Stakeholder Meetings and Workshops on Formulation of CMP 1-6

Table 2-1 Major Indicators in M/P1995 2-2
Table 2-2 Basic Concepts on Water Source Development 2-8
Table 2-3 Basic Concepts on Water Source Conservation 2-9
Table 2-4 Basic Concepts on Sub-Sector Development 2-9
Table 2-5 Projected Population of Nigeria by United Nations 2-10
Table 2-6 Census and Projected Population 2-10
Table 2-7 Categorization of Settlement on Water Demand Projection 2-12
Table 2-8 National Water Supply Coverage by Settlement Category in Target Years 2-12
Table 2-9 Population Served by State 2-12
Table 2-10 Per Capita Consumption of Domestic Water 2-12
Table 2-11 Water Demand Projection 2-13
Table 2-12 Production of Rain-fed Rice as of 2030 2-14
Table 2-13 Production of Irrigated Rice as of 2030 2-15
Table 2-14 Current Cropping Pattern 2-15
Table 2-15 Proposed Cropping Pattern 2-16
Table 2-16 Monthly Variations of Diversion Water Requirement 2-17
Table 2-17 Monthly Variations of Diversion Water Requirement 2-17
Table 2-18 Current Irrigation Water Demand 2-18
Table 2-19 Proposed Irrigation Water Demand 2-18
Table 2-20 Coefficient of Air Temperature Variation 2-18
Table 2-21 Variation of Water Demand due to Climate Change 2-19
Table 2-22 Number of livestock heads / fowls in 1,000 head/fowl 2-19
Table 2-23 Estimated Municipal Water Demand by Sources 2-22
Table 2-24 Estimated Total Water Demand by Sources 2-22
Table 2-25 Spatially Averaged Annual Precipitation, Annual Mean Air Temperature and Annual PET for Each HA 2-24
Table 2-26 Groundwater recharge by HA 2-27
Table 2-27 Scenarios for Change in Precipitation and Air Temperature 2-27
Table 2-28 Estimated Water Resources Potential 2-29
Table 2-29 Groundwater Recharge and Groundwater Demand (2030) 2-31
Table 2-30 Groundwater Recharge and Demand by Effect of Climate Change (2030) 2-32
Table 2-31 Comparison between Water Demand and Water Supply Capacity at Scale of Entire HA 2-34
Table 2-32 Items considered in Detail Water Balance Study 2-34
Table 2-33 Estimated Hydropower Generation by Significant Dams 2-36
Table 2-34 Groundwater Development Potential 2-37
Table 2-35 Concept of Groundwater Development for Municipal Water Supply 2-38
Table 2-36 Optimum Yield of Borehole Field 2-39
Table 2-37 Borehole Specification 2-39
Table 2-38 Number of newly Drilled Boreholes and Rehabilitated Boreholes to meet Water Demand of 2030 2-40
Table 2-39 Annual Average Number of Rehabilitated Boreholes by Year (Nationwide) 2-41
Table 2-40 Annual Average Number of Newly Drilled Boreholes by Year (Nationwide) 2-41
Table 2-41 Summary of Survey on Management Status of Selected Existing Dams 2-42
Table 2-42 Strategy on Surface Water Development 2-43
Table 2-43 Potential Surface Water Source Development Sites 2-43
Table 2-44 Proposed Surface Water Development Project 2-44

Table 2-45 Integrated Surface Water Development 2-45
Table 2-46 Type of Groundwater Contamination and Measures against It 2-47
Table 2-47 Groundwater Management Plan and Responsible Organization 2-48
Table 2-48 Issues on Conservation of Surface Water Source 2-49
Table 2-49 Recent Water Supply and Sanitation Coverages and Estimate by the Project 2-51
Table 2-50 Common Composition of Public Water Supply Facilities 2-51
Table 2-51 Existing Water Treatment Facility of Surface Water 2-51
Table 2-52 Number and Operating Ratio of Existing Boreholes in 2006 2-52
Table 2-53 Sanitation and Sewerage Coverage 2-52
Table 2-54 Per Capita Consumption by Water Supply Category 2-52
Table 2-55 Composition of Water Supply Facilities in Development Plan 2-53
Table 2-56 Standard Sanitation Service Level 2-53
Table 2-57 Components of Sanitation Development Plan 2-53
Table 2-58 Water Supply Development Plan for Hydrological Balance 2-54
Table 2-59 Water Supply Development Plan for Facility Planning (Installed Capacity) 2-54
Table 2-60 Sanitation Development Plan (2015-2030) 2-55
Table 2-61 Required Development of Domestic Sanitation Facilities 2-55
Table 2-62 Category of Public Irrigation Scheme 2-56
Table 2-63 Completion with No Extension Scheme 2-56
Table 2-64 Ongoing Scheme 2-56
Table 2-65 Extension Scheme 2-57
Table 2-66 Integrated Development Scheme 2-57
Table 2-67 Planned Irrigation Area as of 2030 2-58
Table 2-68 Prioritized Activities for Flood Control Sector in FMWR 2-59
Table 2-69 Action Plan for Institutional Development and Strengthening 2-63
Table 2-70 Necessary Survey for Dam Management 2-65
Table 2-71 Directions for Future Improvement of Water Resource Facility Operations 2-66
Table 2-72 Strategy on Improvement of Surface Water Monitoring 2-68
Table 2-73 Proposed Items of Basic Investigation 2-69
Table 2-74 Outline of Proposed Schemes 2-73
Table 2-75 Conditions for Estimate 2-76
Table 2-76 Project Cost for Water Sources Development Schemes 2-77
Table 2-77 Cost of Sub-sector Development Schemes 2-77
Table 2-78 Cost of Water Resources Management Schemes 2-77
Table 2-79 Financial Program of Investment for Water Resources Development Schemes 2-78
Table 2-80 Results of Economic Analysis of Water Supply Projects 2-78
Table 2-81 Results of Economic Analysis of Existing Schemes 2-78
Table 2-82 Results of Economic Analysis of New Schemes 2-78
Table 2-83 Financing to Water Supply Projects 2-79
Table 2-84 Financing to Irrigation Projects 2-80
Table 2-85 Number of Projects under M/P2013 2-80
Table 2-86 Categorization of Projects in M/P2013 subjected to IEE/EIA Study 2-80
Table 2-87 Summary of Matrix for Scoping (Dams and Municipal Water Supply Sectors) 2-82
Table 2-88 Summary of Matrix for Scoping (Irrigation/Drainage and Sanitation Sectors) 2-82
Table 2-89 Recommended Main Mitigation Measures 2-83

Table 3-1 Strategic Issues of Water Resources Management and Development 3-4
Table 3-2 Estimated Water Resources Potential in HA-1 and Ogun-Oshun Basin 3-7
Table 3-3 Overall Water Balance between Total Water Demand and Water Resources Potential 3-9
Table 3-4 Summary of Finding in Water Balance Study 3-10
Table 3-5 Aquifer Classification 3-10
Table 3-6 Optimum Yield from Borehole Fields 3-11
Table 3-7 Number of Newly Drilled Borehole and Rehabilitated Boreholes to meet Water Demand of 2030 3-11
Table 3-8 Strategy on Surface Water Development 3-11
Table 3-9 Proposed Surface Water Development Project in HA-1 3-12
Table 3-10 Proposed Surface Water Development Project in Ogun-Oshun Basin 3-12
Table 3-11 Water Supply Development Plan for Facility Planning in HA-1 3-13
Table 3-12 Water Supply Development Plan for Facility Planning in Ogun-Oshun Basin 3-13
Table 3-13 Sanitation Development Plan in HA-1 3-13
Table 3-14 Sanitation Development Plan in Ogun-Oshun Basin 3-13

Table 3-15 Category of Public Irrigation Scheme 3-14
Table 3-16 Planned Irrigation Area as of 2030 3-14
Table 3-17 Measures against Flood and Soil Erosion 3-15
Table 3-18 Content of Water Resources Management Plan 3-15
Table 3-19 Classification of Projects 3-18
Table 3-20 Project Cost for Water Sources Development Schemes 3-18
Table 3-21 Cost of Sub-sector Development Schemes 3-18
Table 3-22 Cost of Water Resources Management Schemes 3-18
Table 3-23 Financial Program for Project Implementation 3-19
Table 3-24 Project Cost for Water Sources Development Schemes (Scenario-A) 3-19
Table 3-25 Cost of Sub-sector Development Schemes (Scenario-A) 3-19
Table 3-26 Cost of Water Resources Management Schemes (Scenario-A) 3-19
Table 3-27 Project Cost for Water Sources Development Schemes (Scenario-B) 3-20
Table 3-28 Cost of Sub-sector Development Schemes (Scenario-B) 3-20
Table 3-29 Cost of Water Resources Management Schemes (Scenario-B) 3-20
Table 3-30 Financial Program for Project Implementation (Scenario-A) 3-20
Table 3-31 Financial Program of Investment for Water Sources Development Schemes (Scenario-B) 3-20
Table 3-32 Results of Economic Analysis of Water Supply Projects 3-21
Table 3-33 Results of Economic Analysis of Existing Schemes 3-21
Table 3-34 Results of Economic Analysis of New Schemes 3-21
Table 3-35 Results of Economic Analysis of Water Supply Projects 3-22
Table 3-36 Results of Economic Analysis of Existing Schemes 3-22
Table 3-37 Results of Economic Analysis of New Schemes 3-22
Table 3-38 Water Supply Project Costs by Stage 3-23
Table 3-39 Irrigation & Drainage Project Costs by Stage 3-23
Table 3-40 Number of Projects of CMP 3-24
Table 3-41 Categorization of Projects in Draft CMP subjected to IEE/EIA Study 3-24

Figure

Figure 1-1 Hydrological Map of Nigeria 1-2
Figure 1-2 Project Organization 1-2
Figure 1-3 The Cities where Workshops were held 1-6

Figure 2-1 Map of M/P1995 2-3
Figure 2-2 Concept of National Water Resources Master Plan 2013 2-6
Figure 2-3 Contents of National Water Resources Master Plan (M/P2013) 2-7
Figure 2-4 Flowchart of Water Demand Projection 2-11
Figure 2-5 Cropping Calendar 2-15
Figure 2-6 Calculation Flow of Water Demand Projection 2-16
Figure 2-7 Water Demand of Livestock 2-19
Figure 2-8 Water Demand of Freshwater Aquaculture 2-20
Figure 2-9 Change in Share of Water Demand by Sectors 2-22
Figure 2-10 Water Demand by Sectors and by HAs 2-22
Figure 2-11 Water Demand for Surface Water Source 2-23
Figure 2-12 Water Demand for Groundwater Source 2-23
Figure 2-13 Spatial Patterns of Annual Precipitation and Annual PET 2-24
Figure 2-14 Coverage Area of Long-term Rainfall-Runoff Simulation Model 2-24
Figure 2-15 Spatial Distribution of Average Annual Runoff Yield 2-25
Figure 2-16 Long-term Averaged Water Balance in terms of Annual Total Runoff Volume 2-26
Figure 2-17 Procedure of Water Balance Study 2-30
Figure 2-18 Predicted Lowering of Groundwater Level in 2030 2-33
Figure 2-19 Predicted Lowering of Groundwater Level in 2030 by Influence of Climate Change 2-33
Figure 2-20 Detail Water Balance Study for Surface Water 2-35
Figure 2-21 Conceptual Scheme of Municipal Water Supply by Borehole Field 2-38
Figure 2-22 Content of Factors to be considered in Groundwater Development Plan 2-38
Figure 2-23 Number of Boreholes and Yield from each Borehole in Borehole Filed 2-39
Figure 2-24 Conceptual Scheme of Groundwater Development by Step 2-41
Figure 2-25 Location of Existing and Under-Construction Dams 2-42
Figure 2-26 Location of Potential Sites for Surface Water Development 2-44

Figure 2-27 Schematic Drawing on Integrated Surface Water Development 2-45
Figure 2-28 Selected Dam Sites for Surface Water Source Development 2-46
Figure 2-29 Proposed Implementation Schedule for Surface Water Source Development 2-46
Figure 2-30 Concept of Groundwater Management Comprising Monitoring, Prediction and Measures 2-47
Figure 2-31 Method for Groundwater Management and Development 2-48
Figure 2-32 Framework of Conservation of Surface Water Source 2-50
Figure 2-33 Demand and Supply in Water Supply Development Plan for Facility Planning 2-54
Figure 2-34 Integrated Development Location Map 2-58
Figure 2-35 Hydroelectric Potential in HAs 2-59
Figure 2-36 Technical Field on Management of Floodplain for FMWR 2-60
Figure 2-37 Targets of Water Resources Management 2-62
Figure 2-38 Study Flowchart of Priority for Improving Ripeness of Dam Management 2-65
Figure 2-39 Framework on Water Resources Planning, Management and Regulation by Unit of Hydrological Area 2-70
Figure 2-40 Framework on Activities of CMO at Catchment Level 2-71

Figure 3-1 Contents of Catchment Management Plan (CMP) 3-3
Figure 3-2 Change in Share of Water Demand by Sector of HA-1 3-5
Figure 3-3 Water Demand by Sector and by Water Source of HA-1 3-5
Figure 3-4 Change in Share of Water Demand by Sectors of Ogun-Oshun Basin 3-6
Figure 3-5 Water Demand by Sectors and by Sources of Ogun-Oshun Basin 3-6
Figure 3-6 Estimated Water Resources Potential in HA-1 and Ogun-Oshun Basin 3-8
Figure 3-7 Output (Potential) by HA 3-14

Abbreviations

Abbreviation & Acronym	Explanation
ACGSF	Agricultural Credit Guarantee Scheme Fund
ADP	Agricultural Development Project
AEPB	Abuja Environmental Protection Board
AfDB	African Development Bank
BADC	British Atmospheric Data Centre
BCM	Billion Cubicmeter
BOD	Biochemical Oxygen Demand
BOT	Build-Operate-Transfer
CCU	Climate Change Unit
CD	Capacity Development
CITES	Convention on International Trade in Endangered Species
CMCC	Catchment Management Coordinating Committee
CMO	Catchment Management Office
CMP	Catchment Management Plan
CPI	Consumer Price Index
CWIQS	Core Welfare Indicators Questionnaire Survey
DDRO	Department of Dam and Reservoir Operations
DEM	Digital Elevation Model
DFID	Department for International Development in UK (UKAID)
DID	Department of Irrigation and Drainage
DO	Disolved Oxygen
DPRS	Department of Planning and Research and Statistics
DRBOI	Department of River Basin Operation and Inspectorate
DWQ&S	Department of Water Quality Control and Sanitation
DWS	Department of Water Supply
EA	Environmental Assessment
EC	European Commission
ECN	Energy Commission of Nigeria
EIA	Environment Impact Assessment
EL	Elevation
EMSS	Environmental Management Support System
ERICA	European Rivers and Catchment
ET	Evapotranspiration
EU	European Union
FAO	Food and Agriculture Organization
FCA	Fadama Association Committee
FCT	Federal Capital Territory
FEPA	Federal Environmental Protection Agency
FEWS	Flood Early Warning System
FGN	Federal Government of Nigeria
FIWD	Federal Inland Waterways Department
FMANR	Federal Ministry of Agriculture and Natural Resources
FMARD	Federal Ministry of Agriculture and Rural Development
FME(d)	Federal Ministry of Education
FME(n)	Federal Ministry of Environment
FMH	Federal Ministry of Health
FMP	Federal Ministry of Power
FMT	Federal Ministry of Transport
FMWA	Federal Ministry of Women's Affairs
FMWR	Federal Ministry of Water Resources
FMWRRD	Federal Ministry of Water Resources and Rural Development
GCM	Global Climate Models
GDMA	Gurara Dam Management Authority

Abbreviation & Acronym	Explanation
GDP	Gross Domestic Product
GIS	Geographical Information System
GWMA	Gurara Water Management Authority
HA	Hydrological Area
HYCOS	Hydrological Cycle Observation System
ICT	Information and Communication Technology
IEE	Initial Environmental Evaluation
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Programme
kW	Kilowatt
kWh	Kilowatt-Hour
LCBC	Lake Chad Basin Commission
LGA	Local Government Authority
M&E	Monitoring and Evaluation
M/P	Master Plan
MANR	Ministry of Agriculture and Natural Resources
MCM	Million Cubicmeter
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Survey
MLIT	Ministry of Land, Infrastructure and Transport of Japan
MW	Megawatt
MWh	Megawatt-Hour
NACRDB	Nigeria Agricultural Cooperative and Rural Development Bank
NAFDAC	Nigeria Food Drag Administration and Control
NAFSS	National Agriculture and Food Security Strategy
NASRADA	Nigeria Space Research and Development Agency
NBA	Niger Basin Authority
NBN	National Bank of Nigeria
NBS	National Bureau of Statistics
NCC	Nigeria Cameroon Commission
NCWR	National Council on Water Resources
NDHS	National Demographic and Health Survey
NEED	National Economic Empowerment and Development Strategy
NEMA	National Emergency Management Agency
NERA	National Emergency Relief Agency
NESREA	National Environmental Standards and Regulations Enforcement Agency
NEWMAP	Nigerian Erosion and Watershed Management Project
NFDP	National Fadama Development Project
NFSSP	National Food Security Support Project
NGO	Non Governmental Organization
NGSA	Nigeria Geological Survey Agency
NIHSA	Nigeria Hydrological Services Agency
NIMET	Nigerian Meteorological Agency
NIS	Nigerian Industrial Standard
NIWA	National Inland Waterways Authority
NIWRMC	Nigeria Integrated Water Resources Management Commission
NNJC	Niger-Nigeria Joint Commission
NPC	National Population Commission
NPC	Nigeria Planning Commission
NRDS	National Rice Development Strategy
NRW	Non Revenue Water
NTN	National Training Network

Abbreviation & Acronym	Explanation
NWRI	National Water Resources Institute
NWSSBS	National Water Supply and Sanitation Baseline Survey
OORBDA	Ogun-Osun River Basin Development Authority
PET	Potential Evapotranspiration
PHCH	Power Holding Company of Nigeria
PPP	Public-Private Partnership
PSP	Private Sector Participation
RBDA	River Basin Development Authority
RBMC	River Bain Management Commission
RCM	Regional Climate Models
ROPSIN	Review of the Public Irrigation Sector of Nigeria
RUWASSA	Rural Water Supply and Sanitation Agency
SEA	Strategic Environmental Assessment
SHA	Sub Hydrological Area
SON	Standards Organisation of Nigeria
SRRBDA	Sokoto-Rima River Basin Development Authority
SRTM	Shuttle Radar Topography Mission
SSHA	Small Sub Hydrological Area
STWSS	Small Town Water Supply and Sanitation
STWSSA	Small Town Water Supply and Sanitation Project
STWSSP	Small Town Water Supply and Sanitation Agency
SWA	State Water Agencies
TOR	Terms of Reference
UAC	Users Association Committee
UFW	Unaccounted for Water
UNDP	United Nations Development Programme
UNEP	UN Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNISDR	United Nations International Strategy for Disaster Reduction
VAB	Visual Basic Application
WASHCOM	Water, Sanitation and Hygiene Committee
WATSAN	Water and Sanitation
WB	World Bank
WCA	Water Consumers Association
WHO	World Health Organization
WRDP	Water Resources Development Plan
WRMP	Water Resources Management Plan
WRUP	Water Resources Utilization Plan
WSSSRP	Water Supply Sanitation Sector Reform Programme
WTP or WTW	Water Treatment Plant or Works
WUA	Water Users Association

Summary of the Project

The Project for Review and Update of Nigeria National Water Resources Master Plan

Project Period : August 2011 to January 2014
Recipient Agency: Federal Ministry of Water Resources, the Federal Republic of Nigeria

1. Background and Objective of the Project

(1) Background

The needs of water resources development for irrigation, water supply, energy generation and so on have been increasing with population growth and economic development in Nigeria. Under these circumstances, the Government of Nigeria requested the Government of Japan for implementation of technical cooperation of Development Study to review and update the National Water Resources Master Plan (M/P1995) for promotion of Integrated Water Resources Management (IWRM). Responding to this request, JICA Preparatory Study Team was dispatched to Nigeria. The team discussed with Nigerian side on the background and content of the request, institutional situation of the Nigerian side, current cooperation with foreign donors, current situation of the water resources management and development, content of the proposed Project and so on. Based on the discussion, Scope of Work (SW) was signed and exchanged in March 2011 between JICA Preparatory Study Team and the Federal Ministry of Water Resources (FMWR), which is an Implementing Agency of the Project. According to the SW, JICA dispatched the Project Team consisting of Consultants, who commenced site survey in August, 2011 in Nigeria.

(2) Objectives of the Project

Objectives of the Project is to formulate "National Water Resources Master Plan 2013 (M/P2013)" and "The 1st Draft Catchment Management Plan (CMP)" for the two prioritized hydrological areas (HAs) , which will contribute to formulation of CMPs for these 2 HAs and the other HAs.

2. National Water Resources Master Plan

(1) Concept of National Water Resources Master Plan (M/P2013)

Higher plan

The national plans such as "Nigeria Vision 20:2020" and "Water Sector Roadmap", which are the top plans of national water resources master plans, set the current water sector issues that should be improved: 1) Low rate of access to safe and clean water and sanitation facilities, 2) Low contribution of irrigation to national food security, and 3) Insufficient utilization of hydropower for renewable energy. M/P2013 is a plan for promoting concrete actions to solve these problems. To break through this situation, it is necessary to formulate a plan integrating development, utilization and management of water resources through evaluation of water resources potential and demand projection based on the IWRM philosophy.

Main issue and strategies in water resources management and development

The following strategic issues are taken into account in formulating the M/P2013: 1) Water resources management and development in consideration of unevenly distributed water resources and demand, 2) Addressing increasing municipal water demand on the premise of current low operation rate of water supply facilities, 3) Promotion of sound and self-reliant irrigation development, 4) Effective utilization of existing water source facilities in view of contemporary needs, 5) Enhancement of water-related data/information and its uniform management, 6) Consideration of increasing risk on water resources, 7) Active involvement of water resources administrator in management of important rivers and flood plains, 8) Water quality monitoring to secure clean and safe water, 9) Institutional development and strengthening of water resources management.

(2) Water Demand Projection, Water Resources Potential and Water Balance between Demand and Supply

Water demand projection

Water demand for water supply is set to meet 100% of the water supply coverage in 2030 following the goal of Vision 20:2020. Per Capita Consumption for water supply is projected based on the standard per capita consumption of FMWR: 120 lit/cap/day for urban water supply, 60 lit/cap/day for semi-urban/small town water supply, 30 lit/cap/day for rural water supply. The amount of population growth was taken from projection by the United Nations. Regarding Water demand for irrigation, the target is to achieve 100% self-sufficiency in rice production by 2030. The amount of rice consumption in 2030 is projected based on the consumption amount estimated by the Federal Ministry of Agriculture and Rural Development (FMARD), which is the same as the current level of 30 kg/cap/year.

The existing total water demand is estimated at 5.93 billion cubic meter per year (BCM/year) including water supply, irrigation, aquaculture and livestock. The demand is expected to increase to 16.58 BCM/year by 2030. The shares of municipal water demand of the total water demand in 2010 and 2030 are about 50% and 53% respectively. The share of the irrigation water demand will increase from about 30% in 2010 to about 40% in 2030. Each HA has its own water demand characteristics. Present municipal water demand depends on population scale and is the highest in HA-6, followed by HA-8. This tendency will be maintained in the future (2030). Water supply demand also shows the same tendency. The increasing rate of irrigation water demand in HA-3 is much larger than those in other HAs, because many irrigation projects are planned in HA-3 where many suitable fields for irrigation development are found.

Water resources potential

Water resources potential was estimated as output of long-term rainfall-runoff model (Semi-distributed Thornthwaite Monthly Water Balance Model) using 40 years (1970 to 2009) of precipitation and air temperature. The average precipitation over the country for the past 40 years is about 1,150mm. Only 24% of the precipitation becomes runoff and the rest are lost as evapotranspiration and/or others. The total internal generation of the runoff is 244 BCM/year and the surface water resources potential is estimated at about 333 BCM/year. The total water resources potential can be evaluated by adding the component that is lost without becoming surface runoff among recharges. The internal generation of total water resources potential is estimated at 287 BCM/year, and the total water resources potential, including inflow from neighboring countries, is estimated at 375 BCM/year. 88 BCM/year of the water comes from neighboring countries, which roughly indicates that almost 24% of the surface water resources in Nigeria are from neighboring countries. The total groundwater resources potential is estimated at 156 BCM/year as a renewable source based on the groundwater recharge analysis.

Water balance between demand and supply

The water use rate (the ratio between the total water demand and the total water resources potential) in 2010 is just 1.6%. Although the ratio will become 4.4% in 2030, the total water demand in 2030 will be still much less than the total water resources potential. However, it should be noted that the currently usable water with stable supply is also much smaller than the total water resources potential. Furthermore, due to the unevenly distributed water demand and water resources, the necessity of the total water resources development should be examined through the water balance between supply and demand at local level.

(3) Water Sources Development

Surface water development

Two strategies were proposed in surface water development (Strategy-1: Effective utilization of the existing dams, Strategy-2: Preparation of sufficient surface water source to address increasing water demand in consideration of unevenly distributed water resources in the country). The amount of surface water to be newly developed by 2030 is 6.5 BCM/year (2.2 BCM/year for urban water supply and 4.3 BCM/year for irrigation). To secure the surface water demand, new projects are planned

following the strategies mentioned above: 1) Capacity development of dam management, 2) Rehabilitation of equipment for proper operation of major dams, 3) Rehabilitation of deteriorated dams, 4) Surface water development for municipal water supply, 5) Surface water development for irrigation development, and 6) Integrated surface water development.

Groundwater development

Drilling new boreholes and rehabilitating of the existing boreholes are planned to meet water demand for water supply in 2030. Total amount of 3.6 BCM/year of groundwater should be newly developed (2.8 BCM/year for urban water supply and 0.8 BCM/year for rural water supply). To meet the above water demand, 2.6 BCM/year will be pumped by the newly drilled boreholes and 1.0 BCM/year by the rehabilitated boreholes. 16 thousand boreholes with motorized pumps are necessary for urban/semi-urban/small town water supply in 2030 and 10 thousand boreholes for rural water supply. On the other hand, 83 thousand boreholes with hand pumps are necessary for the rural water supply.

(4) Water Resources Subsector Development Plan

Water supply

Water supply development plan in M/P2013 consists of two main schemes: 1) Rehabilitation scheme of existing facilities and 2) New construction scheme of facilities. Water supply plans are formulated aiming to be practical plans responding to real situation, considering higher level plan of this sectors, water resources potential of each HA, water balance between demand and supply, the existing development plans of each states, the current situation of water supply and their plan. As a result, the amount of water to be developed from 2015 to 2030 is 12,620 million litter per day (MLD = 1,000 m^3/day) for hydrological balance and 14,880 MLD for facility planning including both rehabilitation scheme and new construction scheme.

Irrigation and drainage development plan

Development strategies for irrigation and drainage are as follows: 1) To complete on-going public irrigation schemes early, 2) To implement rehabilitation and expansion on public irrigation schemes which FMWR identifies as high priority, 3) To develop new water resource for high priority public irrigation schemes, 4) To utilize existing dams for public irrigation schemes and expand irrigation system 5) To develop new irrigation farmland, and 6) To formulate effective structure for operation and maintenance to run the schemes.

Following the above strategies, the proposed projects are as follows: a) On going scheme, b) Extension scheme, c) Supplementary irrigation scheme, d) Dam irrigation scheme and e) Integrated development scheme. Total area of public irrigation schemes is 468,000ha, including the existing projects and planned projects in 2030.

Recommendation to the other sectors

Recommendation is made on future actions for the projects under jurisdiction of the other ministries, such as hydropower generation (Federal Ministry of Power: FMP), flood and erosion control (Federal Ministry of Environment: FME), inland transportation (Federal Ministry of Transport: FMT), aquaculture and livestock (FMARD).

(5) Water Resources Management Plan

The objective of water resources management is to provide the water services based on 3S (Sufficiency, Safety and Sustainability) and 2E (Efficiency and Equitability) to the water users who expect “Effective Use of Water”, “Mitigation of Flood Damage” and “Conservation of Water Quality”, by using the facilities and operation systems installed on the basis of Water Resources Development Plan. The Water Resources Management Plan compiles with the methods necessary to achieve the objectives.

Water resources management is implemented based on the following strategies: 1) Improvement of water resources management organization and institution, 2) Operation and maintenance for provision of water services, 3) Allocation and regulation of water resources quantity & quality and 4) Facilitation and improvement of water resources management.

(6) Recommendation

M/P2013 makes recommendation on 5 items for promotion of optimum water resources management: 1) Practical use and periodic review of M/P2013, 2) Implementation of water resources development plan, 3) Implementation of water resources management plan, 4) Steady and sound investment (direct capital investment of Federal Government of Nigeria, utilization of private-sector funds, utilization of international development partners and promotion of users' pay principle) and 5) Establishment of project promotion function/body, namely Project Promotion Mission Unit (PMU).

3. Catchment Management Plan (1st Draft)

(1) Target Area

Target of Catchment Management Plan is HA-1(Niger North) and Ogun-Oshun Basin (western part of HA-6: Western Littoral). HA-1 consists of 4 main states (Katsina, Kebbi, Sokoto and Zamfara) and a part of Jigawa, Kano and Niger states. On the other hand, Ogun-Oshun Basin consists of 4 main states (Lagos, Ogun, Osun and Oyo) and a part of Ekiti, Kwara and Ondo states.

(2) Objective of Catchment Management Plan and Higher Level Plan

Catchment Management Plan (CMP) is a guideline and a project implementation programme for realizing water resources management in the target area. IWRM is the approach of proper delivery of water services meeting water user's needs by using the facilities and operation systems prepared by governments and private sectors. The target year of the CMP is year 2030, the same as that of M/P2013. The higher level plan of CMP is national level water policies and strategies for water resources development and management, and the M/P2013 is formulated based on national level policies and strategies. If any policies, master plans or equivalent are confirmed to exist at state level, they should be included here.

(3) Water Demand Projection, Water Resources Potential and Water Balance between Demand and Supply

Water demand projection

HA-1

Water demand projection for CMP is the same as that applied in M/P2013. The existing total water demand in HA-1 for main subsector (water supply, irrigation, aquaculture and livestock) is estimated at 791 million cubic meter per year (MCM/year) in 2010. It is expected to increase to 1,625 MCM/year in 2030.

Ogun-Oshun Basin

The water demand structure for the following two scenarios are analyzed in Ogun-Oshun Basin:

1) Scenario-A: The socio-economic framework and methodology of water demand projection in the target area is the same as that applied in M/P2013.

2) Scenario-B: The socio-economic framework and water demand are projected by States. The existing total water demand in Ogun-Oshun Basin for main subsectors (water supply, irrigation, aquaculture and livestock) is estimated at 1,111 MCM/year in 2010. It is expected to increase to 2,589 MCM/year in 2030 for Scenario-A, and 3,193 MCM/year in 2030 for Scenario-B.

Water resources potential

Water resources potential of both HA-1 and Ogun-Oshun Basin is the same as that applied in M/P2013.

Water balance between demand and supply

The water use rate (the ratio between the total water demand and the surface water resources potential) of HA-1 in 2010 is just 2.1%. The ratio will become 4.3% in 2030. The total water demand in 2030 is still much less than the total water resources potential. However, future development of water

resources should be implemented in careful consideration of constraint condition, such as balance of water demands and water resources potential, which are unevenly distributed.

On the other hand, the water use rate of Ogun-Oshun Basin in 2010 is 8.5%. In 2030, the ratio will become 20.0% for Scenario-A and 24.6% for Scenario-B, respectively. Consequently, the water demand in 2030 will be more than twice as large as the current demand. There are several promising sites for new surface water development in Ogun-Oshun Basin. So the future water demand should be secured by the new development.

(4) Water Sources Development Plan

Water sources development plans are the same as those planned in M/P2013 for both HA-1 and Ogun-Oshun Basin in case of Scenario-A. On the other hand, in development plan for Ogun-Oshun Basin in case of Scenario-B, two dam projects, namely Aiyete Dam and Oba Dam Projects are newly added to the dam projects which are planned in Scenario-A.

(5) Water Resources Sub-sectors Development Plan

Water resources sub-sector development plans including water supply and irrigation are the same as those planned in M/P2013 for both HA-1 and Ogun-Oshun Basin in case of Scenario-A. On the other hand, in development plan for water supply of Ogun-Oshun Basin in case of Scenario-B, the amount of water to be developed from 2015 to 2030 is 6,122 MLD for facility planning, including both rehabilitation scheme and new development scheme. This amount is 194% of that of Scenario-A (3,167 MLD).

(6) Water Sources Development Plan

Water sources development plans are the same as those proposed in M/P2013.

(7) Recommendation

The 1st Draft CMP recommends developing catchment management system and establishing of CMP. With the technical cooperation of JICA, FMWR has formulated M/P2013 through 30 months of work. On the basis of the M/P2013, the 1st Draft CMP was prepared in collaboration with JICA Project Team and Nigeria Integrated Water Resources Management Commission: NIWRMC – an agency of FMWR. Although the CMP is based on the M/P2013, it should be elaborated with further efforts due to the following reasons: 1) A consensus of the stakeholders is not yet sufficient as the preparation of the1st Draft CMP was done in short period, a half year, 2) The 1st Draft CMP still has issues to be solved for its implementation as the organization and institution to authorize it are not yet established. To solve these issue, the 1st Draft CMP recommends 1) Developing catchment management system (three new organizations: Catchment Management Coordinating Committee: CMCC, Technical Advisory Committee: TAC and State IWRM Committee) and 2) Establishing CMP on the basis of the stakeholders' full consensus.

In addition, the 1st Draft CMP makes recommendation on a) Practical use and periodic review of CMP, b) Implementation of water resources development, c) Implementation of water resource management and d) Steady and sound investment.

CHAPTER 1 OUTLINE OF THE PROJECT

1.1 Outline of the Project

1.1.1 Background

In Nigeria, the water shortage is more serious than before mainly in the northern part of the country because the needs of water resources development is increasing for irrigation, water supply and energy generation and so on with population growth and economic development. Therefore, adequate management and development of water resources is an urgent problem, preventing environmental damage.

Japan International Cooperation Agency (JICA) supported formulation of the integrated master plan (M/P) for water resources development of Nigeria in 1995 by the implementation of JICA Study on "National Water Resources Development Plan" (hereinafter referred to as "M/P1995"). In response to the proposal of the M/P1995, Nigeria Integrated Water Resources Management Commission (NIWRMC) was established in 2008 under the Federal Ministry of Water Resources (FMWR). NIWRMC will take comprehensive responsibility for i) water resources management, ii) coordination of stakeholders and iii) improvement of the permitting and licensing system of water resources development and so on.

However, 15 years has passed since formulation of the M/P1995 and the following problems and issues are arising.

- Water demand is increasing with population growth and economic development.
- Usually river flow may decreases in the dry season. In recent years, however, some rives dry up completely between December and January. Groundwater sources also dry up more than before in dry season mainly in Northern part of Nigeria. Actual water resource potential shows considerable difference from what was assessed in the M/P1995.
- Under the influence of a Climate Change, the frequency of extreme weather events is increasing, and the damage caused by water shortage, such as a heavy rain and so on are increasing. Therefore it is necessary to incorporate new viewpoints such as a forecast/prevention of natural disaster into management and development of water resources.
- In addition to establishment of NIWRMC which will take responsibility for water-resources management in the national level, it is institutionalized that the Catchment Management Office (CMO) will be established under NIWRMC in eight hydrological areas (HA). Catchment Management Plan will be formulated under coordination and agreement between the stakeholders for better allocation of water resources and so on. Following such a tendency, it can be said that institutional change is progressing in water-resources management and development sectors.

Under the above background, the Project commenced in August 2011 in order to revise the M/P1995 for promotion of optimum water resources management of Nigeria.

1.1.2 Objective of the Project

Objective of the Project are as follow:

1) Formation of “Nigeria National Water Resources Master Plan 2013 (M/P2013)”, through the process of review and updated of the M/P1995.
2) Formulation of Draft Catchment Management Plan (CMP) for the prioritized two areas; HA-1 (Niger-North) and Ogun-Oshun Basin in the western area of HA-6 (Western Littoral).

These plans will contribute to formulation of CMPs for the other HAs.

1.1.3 Project Area

Project Area of the M/P2013 includes eight hydrological areas covering entire Nigeria, namely HA-1: Niger North, HA-2: Niger Central, HA-3: Upper Benue, HA-4: Lower Benue, HA-5; Niger South, HA-6: Western Littoral, HA-7: Eastern Littoral and HA-8: Chad Basin, and whole land area: 923,700 km^2 and Population: 140.43 million (2006 Census). See Figure 1-1.

The Project consists of three phases of i) Basic study, ii) Formulation of the M/P2013 and iii) Formulation of Draft CMPs. Above i) and ii) are implemented aiming the entire (eight) hydrological

areas. On the other hand, above iii) is implemented aiming at two hydrological areas, these are HA-1: Niger North and Ogun-Oshun Basin in HA-6: Western Littoral. See Table 1-1.

Figure 1-1 Hydrological Map of Nigeria

Table 1-1 Schedule of Project

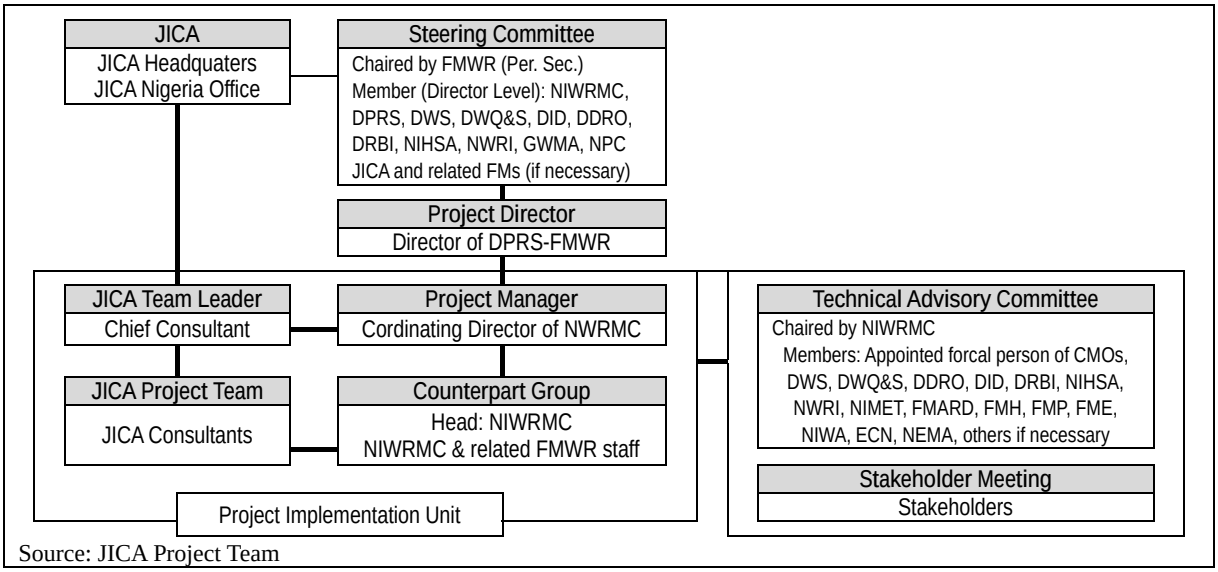
Phase - 1 (Aug. 2011 - Oct. 2012, 15 months)	Phase - 2 (Dec. 2012 - Apr. 2013, 6 months)	Phase - 3 (May 2013 - Jan. 2014, 9 months)
Basic Study ◆ Data Collection ◆ Evaluation of Potential ◆ Projection of Demand ◆ Clarification of Issues ◆ Discussion on Direction of Water Resources Management	M/P2013 ◆ Formulation of National Water Resources Master Plan (M/P2013)	CMP ◆ Formulation of Draft Catchment Management Plan for 2 hydrological areas: - HA-1:Niger North - Ogun-Osun Basin in the western area of HA-6:Western Littoral

Source: JICA Project Team

1.2 Project Management

1.2.1 Project Operation

Project organization is shown in Figure 1-2.



Source: JICA Project Team

Figure1-2 Project Organization

1.2.2 Members of Japanese Side

Members of Japanese side of this Project are shown in Table 1-2.

Table 1-2 Member of Japanese Side

Name	Organization	Position
JICA Headquarters		
Mr. Yusuke Amano	JICA Headquarters	Senior advisor to the director general, Global Environment Department
Mr. Eiji Otsuki		Senior advisor to the director general, Global Environment Department
Mr. Junji Wakui		Director, Global Environment Department
Mr. Tatsuya Imai		Director, Global Environment Department
Mr. Kiyoshi Takashima		Global Environment Department
Mr. Toshikazu Watanabe		Global Environment Department
Mr. Masahito Miyagawa		Global Environment Department
Mr. Masanori Yamazaki		Global Environment Department
JICA Nigeria Office		
Mr. Yoshitaka Sumi	JICA Nigeria Office	Chief Representative
Mr. Tetsuo Seki		Chief Representative
Mr. Yoshiro Masuda		Representative
Mr. Masato Mikamo		Representative
Ms. Chie Shimodaira		Representative
JICA Project Team		
Mr. Masatomo Watanabe	yec	Team Leader, Water Resources Management and Development Plan
Mr. Tadanori Kitamura	CTII	Surface Water Management and Development, Hydrology
Mr. Hiroshi Nakamura	yec	Groundwater Management and Development, Hydrogeology
Mr. Akinori Miyoshi		Water Supply and Sanitation
Mr. Yuichi Matsumoto	SCI	Irrigation and Drainage
Mr. Toshihide Shibata		Agriculture
Mr. Taizo Hashiguchi	yec	Dam and Hydropower Generation 1
Mr. Seiichi Hara		Dam and Hydropower Generation 2
Mr. Kazunori Inoue	CTII	Erosion Control
Mr. Junkichi Yamazaki	yec	Institution / Human Resources Development
Mr. Noboru Osakabe		Social Economic Analysis
Mr. Sebastian G. Jara	CTII	Water Environment, Social and Environmental Consideration
Mr. Uyu Tanaka	yec	Management of Water Resources Information
Mr. Hisashi Oura		Coordination, Management of Water Resources Information

yec: Yachiyo Engineering Co., Ltd. CTII: CTI Engineering International Co., Ltd. SCI: Sanyu Consultants Inc.
Source: JICA Project Team

1.2.3 Members of Steering Committee, Technical Advisory Committee and Counterpart

Table 1-3 shows members of Steering Committee, Table 1-4 for members of Technical Advisory Committee and Table 1-5 for members of Counterpart.

Table 1-3 Members of Steering Committee

Name	Organization	Position
Mr. Baba Umar Farouk	FMWR	Chairman of Steering Committee, Permanent Secretary
Amb.(Dr) Godknows B. Igali	FMWR	Chairman of Steering Committee, Permanent Secretary
Mrs. LD Bagaiya	FMWR	Director PRS
Dr. E.A .Adanu	FMWR	Director Dams & reservoir Operation
Engr. J Kwanashie	FMWR	Director Irrigation & Drainage
Engr. Bello Tunau	FMWR	Director Water Supply
Engr. S.O Ome	FMWR	Director Water Quality Control & Sanitation
Mr. Nelson Nwosu	FMWR	Dir. River Basin Operations & Inspectorate
Mr. Reuben A. Habu	NIWRMC	Coordinating Director
Engr. R.A.K Jimoh	NIWRMC	Coordinating Director
Engr. Halidu Yusuf	SRRBDA	Managing Director
Engr. Jimi Omobki	OORBDA	Managing Director
Mr. J.A. Shamonda	NIHSA	Director General
Dr. Olusanjo A. Bamgboye	NWRI	Executive Director
Engr. Babaji I.	FMWR	Director Gurara
Mr. Ojo Sunday	NPC	Director, International Cooperation Dept.

Source: JICA Project Team

Table 1-4 Member of Technical Advisory Committee

Name	Organization	Position
Engr. (Mr.) Okon Ekpenyong	ECN	Deputy Director
Engr. (Mr.) James Akinjobi	NEMA	Senior Scientific Officer
Mr. John A. Onov Biona	FMARD	Chief Fish Officer
Mr. Temitope R. Omotola	NPC	Deputy Director
Engr. (Mr.) N. D. Madu	FMWR	Assistant .Director
Mr. Adetunji Idowu	FMWR	Deputy Director
Engr. (Mr.) Peter Y. Manjuk	FMWR	Deputy Director
Engr. (Mr.) R. A. K. Jimoh	NIWRMC	Coordinating Director
Baryr (Mrs.) Von Emeka-Aneke	FMWR	Deputy Director
Engr. (Mr.) Mohammed U. Galadima	NIWRMC	Deputy Director
Mr. Philip D. Abah	FMARD	Deputy Director
Mrs. R. A. Bako	FMWR	Assistant Director
Rev. Engr. Dr. (Mrs.) Nwosah G. C.	FMWR	Assistant Director
Rev. (Mr.) M. I. Nwabufo	NIHSA	Director
Mr. Lawal Kola Maroof	NIWRMC	Deputy Director
Mr. S. Zakari	FMWR	Deputy Director

Source: JICA Project Team

Table 1-5 Members of Counterpart

Name	Organization	Position
Engre. R.A.H Jimoh	NIWRMC	Project Manager
Engr. K.S Sunmonu	NIRWRMC	Deputy Project Manager
Mr. Ogbonna Kenneth E.	FMWR	Hydrogeologist., DWS, FMWR
Mr. Bitrus Joshua	NIWRMC	Principal Technical Officer
Mr. Oyakhirome Florence	FMWR	Chief Scientific Officer, DDRO, FMWR
Engr. Enyi Hycinth	FMWR	Principal Technical Officer, DWQC, FMWR
Engr. A. O. Mebude	FMWR	Assistant Director, DID
Mr. Ihuoma Anthony	FMWR	Senior Statistical Officer , DPRS
Mr. G. A Agwuma	FMWR	Senior Statistician, DPRS
Mr. S.O Abdulyekeen	NIWRMC	Senior Hydrogeologist
Mr. S. O Okpara	NIHSA	Assistant Chief Hydrogeologist
Mr. B.C OJO	NIHSA	Principle Hydrogeologist
Engr. J.A Gbadegesi	NIHSA	Principle Hydrologist
Mr. E. O. Oton	NIWRMC	Assistant Director
Engr. Kassim Bello	FMWR	Civil Engineer, DWS
Ms Yemisi	FMWR	Senior Scientific officer, DWQC
Engr. Anthea Ochedikwu	FMWR	Assistant Chief Irrigation Engineer, DID
Mr. Ikpeamaeze Joseph	FMWR	Assistant Chief Admin Office
Engr N.D Madu	FMWR	Assistant Director, DDRO
Mr. D.A Amodu	NIHSA	Assistant Chief Hydrologist
Mrs. Alice O. Ojowu	FMWR	Assistant Director, DPRS
Mr. A. Olayinka	FMWR	Assistant Statistician, DPRS
Mr. Charles Ikediashi	FMWR	Chief Scientific Officer
Mr. E.A Bassey	FMWR	Chief Statistician, DPRS
Mrs Biritu Ali	GWMA	Hydrogeolgist

Source: JICA Project Team

1.2.4 Main Meetings

Main Meetings of the Project are Steering Committees and Stakeholder Meetings. Main meetings of the Project are listed in Table 1-6.

Table 1-6 Main Meetings

Date	Meeting	Content
9th August, 2011	1st Steering Committee Meeting	Explanation and discussion of Inception Report
12th August, 2011	1st Stakeholder Meeting	Explanation and discussion of Inception Report
14th February, 2012	2nd Steering Committee Meeting	Explanation and discussion of Progress Report-1
10th July, 2012	3rd Steering Committee Meeting	Explanation and discussion of Progress Report-2
12th July, 2012	2nd Stakeholder Meeting	Explanation and discussion of Progress of the Project
16th May,2013	5th steering committee Meeting	Explanation and discussion of Interim Report
23rd May, 2013	3rd Stakeholder Meeting	Explanation and discussion of Interim Report
27th November, 2013	6th Steering Committee Meeting	Explanation and discussion of Draft Final Report
3rd December, 2013	Seminar	Explanation and discussion of Draft Final Report

Source: JICA Project Team

In addition to the meeting above, Technical Advisory Committee Meeting was held in January 2013 for discussion of planning condition of the M/P2013, and JICA Project Team and Technical Advisory Committee reached basic agreement on the condition.

1.2.5 Workshops on M/P2013

Two types of Workshop were carried out in the Project. They are, i) National workshop and ii) Workshops in eight hydrological areas, respectively. Purpose and results of workshop is as follows:

(1) National Workshop

Purpose of the National Workshop held in Abuja is that the Project Team requests stakeholders to participate in the Project and exchange information on water resources management and development, ongoing and planned projects and related issues. The workshop was held three times as shown in Table 1-7 during the Project.

Table 1-7 Schedule of Workshops in Abuja

No.	Content of Discussion	Date	Participants
1st	Water issues and water demand	20th, October, 2011	71
2nd	Water issues and water resources development potential	19th ,March, 2012	75
3rd	Direction for formulation of M/P	16th, May, 2012	75

Source: JICA Project Team

(2) Workshops in Eight Hydrological Areas

Purpose of workshops in eight hydrological areas is to make clear issues of water resources management and development of each hydrological area and request provision of related information from responsible organizations. Participants made discussion and exchanged information on water resources issues. Schedule of the workshops in eight hydrological areas is shown in Table 1-8, and refer to Figure 1-3.

Table 1-8 Outline of Workshops in Eight Hydrological Areas

No.	Catchment Area		City	Date	Participants		
	Catchment No.	Name			Attendance	RBDA	State
1st	2	Niger Central	Minna	6th Oct., 2011	73	Upper Niger	Niger, Kaduna, Kwara, Kogi, FCT
2nd	8	Chad Basin	Kano	1st Nov., 2011	58	Hadejia Jama'are	Kano, Boruno, Jigawa
3rd	1	Niger North	Sokoto	3rd Nov., 2011	54	Sokoto Rima	Sokoto, Katsina, Kebbi, Zamfara
4th	5	Niger South	Benin	17th Nov., 2011	67	Bennin Owena	Delta, Edo, Ekiti, Ondo, River
5th	7	Eastern Littoral	Owerri	22nd Nov., 2011	79	Anambra Imo, Cross River and Niger Delta	Anambra, Abia, Imo, Ebonyi, Enugu, Cross River, River
6th	4	Lower Benue	Makurdi	2th Nov., 2011	36	Lower Benue	Benue,Nassarawa, Plateau
7th	3	Upper Benue	Yola	29th Nov., 2011	103	Upper Benue	Adamawa, Taraba, Yobe, Bauch, 、Gombe
8th	6	Western Littoral	Abeokuta	7th Dec., 2011	60	Ogun Oshun	Ogun, Osun, Ooyo, Lagos

Note) City and catchment area is not necessarily corresponding. Considering security condition and location of RBDA office, the Project team and FMWR selected combination of city and catchment area.

Source: JICA Project Team

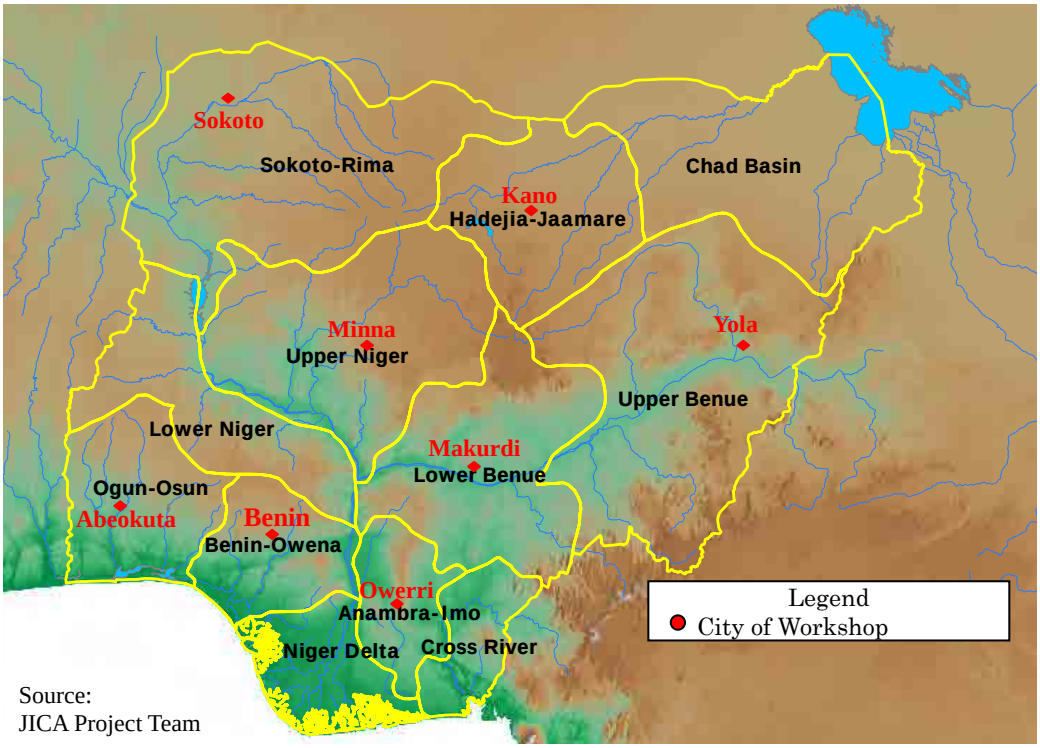


Figure 1-3 The Cities where Workshops were held

1.2.6 Stakeholder Meeting in period of Formulation of Catchment Management Plan

The JICA Project Team had meeting with stakeholders of HA-1 and Ogun-Oshun Basin for formulation of the CMP. Content of the Stakeholder Meeting is summarized in Table 1-9.

Table 1-9 Schedule and Outline of Stakeholder Meetings and Workshops on Formulation of CMP

Date	Activity	Content
23rd May, 2013	• Stakeholder Meeting for Stakeholders of the entire HA	• JICA Project Team explained MP/2013 and discussed with Stakeholders.
24th May, 2013	• Kick off Meeting for Stakeholders of HA-1 and Ogun-Oshun Basin	• Stakeholders listed up and confirmed organizations and demarcation on responsibility of water resources management and development.
12th May, 2013	• Stakeholder Meeting for HA-1 (Zamfara State)	• Issues of implementation of MP/2013 were analyzed and discussed.
24th June to 28th June, 2013	• Workshop with Stakeholder of Ogun-Oshun Basin (4 States) • Stakeholder Meeting for Ogun-Oshun Basin (26th June)	• JICA Project Team visited related organizations of 4 States of Ogun-Oshun Basin to collect information and explain content of MP2013. • Issues of implementation of MP/2013 were analyzed and discussed.
3rd July, 2013	• Stakeholder Meeting on HA-1 (3 States)	• Issues of implementation of MP/2013 were analyzed and discussed on 3 Sates of HA-1.
15th July to 19th July, 2013	• Workshop with Stakeholders of Ogun-Oshun Basin (4 State) • Stakeholder Meeting for Ogun-Oshun Basin (18th July)	• JICA Project Team visited related organizations of 4 States of Ogun-Oshun Basin to collect information and explain content of MP/2013. • Stakeholders discussed method to solve issues on water management among stakeholders. • JICA Project Team requested 4 States to submit water demand projection proposed by them.
24th July, 2013	• Stakeholder Meeting for HA-1 (4 States)	• Content of proposed projects were explained. • Measures to solve issues were proposed. • It was confirmed whether there is water demand projection by 4 states.
26th Sep., 2013	• Stakeholder Meeting for HA-1 (4 States)	• Progress of Catchment Management Plan was explained including institutional issues.
2nd Oct., 2013	• Stakeholder Meeting for Ogun-Oshun Basin (3rd Oct.)	• Progress of Catchment Management Plan was explained including institutional issues. JICA Project Team explained water resources development plan to meet water demand projected by Lagos state.
3rd Oct., 2013		

Source: JICA Project Team

CHAPTER 2 NATIONAL WATER RESOURCES MASTER PLAN 2013

2.1 Review of Existing National Water Resources Master Plan 1995

2.1.1 General

(1) Background

In Nigeria, the government led water resources development projects have been carried out full-fledged since the 1970s. Federal Ministry of Water Resources and Rural Development (FMWRRD) undertook the formulation of "National Water Resources Master Plan" with the assistance of FAO, aiming at efficient management and development of water resources. However, due to lack of funds, this work did not reach conclusion, coming up with only preliminary draft report. In order to complete the master plan, FMWRRD requested the Japanese government to implement the study on the water resources master plan. By accepting the request from the Nigerian government, the Government of Japan dispatched in October 1991 Japan International Cooperation Agency (JICA) to the Nigeria to discuss the "Scope of Work" summarizing the framework of the master plan study. This "Scope of Work" was agreed and signed on 6 November 1991.

Then, JICA has formed a team of consultants and sent to Nigeria. The master plan study was conducted over a period of three years from the end of March 1992 until the end of March 1995. The final report of the Study, including all the study results, is contained in the Main Report, Sector Report, Inventory Summary Report, Database Diagram, Diagram of Satellite Image Interpretation, and so on. The Main Report explains the analysis results of Current Status and Problem related to water resources, the plans of water source development, water supply, irrigation and so on. Also, the Main Report shows the implementation plans of the project proposed in the master plan.

(2) Basic Strategies

Along the basic approach of "Draft National Long-Term Plan, December 1992, NPC" the National Water Resources Master Plan set the basic policies. Draft National Long-Term Plan was targeting the Human-Centered Development Plan along the overall policy of promotion of achievement of people independence on the basis of the implementation of the "Structural Adjustment Program, SAP". As for water resources, "Construction of facilities to provide safe water for life", "Expansion of irrigated agriculture to meet the growing food demand due to population growth", "Preservation of the quality of water environment" were woven as key policies. Along with the basic policies, National Water Master Plan has been formulated with the following strategies.

- Establishment of a system to enforce "Federal Water Resources Decree, August 1993 "
- Development and implementation of monitoring surface and ground water observation network
- Implementation of water management and rehabilitation of existing water resource development projects
- Completion of the unfinished end systems of water source development
- Promotion of new small and medium-sized projects of water resources development

(3) Project Outline of Main Sectors

According to the basic policies and strategies mentioned above, National Water Resources Master Plan (hereinafter "M/P1995") has been drafted targeting the year 2020. The outline plans of the major sectors proposed in the M/P1995 are as follows. Table 2-1 shows the plan index of the M/P1995, and Figure 2-1 shows the general plan of the M/P1995.

Water Storage

There are new retention dam projects to develop 10 BCM to meet new demands (12 BCM) by the year 2020, for public irrigation and water supply. In addition, the water storage project includes the rehabilitation project of existing 50 dams and improvement of dam operation programs in the Chad and Sokoto-Rima basins.

Irrigation and Drainage

Out of 320,000 ha of irrigation area planned in the existing irrigation and drainage plan, about 70,000 ha of irrigation area requires rehabilitation. The unimplemented irrigation area (250,000 ha) is scheduled for implementation by the end of 2005. By the year 2020, there will be a total new irrigation

area of 800,000 ha. In the year 2020, the total irrigation area will be 1,500,000 ha composing of public irrigation area (1,120,000 ha) and private irrigation area (380,000 ha), with a demand for total irrigation water of 16.8 BCM/year.

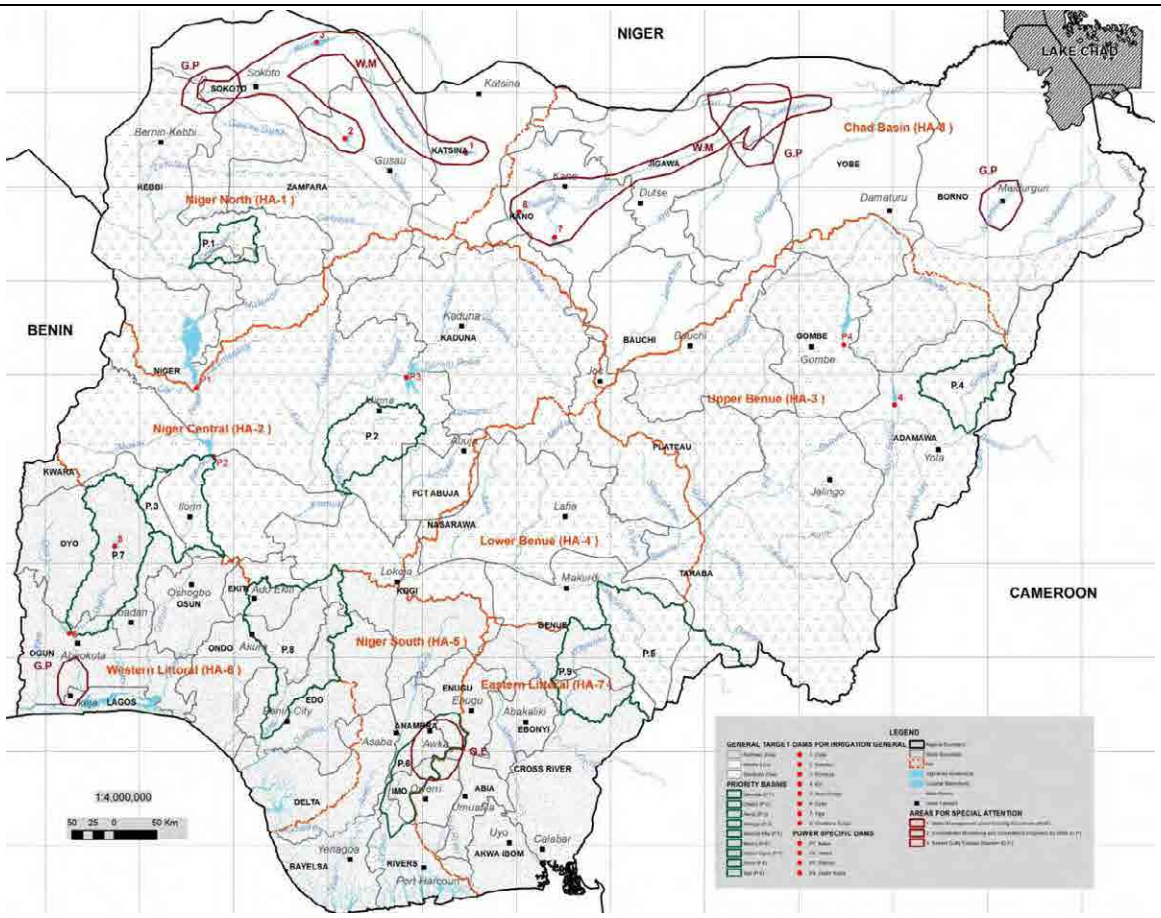
Public Water Supply

Rehabilitation of existing water supply facilities will increase the capacity: 910 MCM/year from 620 MCM/year for surface source, and 460 MCM/year from 260 MCM/year for groundwater source. Considering the new capacity, newly developed water supply volume will be 4,440 MCM/year for Urban and 1,590 MCM/year for rural uses. Total demand of water supply in 2020 will be 7.4 MCM/year.

Table 2-1 Major Indicators in M/P1995

Items \ Hydrological Area		NW	NE	CW	CE	SW	SE	Total/ Average
		HA-1	HA-8	HA-2	HA-3 HA-4	HA-6	HA-5 HA-7	
1. Area (1000km3)		131.6	188.0	158.1	231.9	100.5	113.7	923.8
2. Population	- 1991 (Million)	10.3	16.8	10.6	9.7	22.3	18.9	88.5
	- 2020 (Million)	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	2.69
3. Water Resources Potential								
3.1 Surface W.	(a)Annual Yield (BCM)	22.4	8.2	32.6	83.0	35.4	85.7	267.3
	(b)Specific Yield (mm p.a.)	38	44	206	245	352	674	178
3.2 Ground W.	(a)Annual Yield (BCM)	4.3	5.6	8.2	11.4	9.0	13.4	51.9
	(b)Specific Yield (mm p.a.)	33	30	52	49	132	118	56
4. Water Resources Development								
4.1 Existing	(a) Num. of Dams	20	23	32	35	32	18	160
	(b) Effective Vol. (MCM)	13,269	5,951	7,980	2,413	1,053	2	30,668
	(c) Storage Rate (%)	59	73	24	3	3	0	11
4.2 Planned	(a) Num. of Dams	64	20	304	362	141	193	1,084
	(b) Effective Vol. (MCM)	950	100	4,090	4,690	1,410	1,720	12,960
	(c) Storage Rate (%)	4	1	13	6	4	2	5
4.3 Total	(a) Num. of Dams	84	43	336	397	173	211	1,244
	(b) Effective Vol. (MCM)	14,219	6,051	12,070	7,103	2,463	1,722	43,628
	(c) Storage Rate (%)	63	74	37	9	7	2	16
	(d) Ave. Vol. (MCM/dam)	169	141	36	18	14	8	35
5 Irrigation and Drainage								
5.1 Existing	(a) Public (1000ha)	8	27	12	12	3	8	70
	(b) Private (1000ha)	35	98	10	3	0	4	150
	(c) Total (1000ha)	43	125	22	15	3	12	220
5.2 Planned Area 2020	(d) Public (1000ha)	120	95	305	304	115	180	1,120
	(e) Private (1000ha)	75	190	40	45	10	20	380
	(f) Total (1000ha)	195	185	345	349	125	200	1,500
6 Public Water Supply								
6.1 Volume	(a) Existing	Urban:108LCD, Rural: 40LCD						
	(b) Planned	Urban: 216LCD, Rural: 80LCD						
6.2 Rate	(a) Existing-Urban (%)	67	58	82	44	45	35	60
	(b) Existing-Rural (%)	10	9	10	9	10	6	9
	(c) Planned (%)	Urban and Rural: 80%						
6.3 Deep Well	(a) Existing (1000)	32.8	54.0	3.0	2.9	41.6	54.8	265.4
	(b) Planned (1000)	4.2	5.2	38.4	49.7	3.1	3.0	21.4
	(c) Total (1000)	37.0	59.2	35.4	46.8	44.7	57.8	286.8
7 Water Use Rate								
7.1 Existing	(a) Surface water (%)	2.1	14.6	1.1	0.3	0.8	0.2	1.0
	(b) Groundwater (%)	0.5	1.1	0.2	0.1	0.9	0.5	0.5
	(c) Total (%)	2.6	15.7	1.3	0.4	1.7	0.7	1.5
7.2 Planned	(g) Public (1000ha)	9.1	35.6	13.5	5.5	9.8	3.3	7.6
	(h) Private (1000ha)	7.8	11.1	4.5	3.7	10.8	8.9	7.5
	(i) Total (1000ha)	16.9	46.7	18.0	9.2	20.6	12.2	15.1

Source: M/P1995



General Target

1. Northern Zone: Water Resources Management
2. Middle Zone: Water Resources Development for Irrigation and Water Supply
3. Southern Zone: Water Resources Development for Water Supply and Irrigation

Priority Basins for Water Resources Development

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

Area for Special Attention

WM : Water Management under Existing Dams

GE : Gully Erosion Disaster

GP : Groundwater Monitoring and Surveillance Programs by 2000

Existing Major Dams

(For Irrigation Dam)
1. Zobe, 2. Bakolori, 3. Goronyo, 4. Kiri, 5. Ikere Gorge, 6. Oyan,7. Tiga, Challawa Gorge
(For Hydropower Generation)
P1 Kainji, P2 Jebba, P3 Shiroro, P4 Dadin Kowa
Source: M/P1995

Figure 2-1 Map of M/P1995

2.1.2 Conclusion and Feedback

Based on the projects proposed in the M/P1995 and overall performance of its implementation, the Project should consider the followings:

(1) National Policies and Basic Strategies of Water Master Plan

The M/P1995 take into account water policies shown in the "National Long Term Plan, 1992, NPC" such as 1) Expansion of irrigated agriculture to meet the growing food demand due to population growth, 2) Provision of facilities to supply safe and clean domestic water, and 3) Preservation of the quality of water environment. Strategies of the M/P1995 have been developed along with these basic policies. These policies, still important national water policies, should be retained by the Project in accordance with the latest national plans (Nigeria Vision 20: 2020, Water Sector Roadmap etc.).

(2) Evaluation of Water Resources Potential

In the M/P1995, the water resources potential has been evaluated by using the observed flow and rainfall observations of the 1970s and 1980s. It was the first time comprehensive evaluation of water resources across the country as a whole. However, it has several drawbacks from the viewpoint of appropriate water resources management. For example, regarding the evaluation of surface water potential, 1) Evaluation period using data is short. 2) Potential is evaluated only in average and drought is not evaluated. 3) There is no discussion on flood discharge. In the Project, using long-term observation data (long-term rainfall data is available) as long as possible, evaluation should clarify the flow regime, flood discharge and probability of flow. Regarding the evaluation of groundwater potential, evaluation shall take into account not only meteorological conditions but also hydrogeological conditions of the area.

(3) Demand Projection and Implementation of Water Resources Development Plan

The M/P1995 shows water demand to satisfy as target of the national plan, but the process to decide final amount of demand which is a base of development plan for water supply and irrigation is not clear. Demand options should be compared based on various development scenarios. As an evaluation of the present, the planned demand seems to be somewhat excessive. About this, it may be said that progress of various projects is late adversely. Water development project (for surface water and groundwater development), water supply project and irrigation project shows the delayed progress. The delay of the project extends to the rehabilitation project for existing facilities as well as a new project. Although it is pointed out that the project is delayed due to budget shortfall, there seems to be a problem with not only budget shortfall but also the project operation systems. Concerning sub-sectors other than water supply and irrigation, there is insufficient discussion in the M/P1995 due to the jurisdiction of other ministries.

In recent years, the demands for flood / erosion control and small scale hydropower generation are increasing. In the Project, discussion on these new demands should be deepened from the viewpoint of "Integrated Water Resources Management (IWRM)".

(4) Implementation of Water Resources Management Plan

The M/P1995 has proposed the foundation of monitoring system to observe the quantity and quality of water resources elements (climate, surface water and groundwater) but its implementation is very late. Since monitoring of water resources is the cornerstone of water resources management, in the Project, the method of early realization of water resources monitoring system should be examined.

New organizations such as NIHSA and NIWRMC were established changing the form but taking over the functions of the organization proposed in the M/P1995. NIWRMC was established to be responsible for water resources management. The M/P1995 does not mention the contents of water resources management. The Project should discuss the contents of water resources management that NIWRMC should carry out. Also, these new organizations have important issues in addition to existing organizations. One of the challenges is Capacity Development (CD). In addition to CD mentioned above, the Project should discuss current and important challenges concerning water resources management such as information management, risk management (including drought, flood, cross boundary water), adjustment of water right, conservation of water environment, promotion of PPP, effective application of monitoring and evaluation (M&E) etc. The Project should also propose the practical measures to realize them.

(5) Conclusion

The M/P1995 outlined how to achieve the targets set in the national policy at the time (on water supply, and irrigation etc.). Implementation of the projects proposed in the M/P1995 does not proceed as

scheduled after some 20 years have passed from the planning, and it is also difficult to achieve goals for the target year (2020). There are such reasons as

- Is it correct demand projection? (water supply unit rate, irrigation scale, cropping pattern, combination with irrigation and rain-fed agriculture etc.),
- Is it weak implementation structure? (deficient regulatory & operational system, lack of human capacity, insufficient participation of stakeholders etc.),
- Is it lack of budget? (unsuitable project environment such as consensus building, poor project justification note, lack of lobbying for budget acquisition).

2.2 Concepts of National Water Resources Master Plan 2013

2.2.1 Framework of National Water Resources Master Plan 2013 (M/P2013)

The national plans such as "Nigeria Vision 20:2020", "Water Sector Roadmap" which are the top plans of national water resources master plan set the goals to improve the current situation in the water sector:

- Low rate of access to safe and clean water and sanitation facilities
- Low contribution of irrigation to national food security, and
- Insufficient utilization of hydropower for renewable energy

National water resources master plan is a plan stimulating concrete actions to solve these problems. To break through this situation, it is necessary to formulate a plan integrating development, utilization and management of water resources through evaluation of water resources potential and demand projection on the basis of the philosophy of Integrated Water Resources Management (IWRM). This section introduces the framework of the updated/new master plan that was prepared to address these issues.

(1) Definition

National Water Resources Master Plan 2013 (M/P2013)

The National Water Resources Master Plan (hereinafter M/P2013) is a review and update of the existing national water resources master plan, 1995 (M/P1995) which was prepared also by the technical cooperation of JICA. The M/P2013, targeting the year 2030, will be a part of the National Plan through formal and established procedures. JICA Project Team prepared the M/P2013 (Draft M/P2013) in collaboration with Nigerian Counterpart Team. The M/P2013 is formulated analyzing available data and information on the basis of the philosophy of IWRM. The Main components of the plan are: 1) **Water Sources Development Plan**, 2) **Water Sub-sector Development Plan** and 3) **Water Resources Management Plan**. Refer to Figure 2-2.

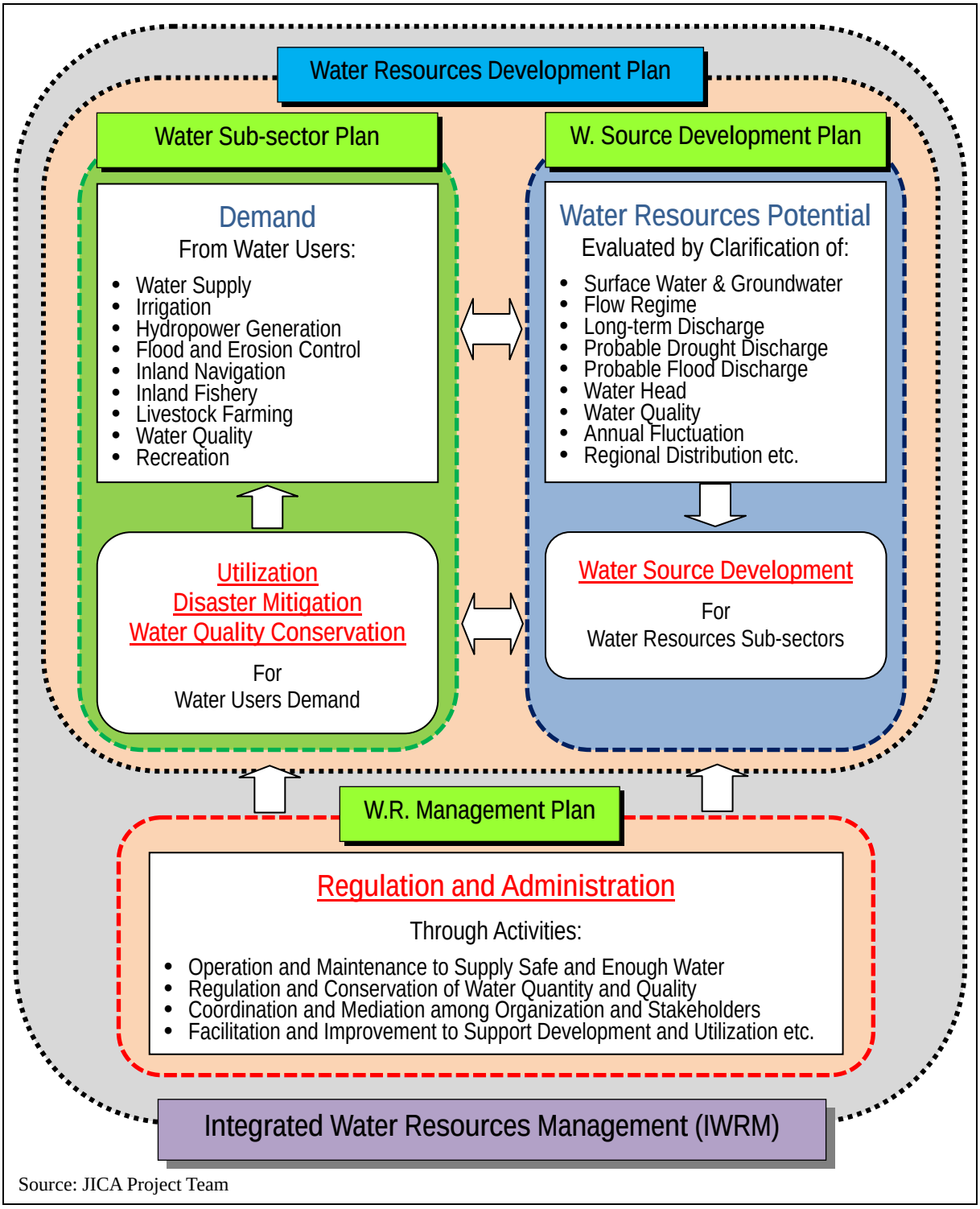
Integrated Water Resources Management (IWRM)

Integrated Water Resources Management (IWRM) is being recognized internationally as an effective method on the development and management of water resources. IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. IWRM is targeting the following three integrations:

- Integrated consideration on natural world
- Integrated consideration on various sectors related to water, and
- Participation of various stakeholders

Water Sources Development Plan (WSDP)

Water Sources Development Plan (WSDP) is the approach of water resources development (such as dam/reservoir, intake facility, channel, well and so on) to meet the needs of water users, on the basis of evaluation of water resources potential and projection of users' demand WSDP plans facilities and also basic operation systems. WRDP targets basically new projects for water resources development. If the new water source is developed by the change or remodeling of facility and system, this re-development project is planned in WSDP. Also WSDP plans the mitigation measures for flood disaster. Target water resources are generally conventional ones such as surface and groundwater. But in semi-arid areas, non-conventional ones such as desalinated sea water and reclaimed waste water are targets of development as well as conventional ones.



Source: JICA Project Team

Figure 2-2 Concept of National Water Resources Master Plan 2013

Water Sub-sector Development Plan (WSSP)

Water Sub-sector Development (WSSP) plans the approach of utilization of facilities and systems to meet demands of such sub-sectors as water supply, irrigation, hydropower generation and so on. This plan is referred to as Sector Development Plan (such as Water Supply Plan and Irrigation Development Plan and so on).

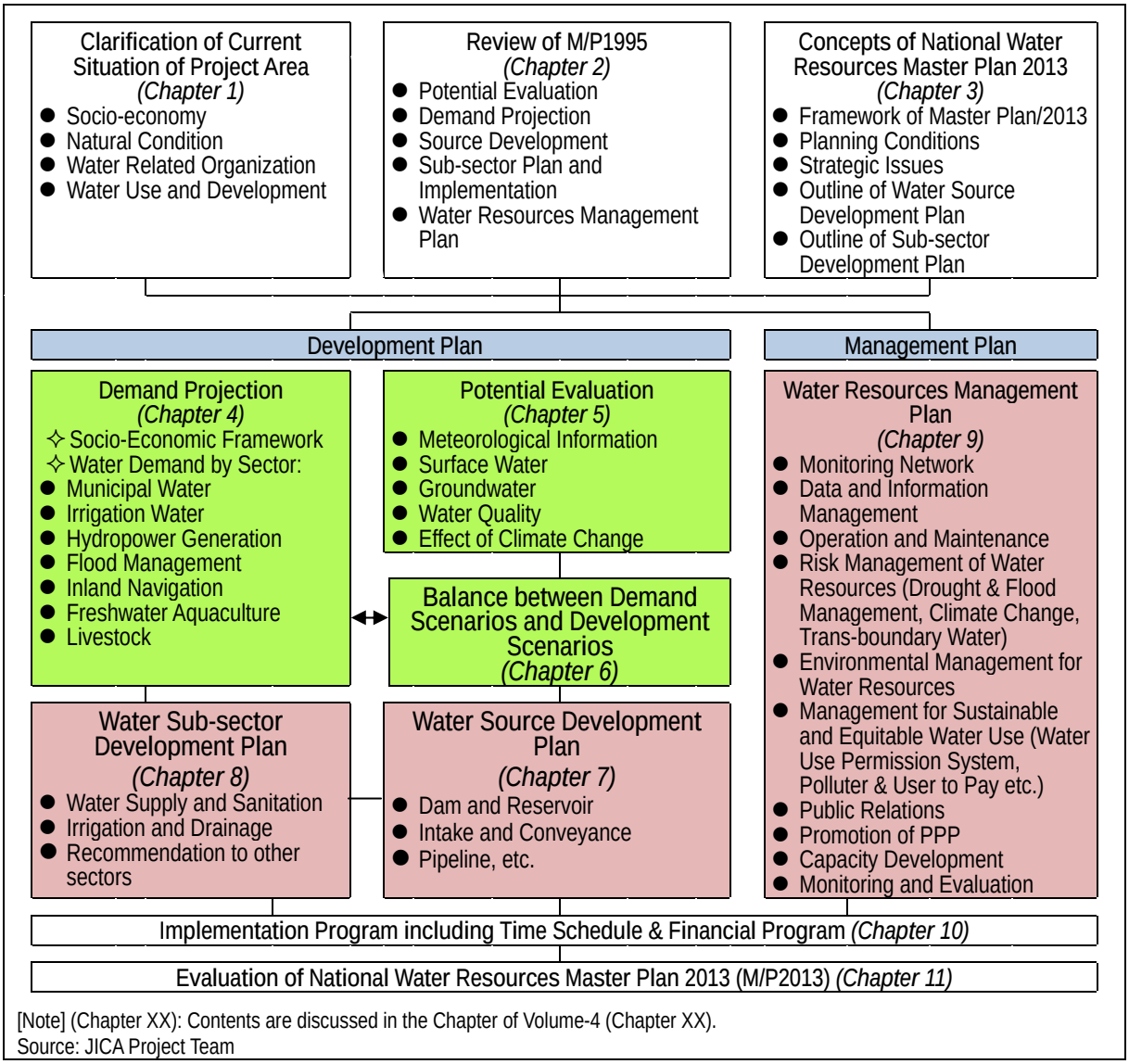
Water Resources Management Plan (WRMP)

Water Resources Management Plan (WRMP) is the approach of proper delivery of water services to meet water user's needs such as water supply, irrigation, hydropower, flood control and environmental protection, on basis of sufficiency, efficiency, equitability and sustainability, by using facilities and operation systems established by WSDP and WSSP. A principle of water resources management is to

operate facilities and systems on routine process of monitoring - prediction (evaluation) - operation. Additionally, it is an important element of water resources management to continue to maintain, repair and improve the facilities and systems for water resources development / utilization / management. Also, WRMP includes the activity plans to support and improve water technology and human resources.

(2) Contents of National Water Resources Master Plan 2013 (M/P2013)

Figure 2-3 shows the contents of the M/P2013 including main three plans: 1) Water Sources Development Plan, 2) Water Sector Development Plan and 3) Water Resources Management Plans. Further, based on the results of the M/P1995 review discussed in Section 2.1, its feedback is reflected in the discussion of the M/P2013.



[Note] (Chapter XX): Contents are discussed in the Chapter of Volume-4 (Chapter XX).
Source: JICA Project Team

Figure 2-3 Contents of National Water Resources Master Plan (M/P2013)

(3) Usage of National Water Resources Master Plan 2013 (M/P2013)

The M/P2013 deals with nationwide water resources development and management in Nigeria comprehensively. However, many activities of water resources development and management should be carried out at the level of hydrological area or state, and some of the sub-sectors are under the jurisdiction of other federal ministries or agencies.

Therefore, the M/P2013 is formulated with respect to water usage as follows:

- Application to Catchment Management Plan (CMP) as master plan for each hydrological area
- Application to sub-sector development plans except water supply, sanitation, irrigation and drainage

2.2.2 Outline of National Water Resources Master Plan 2013 (M/P2013)

(1) Strategic Issues

Through the present project, the strategic issues on water resources in Nigeria have been identified. The following strategic issues are taken into account in formulating the M/P2013.

Strategic Issue-1: Water Resources Management and Development in Consideration of Unevenly Distributed Water Resources and Demand
Strategic Issue-2: Addressing Increasing Municipal Water Demand on the Premise of Current Low Operation Rate of Water Supply Facilities
Strategic Issue-3: Promotion of Sound and Self-reliant Irrigation Development
Strategic Issue-4: Effective Utilization of Existing Water Source Facilities in View of Contemporary Needs
Strategic Issue-5: Enhancement of Water-related Data/Information and Its Uniform Management
Strategic Issue-6: Consideration of Increasing Risk on Water Resources
Strategic Issue-7: Active Involvement of Water Resources Administrator in Management of Important Rivers and Flood Plains
Strategic Issue-8: Water Quality Monitoring to Secure Clean and Safe Water
Strategic Issue-9: Institutional Development & Strengthening of Water Resources Management

(2) Outline of Water Source Development Plan

The water source development plan is proposed on the basis of water balance between water demand and supply capacity, in consideration of the unevenly distributed water resources potential. The basic concept for water source development plan for surface water and groundwater is shown in Table 2-2.

Table 2-2 Basic Concepts on Water Source Development

Source	Basic Concept
Surface Water	Effective Utilization of Existing Dams Many of the existing dams do not keep their original functions, because of lack of proper operation and maintenance including management of information on reservoir operation. It is necessary to revive these dams urgently, in order to prepare for the expected increase in water demand. Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country The primary objectives of the surface water resources development is to prepare and supply sufficient volume of surface water in view of the expected increase in water demand from water users; such as municipal water supply and irrigation water. Water resources development should consider the uneven distribution of water resources in the country. The following are considered. ● The necessary water resources development would be proposed by utilizing the proposed dams in the M/P1995 as the potential dams as well as other potential sites. ● By examining water balance for the potential dam sites, efficiency of each site is roughly evaluated. The priority for development should be given to the sites with higher efficiency. ● In the area where water resources is very limited and future demand is expected to be more than the supply capacity of water source, demand control such as reduction of planned irrigation area and/or changing the crop should be considered as one of options for managing the available water, in order to avoid conflict among water users. ● The integrated development with hydropower generation and irrigation components is proposed in order to promote self-reliant project.
Ground-water	Sustainable and efficient groundwater development Items below should be considered in groundwater development ● Amount of groundwater development should be less than amount of groundwater recharge for sustainable groundwater development ● Aquifer capacity should be taken into account in groundwater development of each region. ● Efficient location of boreholes should be planned for maximum yield from boreholes with minimum drawdown of groundwater level. Rehabilitation and repair of borehole facilities ● Borehole operational rate is currently only 63% in Nigeria. Breakdown of pumps is main reason of nonoperational boreholes. Broken pumps should be repaired to recover borehole capacity, and borehole maintenance should be strengthened to keep high borehole operational rate. ● Yield of boreholes should be increased by changing pump type from hand pump to motorized pump to meet future groundwater demand with minimum number of boreholes.

Source: JICA Project Team

The basic concept for water source conservation is shown in Table 2-3.

Table 2-3 Basic Concepts on Water Source Conservation

Source	Basic Concept
Surface Water	Conservation of surface water resources would be implemented in dams and reservoirs as well as in watershed areas. Both activities are related to each other. The former is a part of dam management activities, and as one of the measures for recovering and upgrading existing dams. This is mainly implemented by dam owners. On the other hand, the latter needs cooperation among wider range of stakeholders in a watershed, which deals with environmental management, water quality management, erosion control and so on.
Ground-water	Groundwater conservation in quantity and quality is important for sustainable usage of groundwater. It is taking place in many boreholes: i) lowering of groundwater level and drying up of boreholes due to over pumping, ii) deterioration of groundwater quality by sea water intrusion and infiltration of domestic drain and factory pollutant into aquifer. Pumping will be controlled as quantity conservation measure based on aquifer capacity assessment. On the other hand as quality control measure, pumping will be controlled against sea water intrusion, and pollutant discharge will be controlled against pollutant infiltration based on water quality standard. Guideline for measures will be prepared, and technical transfer is necessary for NIWRMC, CMO, NIHSA, which are in charge of groundwater management and conservation.

Source: JICA Project Team

(3) Outline of Water Sub-Sector Development Plan

The basic concept of sub-sector development plan related to water resources development has been prepared for the following sub-sectors which is under jurisdiction of FMWR; Water Supply and Sanitation, and Irrigation and Drainage. For the other sub-sectors such as hydropower generation, flood and erosion control, inland transportation, inland fishery, livestock, recommendations are provided. Table 2-4 shows the basic concept of sub-sectors.

Table 2-4 Basic Concepts on Sub-Sector Development

Subsector	Basic Concept
Water Supply and Sanitation	● Water supply plan for new infrastructure, upgrading, rehabilitation and expansion of existing infrastructure, to respond to increase in water demand ● Water supply plan for optimum and sustainable utilization of water resources (surface and groundwater) and areal demand distribution ● Sanitation plan with criteria on standard sanitation facilities in accordance with settlement classification
Irrigation and Drainage	● To complete early on-going public irrigation schemes ● To implement rehabilitation and expansion of public irrigation schemes which FMWR identifies as high priority ● To develop new water resource for high priority public irrigation schemes ● To utilize existing dams for public irrigation schemes and expand its system in developed area ● To develop new proposed irrigated farmland ● To develop effective structure for operation and maintenance to run schemes
Hydropower generation	● On the basis of updated results for water resources, potential sites for hydropower generation would be examined at conceptual level. The recommendation would be provided for future development of hydropower generation from the view point of water resources management. ● Necessity of coordination of water users when hydropower plant is installed in a multi-purpose dam managed by FMWR would be examined at conceptual level. Recommendation would be provided.
Flood and Erosion Control	● Strategies related to water resources are as follows: - Proper development and management of floodplain along Niger and Benue Rivers, - Implementation of flood control projects in urban centers and developing flood warning system for disaster management, and - Implementation of erosion control project. ● Considering the strategies shown above, the concept for dealing with the sector is as follows: - The role of FMWR on flood and erosion control would be examined from the view point of water resources management. The items related to flood and erosion control to be addressed by FMWR would be proposed.
Inland Transportation	● National strategies on the sector are as follows: - Operation and maintenance of inland navigation routes, and - Securing enough investment for developing inland navigation as a part of integrated transportation system. ● Considering the strategies shown above, the concept for dealing with the sector is as follows: - Recommendations would be made on necessary measures in floodplain management in view of navigation management.
Inland Fishery	● Water demand for freshwater aquaculture would be estimated and its water balance with water supply capacity would be checked. Recommendation on necessary coordination of other water users would be provided.
Livestock	● Water demand for livestock would be estimated and its balance with water supply capacity would be checked. Recommendation on necessary coordination of other water users would be provided.

Source: JICA Project Team

(4) Outline of Water Resources Management Plan

As mentioned below, Water Resources Management Plan (WRMP) shows the approach of proper delivery of water services meeting water user's needs on the basis of 3Ss (sufficiency, sustainability, safety) and 2Es (efficiency, equity) by using facilities and operation systems to be established by WSDP and WSSP. WRMP is established based on the following strategies:

Strategy-1	Organization and Institution for Public Water Services
Strategy-2	Operation and Maintenance for Provision of Proper Water Services
Strategy-3	Allocation and Regulation of Public Water
Strategy-4	Facilitation and Improvement of Water Resources Development / Utilization / Management

In order to realize appropriate water resources management, the M/P2013 proposes the plans for the following items to be controlled:

- Organization and institution of public water services
- Operation and maintenance of water resources development facilities
- Hydrological monitoring
- Data and information management of water resources
- Floodplain control
- Consideration of risks caused by climate change and trans-boundary water
- Water environment conservation
- Water allocation and regulation
- Public relation of water resources
- Public-Private Partnership
- Human resource development, and
- Monitoring and Evaluation

2.3 Projection of Future Water Demand

2.3.1 Future Socio-Economic Framework

(1) Population

The long-term projection of population is indispensable for formulating the future framework of socio-economic structure in project areas. The projected population up to 2030 was carried out based on the following data:

- Census Population of 1991 and 2006.
- Estimated Population of 2010 by the United Nations.

"The 2010 Revision of World Population Prospects" of the United Nations projected the three different cases of future national population of Nigeria as presented in Table 2-5. It is obvious that the Case-2, median case, is similar to the estimated population of FMWR. Accordingly, based on the Case-2, the JICA Project Team projected the future population up to 2030 as shown in Table 2-6.

Table 2-5 Projected Population of Nigeria by United Nations (People in million)

Population		2010	2015	2020	2025	2030	2050
Case-1 High	Population	158.4	181.1	207.6	237.1	269.2	433.2
	(Growth Rate)	-	(2.72%)	(2.77%)	(2.69%)	(2.58%)	(2.41%)
Case-2 Median	Population	158.4	179.7	203.8	229.7	257.8	389.6
	(Growth Rate)	-	(2.56%)	(2.55%)	(2.42%)	(2.33%)	(2.09%)
Case-3 Low	Population	158.4	178.4	200.0	222.4	246.3	348.3
	(Growth Rate)	-	(2.41%)	(2.31%)	(2.15%)	(2.06%)	(1.75%)

Source: "The 2010 Revision of World Population Prospects" of the United Nations

Table 2-6 Census and Projected Population (People in thousands)

Region	Census [1]		Estimate [2]	Projection [3]			
	1991	2006	2010	2015	2020	2025	2030
Nigeria	88,992	140,432	158,423	179,791	203,869	229,796	257,815
Growth Rate	-	3.18%	3.06%	2.56%	2.55%	2.42%	2.33%

Note: A figure of the Case-2 (median growth) set out in Table 2-5 is applied for projection from 2015.
Source: 1) NPC - Census, 2) & 3) United Nations - estimate and projection on Nigeria, and 3) JICA Project Team - Projection on the basis of the projection on Nigeria by the United Nations

(2) Economic Growth of Industry

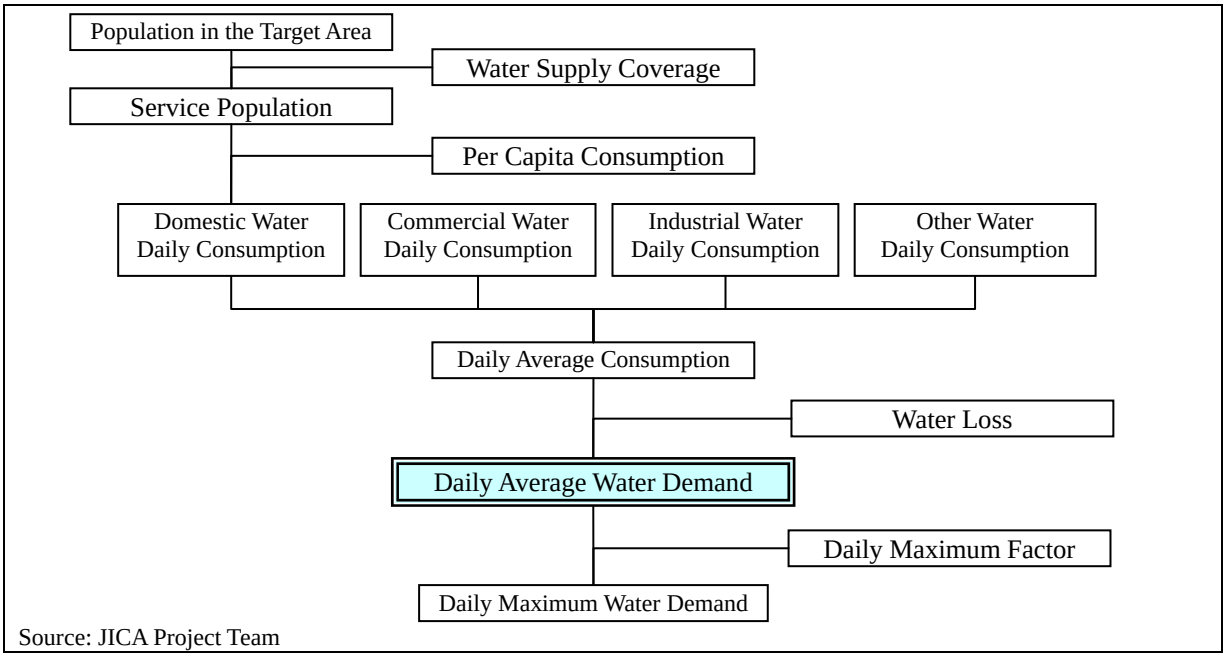
Through validation in the Project, it is concluded that the "National Aspirations" of Vision 20:2020 could not be reflected in the M/P2013. From the following viewpoints, an annual rate of 8.5% is applied for the manufacturing sector GDP growth in terms of the industrial water demand projection.

- NBS estimates the average GDP growth rate of 7.3% in "Revised Economic Outlook for 2012 – 2015, September 2012".
- The GDP growth rate of the manufacturing sector has generally recorded higher than that of the nation's GDP.
- The real growth rate of the manufacturing sector was 8.4% on average over the period between 2006 and 2011.

2.3.2 Municipal Water

(1) Method of Water Demand Projection

Figure 2-4 shows flowchart of water demand projection.



Source: JICA Project Team

Figure 2-4 Flowchart of Water Demand Projection

(2) Basic Conditions and Framework for Water Demand Projection

(2-1) Domestic Water

Domestic water consists of drinking, cooking, bathing, flushing and washing water, and also other water usage in our daily lives. It typically grows by not only increase in population served but also lifestyle change and improvement in living standards.

Daily average domestic water consumption is calculated by multiplying population served by per capita consumption (lit/cap/day).

Population

The Project estimates population by local government area (LGA) as the smallest unit, which is described in Section 2.3.1.

Categorization of Settlement on Water Demand Projection

Categorization of settlement by population size, consisting of three categories for water supply planning, has been defined by the Federal Ministry of Water Resources (FMWR). The Project, in principle, conforms to this categorization shown in Table 2-7. And, per capita consumption of domestic water by this categorization is applied in water demand projection for the Project.

However, water demand projection by settlement category based on population size only may cause inaccuracy because there is mixture of various water supply schemes, various living or water usage

situations, and various income groups in the settlement. In the process of water demand projection, the Project put additional category shown in Table 2-7 and allocate population based on referenced indicators such as household using flush toilet.

Table 2-7 Categorization of Settlement on Water Demand Projection

Population Size		Settlement Category	Typical Water Supply Scheme	Category on Water Demand Projection
1	More than 20,000	Urban	Surface water, piped supply, house or yard connection	Urbanized water usage (referenced indicator: household using flush toilet)
2	5,000 to 20,000	Semi-Urban or Small Town	Surface or groundwater, small scale piped supply, communal standpipes, house or yard connection	Semi-urbanized water usage (except the above 1 and the below 3)
3	Less than 5,000	Rural	Ground water, 250m radius, 250-500 persons per point	Ruralized water usage (referenced indicator: household using handpump)

Source: FMWR and JICA Project Team

Water Supply Coverage

National water supply coverage of 75% in 2015 as midterm goal and 100% in 2025 as long-term goal specified in the Sector Roadmap 2011 by FMWR are considered as guidepost. But, water supply coverage in each target year should be set by the above settlement categories based on population size, because water supply infrastructure development is determined by socioeconomic activities.

The Project utilizes the water supply coverage by settlement category at the State level, published by the results of Core Welfare Indicators Questionnaire Survey (CWIQS), 2006 in order to estimate present water demand. Summation of water consumption by LGA on the basis of the above supply coverages and 100% attainment in 2025 with constant improvement of supply coverage resulted in national water supply coverage of 56% in 2010, 71% in 2015 and 85% in 2020 as each target coverage. Refer to Table 2-8.

Table 2-8 National Water Supply Coverage by Settlement Category in Target Years

Target Year	National Water Supply Coverage			
	Nationwide	Urban	Semi-Urban, Small Town	Rual
2010 (Current), estimated by the Project	56%	72%	51%	40%
2015	71%	81%	68%	60%
2020	85%	91%	84%	80%
2025	100%	100%	100%	100%
2030	100%	100%	100%	100%

Source: JICA Project Team

Population Served

Based on the above coverage, the Project estimates population served shown in Table 2-9:

Table 2-9 Population Served by State

	Population Served (1,000 persons)				
	2010	2015	2020	2025	2030
Nigeria (Nationwide)	79,848	120,287	170,100	229,796	257,815

Source: JICA Project Team

Per Capita Consumption of Domestic Water

In view of the present water supply coverage and high growth of water demand due to increase in population, progress of the coverage should be emphasized above everything else, although revision of the per capita consumption is normally considered due to possibility of future improvement in living standards. So, the Project applies current standard per capita consumption shown in Table 2-10 until 2030, the target year of the M/P2013.

Table 2-10 Per Capita Consumption of Domestic Water

Settlement (Water Supply) Category		Category on Water Demand Projection	Per Capita Consumption
1	Urban	Urban water usage	120 lit/cap/day
2	Semi-Urban or Small Town	Semi-urban or small town water usage	60 lit/cap/day
3	Rural	Rural water usage	30 lit/cap/day

Source: Federal Ministry of Water Resources (FMWR)

(2-2) Commercial Water

Commercial water is defined as water for public and private institutions, stores and shops, accommodation facilities, hospitals and clinics, educational institutions, urban greening, etc.. It typically grows by not only development of urban activities but also as a result of improvement in facilities and equipment of institutions.

Daily average commercial water consumption is calculated at the ratio of 10% of daily average domestic water consumption across the board at the State level; and at 20% for Kano, Lagos States and FCT Abuja.

(2-3) Industrial Water

Industrial water is defined as water for raw material of commodity and production, treatment, coolant, cleaning, et al. It typically grows by development of socioeconomic activities.

Daily average industrial water consumption in 2010 is calculated at the ratio of 1.25% of daily average domestic water consumption in the Northern area, 2.5% in the Southern area and 5.0% in Kano and Lagos States. It is estimated that daily average industrial water consumption increases at an annual ratio of 8.5% (GDP growth rate).

(2-4) Water Loss

Water loss is defined as total volume of water leakage from pumping equipment, reservoirs and pipelines, and also missing water by illegal connections, that is, synonymously with unaccounted for water (UFW). But, most State Water Agencies can not figure out water loss ratio accurately because flat rate tariff is much more common in water supplies in Nigeria, which means there is almost no water meter installation. Furthermore, poor data management of existing facilities causes difficulty of status analysis. In view of these facts, 30% of water loss ratio is applied across the board except for rural water supply.

(3) Result of Water Demand Projection

Table 2-11 shows result of water demand projection, based on the above basic conditions and frame.

The estimated nationwide water demand will nearly triple between 2010 and 2030, and the growth of states differs in degree.

Table 2-11 Water Demand Projection

	Water Demand (Million Liter per Day : MLD)					2030/2010
	2010	2015	2020	2025	2030	Ratio
Nigeria (Nationwide)	8,254	11,666	15,890	20,994	23,876	2.9

Source: JICA Project Team

2.3.3 Irrigation Water

(1) Agricultural and Irrigation Policies

Major crops produced in Nigeria are rice, cassava, yam, maize, sorghum, millet, groundnut, etc. The country is self-sufficient in most basic staples such as cassava, yam, etc, but it is still heavily dependent on import of processed agricultural products, particularly rice, wheat, sugar, livestock products and fish. The vision is to ensure sustainable food security to all Nigerians and to transform into on agricultural exporting country.

(2) Development of Agriculture and Irrigation

Keys to Nigerian agricultural and irrigation policies are (a) enhanced agricultural productivity, (b) expanded irrigated farmland, and (c) internal reform of irrigated farming. In order to achieve these, the followings should be promoted.

- Completion of ongoing schemes for irrigation development and rehabilitation,
- Development of new irrigated farmland,
- Increased rice production,
- Expansion of rain-fed farmland and growth of crop production, and
- Creation of employment opportunity

(2-1) Planted area and yield of rain-fed rice cultivation

Rain-fed upland rice and lowland rice is predominant in Nigeria and irrigated paddy field is less common. In 2008, the farmland areas of these three types of rice cultivation are 510,050ha, 1,243,151ha, 47,799ha, respectively.

According to statistical data of National Bureau of Statistics and Regional Office, the rates of annual increase of rice cultivation in the past 16 years are 0.83% and 3.98% in the last 5 years. On the other hand, annual rate of yield in the past 16 years is 0.92%.

(2-2) Required rice production for accomplishing 100% self-sufficiency

To achieve 100% self-sufficiency in rice production for the population in 2030, 11.9 million tons of rice production is required, according to "National Rice Development Strategy, Nigeria".

- Polished rice consumption : 30 kg/capita/yr (Source: NRDS)
- Projected population in 2030 : 257,8000,000
- Projected polished rice consumption in 2030 : 30 (kg/capita/yr) × 257,800,000 (people) × 1.0 (self-sufficiency ratio) = 7,700,000 (t/yr: milled)
- Rice grain yield necessary in 2030 (before polishing) : 7,700,000 (tons) / 0.65 = 11,900,000 (tons)

(2-3) Rice production by rain-fed upland and lowland rice

Production of rain-fed upland and lowland rice as of 2030 are in Table 2-12 calculated based on acreage under cultivation and annual rate of increase in yield mentioned above.

Table 2-12 Production of Rain-fed Rice as of 2030

	Area Growth Rate	Cropping area (ha)	Yield growth 1.0%		Yield growth 1.5%		Yield growth2.0%		Yield growth 2.5%	
			Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)
R. upland	1.0%	634,950	2.0	1,270	2.2	1,397	2.5	1,587	2.8	1,778
R. lowland		1,547,535	2.5	3,869	2.8	4,333	3.1	4,797	3.4	5,262
Total		2,182,485		5,139		5,730		6,384		7,040
R. upland	2.0%	788,460	2.0	1,577	2.2	1,735	2.5	1,971	2.8	2,208
R. lowland		1,921,678	2.5	4,804	2.8	5,381	3.1	5,957	3.4	6,534
Total		2,710,138		6,381		7,116		7,928		8,742
R. upland	3.0%	977,160	2.0	1,954	2.2	2,150	2.5	2,443	2.8	2,736
R. lowland		2,381,588	2.5	5,954	2.8	6,668	3.1	7,383	3.4	8,097
Total		3,358,748		7,908		8,818		9,826		10,833
R. upland	4.0%	1,208,700	2.0	2,417	2.2	2,659	2.5	3,022	2.8	3,384
R. lowland		2,945,910	2.5	7,365	2.8	8,249	3.1	9,132	3.4	10,016
Total		4,154,610		9,782		10,908		12,154		13,400
R. upland	5.0%	1,491,750	2.0	2,984	2.2	3,282	2.5	3,729	2.8	4,177
R. lowland		3,635,775	2.5	9,089	2.8	10,180	3.1	11,271	3.4	12,362
Total		5,127,525		12,073		13,462		15,000		16,539

R. upland, R. lowland: Rain-fed upland rice, Rain-fed lowland rice; Growth rate of area and yield indicate per year.
Source: JICA Project Team

(2-4) Development area and rice production due to public irrigation scheme

Based on past performance and given the annual growth rates of currently cropped rice area, paddy yield by 2030 are 4.0% and 1.0%, respectively. Paddy production under rain-fed condition is 9.8 million tons. This is equivalent to 82% of the required amount of paddy production for projected population in 2030.

The planned and developed areas for the existing public irrigation schemes are 440,853ha and 128,097ha, respectively. It is proposed to develop new schemes as well as to complete the expansion of the existing promised schemes by 2030.

According to irrigation development plan mentioned below, planned irrigation areas of public irrigation scheme is 468,752ha by 2030 (refer to Table 2-67) and rice cultivated areas 385,711ha[1] depending on planned cultivation pattern.

[1] (Annual crop intensity of rice) x (Planned public irrigation area)

On the other hand, farmland areas of private small scale irrigation farming are 335,000ha by 2030 in which rice cultivation areas are 39,319ha[2]. Rice production is estimated based on annual yield and shown in the table below. It is possible to produce rice of about 1.9-2.6 million tons comprising public irrigation scheme and private small scale irrigation farming. The amount of rice production becomes about 11.7-12.4 million tons with adding 9.8 million tons by the rain-fed rice production. It is possible to secure almost or more than 100% of rice self-sufficient, when the irrigation area for rice production will be developed as planned by 2030.

Table 2-13 Production of Irrigated Rice as of 2030

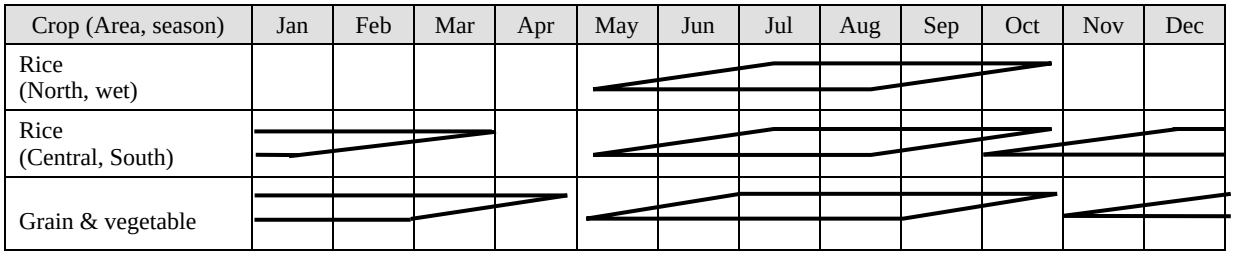
Type of Irrigation	Rice cropping are (ha)	Yield growth 1.0%		Yield growth 1.5%		Yield growth2.0%		Yield growth 2.5%	
		Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)	Yield (t/ha)	Production (,000ton)
Public scheme	385,711	4.4	1,697	4.9	1,890	5.4	2,083	6.0	2,314
Private small scale	39,319	4.4	173	4.9	193	5.4	212	6.0	236
Total	425,030		1,870		2,083		2,295		2,550

Source: JICA Project Team

(3) Proposed Cropping Pattern

(3-1) Cropping Calendar

Figure 2-5 shows cropping seasons in the three large hydrological basins of Nigeria, which are obtained from various materials and interview surveys.



Source: JICA Project Team

Figure 2-5 Cropping Calendar

(3-2) Current Cropping Pattern

Table 2-14 shows the current cropping rate set based on RBDA's materials and cropping acreages of large-scale irrigation schemes. Vegetables and grains are major crops in small-scale private irrigation schemes.

Table 2-14 Current Cropping Pattern

HA	Irrigation scheme (%)				Small-scale private irrigation (%)			
	Wet Season		Dry Season		Wet Season		Dry Season	
	Paddy	Upland	Paddy	Upland	Paddy	Upland	Paddy	Upland
1	40	25	5	60	20	50	0	70
2	10	60	10	30	10	60	0	70
3	10	60	10	30	10	60	0	70
4	10	60	10	30	10	60	0	70
5	70	5	0	0	30	40	0	70
6	35	25	0	35	20	50	0	70
7	70	30	5	15	30	40	0	70
8	80	15	0	25	30	40	0	70

Source：JICA Project Team

(3-3) Proposed Cropping Pattern

Table 2-15 shows the proposed cropping rate set based on current cropping and agricultural policies that emphasize rice product.

[2] (Annual crop intensity of rice) x (Planned private irrigation area)

Table 2-15 Proposed Cropping Pattern

HA	Irrigation scheme (%)				Small-scale private irrigation (%)			
	Wet Season		Dry Season		Wet Season		Dry Season	
	Paddy	Upland	Paddy	Upland	Upland	Upland	Paddy	Upland
1	40	50	0	50	20	70	0	80
2	60	30	20	60	10	80	0	80
3	60	30	20	60	10	80	0	80
4	60	30	20	60	10	80	0	80
5	80	10	60	20	30	60	0	80
6	60	30	40	40	20	70	0	80
7	80	10	60	20	30	60	0	80
8	80	10	0	50	30	60	0	80

Source：JICA Project Team

(4) Projection of Future Water Demand

The Calculation flow to estimate the water demand is shown in Figure 2-6.

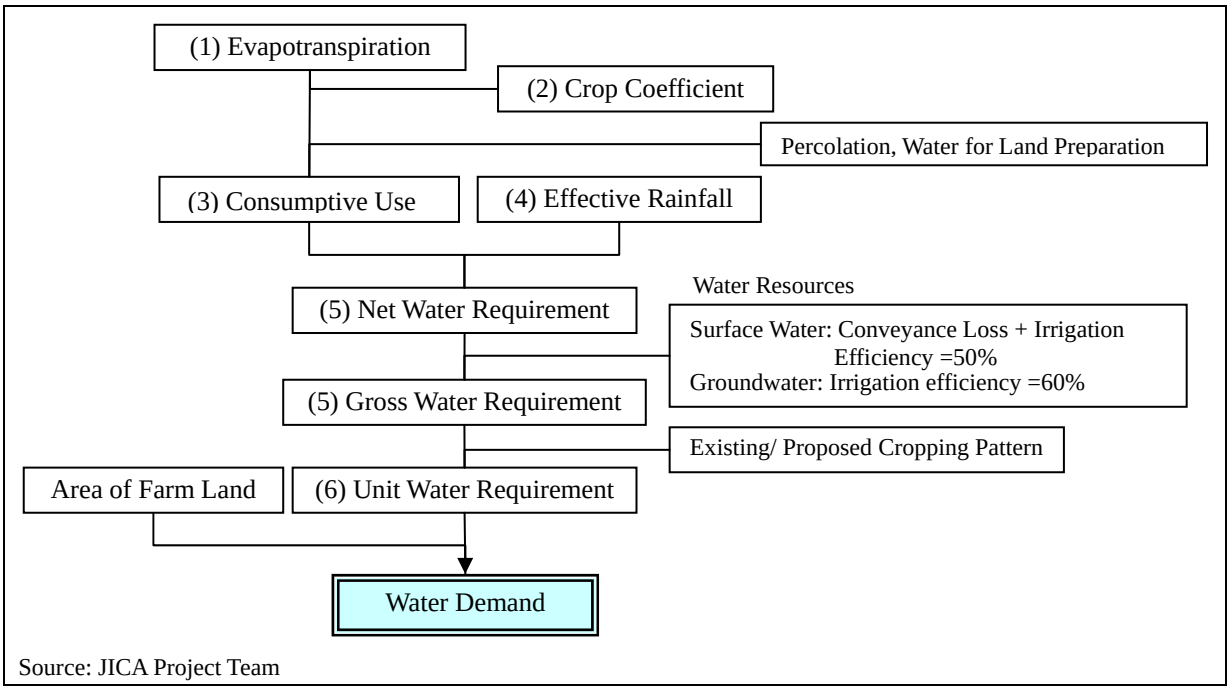


Figure 2-6 Calculation Flow of Water Demand Projection

(4-1) Reference Evapotranspiration

Calculation of the reference evapotranspiration (ETo) applied is Hamon method.

(4-2) Crop Coefficient

The crop coefficient applied is based on FAO technical.

(4-3) Consumptive Use of Water

The consumptive use of water is estimated using reference evapotranspiration (ETo), crop coefficient (kc), deep percolation (Per), and water for land preparation (Pre). The loss due to deep percolation is assumed to be at 2 mm/day in this calculation, and the losses of water due to land preparation are assumed to be 150mm in paddy and 60mm in upland field respectively.

- Crop Evapotranspiration (ETc) = ETo × kc
- Consumptive Use of Water = ETc + Per +Pre

(4-4) Effective Rainfall

The effective rainfall is defined as the amount of precipitation consumed by crops. The M/P2013 adopts 80% for the effective rainfall in paddies, and 70% for the effective rainfall in upland fields.

(4-5) Net Water Requirement, Conveyance, Application Efficiency, and Gross Water Requirement

The net water requirement is calculated by deducting the effective rainfall from the consumptive use of water. Public irrigation schemes take surface water as major water sources. Meanwhile, fadama farming and some small-scale private irrigation systems in floodplains mainly use sub-surface flows, which occur after flood recession. The other small-scale private irrigation systems outside floodplains have irrigation water mainly by extracting groundwater.

For surface water irrigation schemes, one must calculate the gross water requirement by making allowances for conveyance efficiency from the intake to fields and the application efficiency in the field. As for groundwater irrigation schemes, meanwhile, one only needs to take the application efficiency into account. The irrigation efficiency, which is the product of conveyance efficiency and the application efficiency, is generally estimated as follows.

- Surface Water: Conveyance efficiency × Application efficiency = 50%
- Groundwater: Application efficiency =60%

Hence, dividing the net water requirement by the irrigation efficiency gives gross water requirement.

(4-6) Diversion Water Requirement

Diversion water requirements are calculated from gross water requirements and the cropping patterns.

(4-7) Monthly Variations of Diversion Water Requirement by Hydrological Area

Table 2-16 shows monthly variations of diversion water requirement in each hydrological area (HA). As for the surface water sources, the diversion water requirement in the north (HAs-1 and 8) is maximum in June, the beginning of wet-season irrigation. In the central and southern regions where annual precipitation is higher, meanwhile, it is maximum in December and January, the mid-term of dry-season irrigation. Here the diversion water requirement in the south (HAs-5 and 6) required is less in the wet season due to much precipitation.

Table 2-16 Monthly Variations of Diversion Water Requirement (mm)

HA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	71	78	51	5	130	204	142	101	62	47	44	73
2	162	152	98	0	61	100	65	20	0	37	121	156
3	152	142	102	2	73	119	35	0	0	40	119	152
4	166	154	88	0	24	71	41	0	0	14	115	160
5	240	158	19	0	0	0	0	34	0	0	183	236
6	206	155	44	0	17	50	67	139	0	14	157	202
7	242	158	12	0	0	0	0	0	0	0	192	238
8	66	71	48	5	196	292	177	105	94	71	44	70

Water Source: Surface Water Bodies
Source: JICA Project Team

In the case of fadama farming or small-scale private irrigation that mainly use sub-surface flows or groundwater, the diversion water requirement in the northern area (HAs-1 and 8) is maximum in June, the beginning of wet-season irrigation (see Table 2-17). In the central and southern regions, meanwhile, it is maximum in December and January, the mid-term of dry-season irrigation. In addition, farmers grow crops only in the dry season after flood recessions in the case of fadama farming or small-scale private irrigation farming that use sub-surface flows as major water sources.

Table 2-17 Monthly Variations of Diversion Water Requirement (mm)

HA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	95	104	68	7	81	134	94	68	45	29	59	97
2	107	125	91	0	9	24	12	3	0	1	59	101
3	99	116	93	3	10	38	5	0	0	1	57	99
4	109	127	83	0	3	10	6	0	0	0	53	104
5	111	124	48	0	0	0	0	11	0	0	29	101
6	112	124	56	0	5	14	22	81	0	0	45	104
7	112	124	40	0	0	0	0	0	0	0	36	104
8	88	95	64	7	96	155	88	52	58	35	59	93

Water Source: Sub-surface flows or groundwater
Source: JICA Project Team

(4-8) Private Small Irrigate Farming

About 70 percent of the area under private small irrigated farming nationwide is cultivated. The remaining is located in flood plains. In fadama area in the flood plain, crops are planted in dry season after flood recession

(4-9) Private Company Irrigation Scheme

Most private company irrigation schemes utilize surface water to produce sugar cane and vegetables. In the study of water balance in SHA, water demand of those schemes should be considered in addition to public irrigation schemes.

(4-10) Current Irrigation Water Demand

Table 2-18 shows water demand of surface water irrigation schemes, fadama irrigation systems and a part of small-scale private irrigation systems with sub-surface flow water, and small-scale private irrigation systems with groundwater irrigation

The overall water demand is 872MCM in the wet season and 1,054MCM in the dry season, and the total amount is 1,926MCM year-round. The total amount corresponds approximately to 0.7% of Nigeria's total water abundance of 286,600MCM (internal generation only).

Table 2-18 Current Irrigation Water Demand

Water Source	Type	Area (ha)	Wet Season (MCM)	Dry Season (MCM)	Total (MCM)
Surface Water	Irrigation scheme	142,106	741	345	1,086
Sub-surface Flow	Fadama, partial Small-scale private irrigation	93,000	0	361	361
Groundwater	Small-scale private irrigation	90,000	131	348	479
Total		325,106	872	1,054	1,926

Source: JICA Project Team

(4-11) Proposed Irrigation Water Demand

The overall water demand is 2,052MCM in the wet season and 4,193MCM in the dry season, and the total amount is 6,245MCM year-round. The total amount corresponds approximately to 2.2% of Nigeria's total water abundance of 286,600MCM (internal generation only).

Table 2-19 Proposed Irrigation Water Demand

Water Source	Type	Area (ha)	Wet Season (MCM)	Dry Season (MCM)	Total (MCM)
Surface Water	Irrigation scheme	494,252	1,720	2,712	4,432
Sub-surface Flow	Fadama, partial Small-scale private irrigation	139,000	0	617	617
Groundwater	Small-scale private irrigation	196,000	332	864	1,196
Total		829,252	2,052	4,193	6,245

Source: JICA Project Team

(4-12) Preliminary Consideration on Water Demand Variations of Scenarios No.1 and No.2 Due to Climate Change

The Project considers impact of climate change on water demand based on the scenario which is set in Section 2.4.4. Taking projected air temperature variations into account, in this regard, the Project sets the future reference PET derived from the fundamental reference PET multiplied by the coefficients of air temperature variation shown in Table 2-20. Here, the coefficients of air temperature variation are calculated and obtained by the Hamon's equation

Table 2-20 Coefficient of Air Temperature Variation

Items	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8
Air Temp. Variation (^{o}C)	+2.5	+2.4	+2.4	+2.3	+2.1	+2.2	+2.2	+2.5
Coefficients of Air Temperature Variation	1.168	1.160	1.160	1.153	1.139	1.146	1.146	1.168

Source: JICA Project Team

As shown in Table 2-21, given the occurrence of Climate Change, it is projected that the water demand will increase by nearly 16% in total. Water demand will increase more in the wet season rather than in the dry season. Particularly, the groundwater demand for small-scale irrigation is projected to increase most by 18%.

Table 2-21 Variation of Water Demand due to Climate Change

Water Source	Type	Area(ha)	Wet Season	Dry Season	Total
Surface water	Irrigation schems	494,252	+22%	+12%	+16%
Sub-surface flow (Floodplain)	Fadama farming + some small-scale irrigation	139,000	0%	+14%	+14%
Groundwater	Small-scale irrigated farming	196,000	+28%	+14%	+18%
Total		829,252	+22%	+13%	+16%

Source: JICA Project Team

2.3.4 Other Sub-Sectors

(1) Livestock

Dependence of livestock on surface water is greater in southern part of Nigeria than in northern part where by far large livestock herds rely on groundwater and remaining water in Fadama. As to method of estimating, annual water demand for livestock was calculated from the text of FAO livestock guideline in African region, Annual consumption rates by livestock specie applied to the projection toward 2030 are: 7.88, 0.84, 0.73, 1.20, 8.98, 8.10, 3.07 and 0.039 m^3 for head/ fowl of adult cattle, goat, sheep, pig, camel, horse, donkey and poultry. The projected water demand for livestock in 2030 amounts to 320.8 MCM, as against 232.8 MCM in 2010.

Table 2-22 Number of livestock heads / fowls in 1,000 head/fowl

Specie	2007	2008	2009	2010	2030
Cattle	16,279	16,538	16,488	17,893	27,102
Goats	51,208	52,489	54,200	52,085	61,831
Sheep	32,300	33,090	33,674	32,178	33,279
Pigs	9,298	9,555	9,808	10,108	15,461
Poultry	92,035	84,781	86,601	92,134	93,439
Camel	-	-	-	147	147
Horse	-	-	-	789	789
Donkey	-	-	-	371	371

Note：1) Chicken, ducks and Guinea fowls are included in poultry.
2) Sheep is gradually on the decline in long term.
3) As to heads of camels, horses and donkeys data of 2010 are only available in recent term, so the data are also used for 2030 projection due to unpredictability.

Source: JICA Project Team

HA	Water Demand (MCM/year)	
	2010	2030
1	55.7	77.7
2	18.2	25.0
3	46.0	65.1
4	7.7	11.0
5	7.6	10.6
6	10.7	14.6
7	6.8	9.3
8	80.1	107.5
Total	**232.8**	**320.8**

Source: JICA Project Team

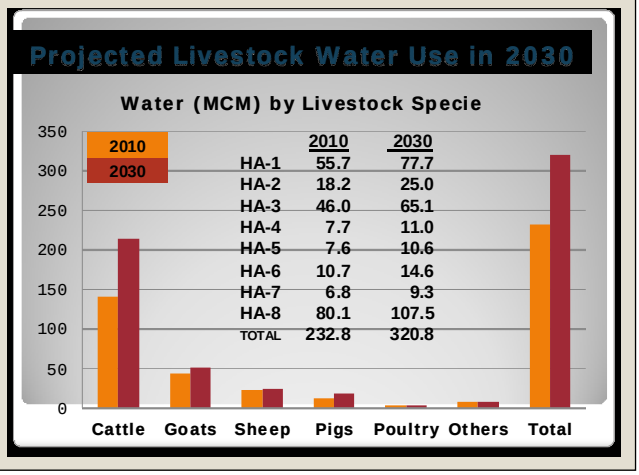


Figure 2-7 Water Demand of Livestock

(2) Freshwater Aquaculture

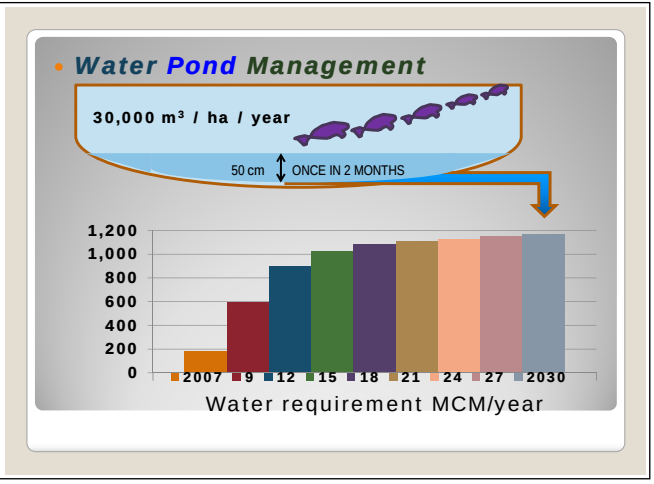
This sub-sector has recently been growing faster than ever supported by policy generated towards the application of subsidy for private facility development, and by rapid growth of domestic demand for fish. Southern states in HA-5 and HA-6 are center of this activity because many feed mills and fingerling hatcheries are available for fish farming.

The method for projecting future water demand for this subsector is based on the data in “Inventory of private and Government Fish Farms”. Water area in fish farms, summarized by fishery department of MFARD in 2007 was 6,126 ha, identified as the total area of fresh inland water. Fish yield per ha will grow from 1.4 t/ha in 2007 to 8.6 t/ha in 2030, then water surface area required for meeting future

annual demand as projected for 2030 is estimated at 38,880ha, assuming this future yield. Water demand for inland fish farming will increase from 727.8 MCM in 2007 to 1,166.1 MCM in 2030.

About 80% of water demand will be met by groundwater, since it supplies suitable quality water with higher dissolved oxygen content for fish farming and relatively safer water than surface one that is often polluted.

HA	Water Demand (MCM/year)	
	2010	2010
1	17.9	28.6
2	35.6	57.0
3	17.5	27.9
4	22.4	35.8
5	158.3	253.7
6	315.4	505.2
7	66.5	106.8
8	94.2	151.1
Total	727.8	1,166.1



Source: JICA Project Team

Figure 2-8 Water Demand of Freshwater Aquaculture

(3) Hydropower Generation

In Nigeria, stable supply of power is one of the key elements for national development. Hydropower generation can contribute to it, and is thereby being introduced.

Because water use by hydropower generation is basically non-consummative[3], total water quantity is not reduced by it. However, the flow regime can be altered in case of hydropower generation with storage dam. Even in case of run-of river type hydropower generation, it is possible that the reach with almost no flow can appear due to the intake flow that is introduced into the turbine off stream.

The optimum utilization of water for hydropower generation desired is on the condition that it would not inhibit other water uses such as municipal and irrigation in downstream reach.

(4) Flood Control

Flood generally means the phenomena of rainwater stagnation or overflow from river channels in the area where it is usually dry, and flood control means controlling of such flooding to store rainfall and river water in ponds and reservoirs and/or to let river water flow downstream safely through man-made channel.

The water demand in urban and rural water supply, agriculture, fishery sectors means the water quantity required for such uses are calculated and quantified for natural river flow or groundwater. In the case of flood control, such water intakes and consumptive uses of water are not so common, and quantitative evaluation of water demand is not conducted.

However, flood control measures such as flood storage in multipurpose dam reservoir and rain water harvesting in arid area could contribute to water resources development. They should be considered in Nigeria in the future.

(5) Inland Water Navigation

Inland Water Navigation is being developed to complement road transportation in Nigerian through appropriate policy initiatives. Since Inland water navigation is under the jurisdiction of NIWA in Federal Ministry of Transport, information on this sector is so limited that the water demand and discharge in navigation route cannot be addressed adequately. However, inland water navigation is one of the multi-modal transportation system composed of road, air and waterway in terms of the latest national policy. So the operation and maintenance of major rivers having navigation routes will be

[3] In case of hydropower generation with storage dam, there is a loss due evaporation and so on, although it is generally small compared to total water resources.

significant in Nigeria. Water demand in inland water navigation should therefore be evaluated comprehensively as part of river discharge for each river section when local water demand of other sectors on rivers are studied in detail.

(6) Minimum Stream Flow Requirement

Aside from the water demand shown in the previous sections, the minimum stream flow should be kept as high priority in order to protect the environment of the water body or for other specific reasons. There is no official measure to determine the minimum stream flow requirement in Nigeria at the moment.

Since the Project is to formulate the national water resources master plan, the hydrological method to discuss the minimum stream flow would be applied[4]. There are many criteria for determining the minimum stream flow using the hydrological method. In the M/P2013, Q_{97DS}90%Y (90% yearly dependable 97 percentaile flow for a single year), which may represent the drought condition according to the flow regime in each area in Nigeria is applied. Similar parameter has been applied in UK. In UK, Q_{95D} (95percentaile flow for long-term multi-year) is usually used for the minimum stream flow requirement[4].

It should be noted that the minimum stream flow discussed in the M/P2013 could be used as a guide for the overall water resources planning and management. It may require more detailed study before a particular project is actually implemented, however. It is desirable that more appropriate minimum stream flow requirement for each of the rivers be set by discussion among stakeholders, when more reliable data of river conditions such as river discharge will be available.

2.3.5 Water Demand Structure

The basic idea and the results of the water demand prediction are presented in the previous sections. In the present section, the water demand structure is discussed based on the following.

- For municipal water demand, which includes domestic, industrial and commercial water demand, the base case shown in Section 2.3.2 is applied. The demand in 2010 and 2030 are to be discussed.
- As for the municipal water demand, the demarcation between surface water and groundwater sources is estimated on the basis of existing condition and future plan for water supply facilities by state governments. The conveyance loss of 5% is additionally considered for surface water source. It is assumed that there is no conveyance loss in case of groundwater source.
- For other sub-sectors, irrigation, livestock and freshwater aquaculture in 2010 and 2030 are to be discussed.
- It is assumed that surface water source is mainly used in rainy season and groundwater source is utilized in dry season. The demarcation between surface water and groundwater sources is assumed to be 25:75.

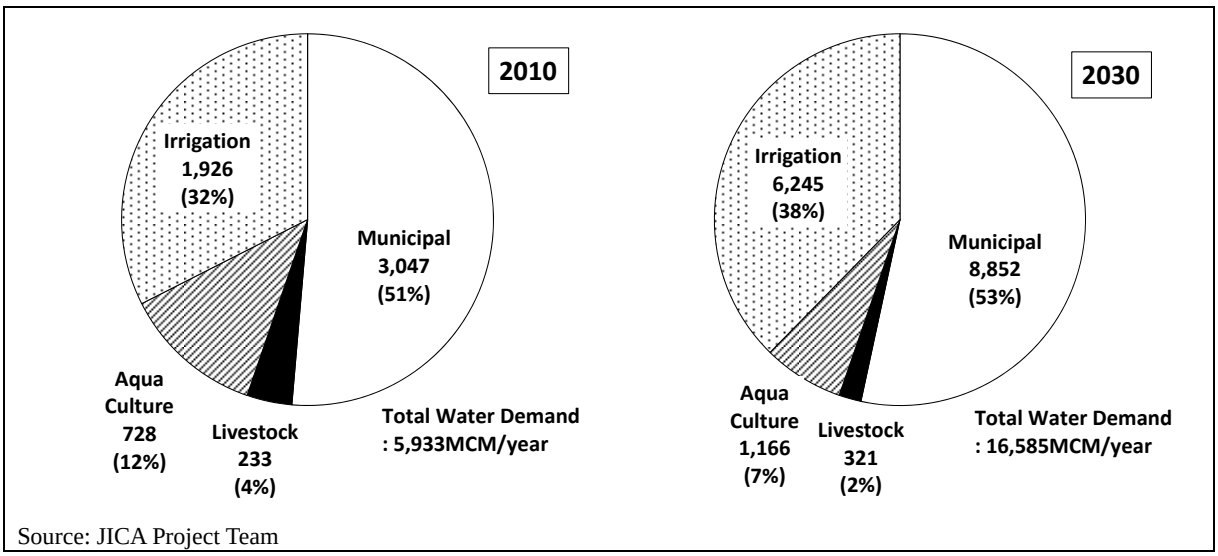
The existing total water demand is estimated at 5.93 BCM/year. It is expected to increase to 16.58 BCM/year in 2030.

Figure 2-9 shows the share of water demand by each sector. The share of municipal water demand in 2010 and 2030 is about 50%. The share of irrigation water demand will increase from about 30% in 2010 to about 40% in 2030.

Figure 2-10 shows the water demand by each sector for each HA. From the figure, the followings are noted.

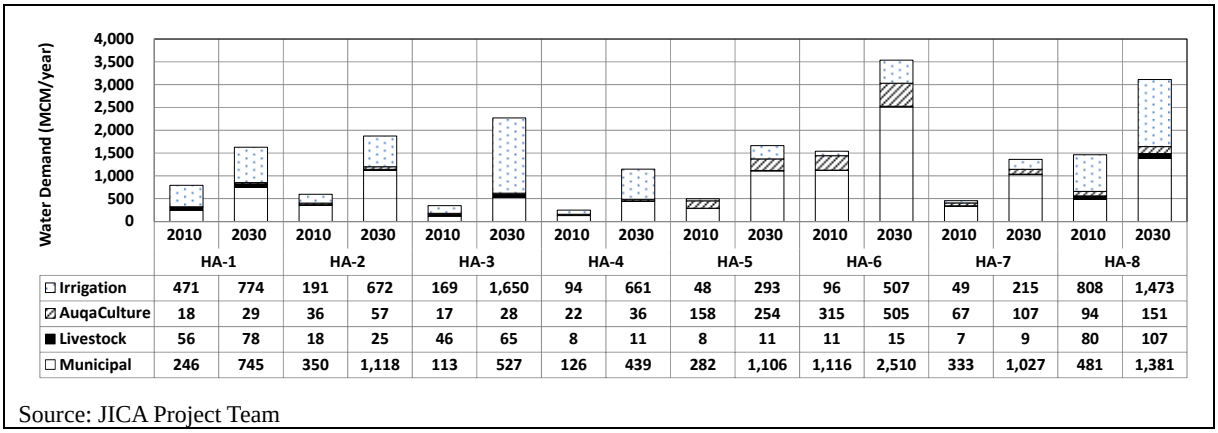
- Present municipal water demand is highest in HA-6, followed by HA-8. This will be maintained in the future (2030).
- Present total water demand is highest in HA-6, followed by HA-8. This will be maintained in the future (2030).
- The increasing rate of irrigation water demand in HA-3 is much larger than that in other HAs.

[4] IUCN: Flow-The Essentials of Environmental Flows



Source: JICA Project Team

Figure 2-9 Change in Share of Water Demand by Sectors



	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030
	HA-1		HA-2		HA-3		HA-4		HA-5		HA-6		HA-7		HA-8	
Irrigation	471	774	191	672	169	1,650	94	661	48	293	96	507	49	215	808	1,473
AuqaCulture	18	29	36	57	17	28	22	36	158	254	315	505	67	107	94	151
Livestock	56	78	18	25	46	65	8	11	8	11	11	15	7	9	80	107
Municipal	246	745	350	1,118	113	527	126	439	282	1,106	1,116	2,510	333	1,027	481	1,381

Source: JICA Project Team

Figure 2-10 Water Demand by Sectors and by HAs

Table 2-23 shows the estimated municipal water demand by sources. The average ratio of surface water source to the total municipal water demand is estimated at about 24% in 2010 and would increase to about 33% in 2030.

Table 2-23 Estimated Municipal Water Demand by Sources

		HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Present (2010)	**Total**	**246**	**350**	**113**	**126**	**282**	**1,116**	**333**	**481**	**3,047**
	Surface water	81	159	38	38	18	241	58	82	716
	Groundwater	164	190	75	88	265	875	275	398	2,330
Future (2030)	**Total**	**745**	**1,118**	**527**	**439**	**1,106**	**2,510**	**1,027**	**1,381**	**8,852**
	Surface water	162	476	131	147	181	1,242	189	359	2,888
	Groundwater	583	641	395	292	925	1,268	838	1,021	5,964

Unit: MCM/year
Source: JICA Project Team

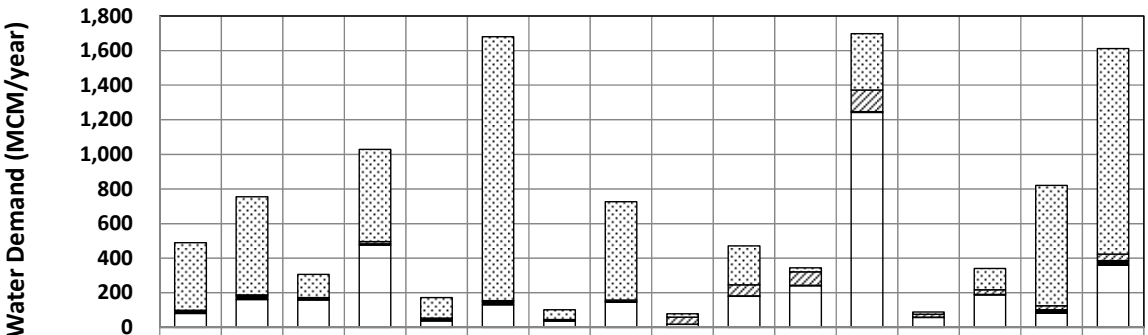
Table 2-24 summarizes the total water demand by sources. The average ratio of surface water source to the total water demand in the existing condition (2010) is estimated at about 40%. In the future (2030), the ratio would be increased to about 50%.

Table 2-24 Estimated Total Water Demand by Sources

		HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Present (2010)	**Total**	**791**	**594**	**345**	**250**	**496**	**1,538**	**455**	**1,463**	**5,933**
	Surface water	489	307	172	102	79	345	89	820	2,403
	Groundwater	302	288	173	148	417	1,193	367	643	3,530
Future (2030)	**Total**	**1,625**	**1,872**	**2,270**	**1,147**	**1,663**	**3,537**	**1,359**	**3,113**	**16,584**
	Surface water	754	1,029	1,679	727	471	1,697	341	1,611	8,309
	Groundwater	871	843	591	420	1,192	1,840	1,018	1,502	8,276

Unit: MCM/year
Source: JICA Project Team

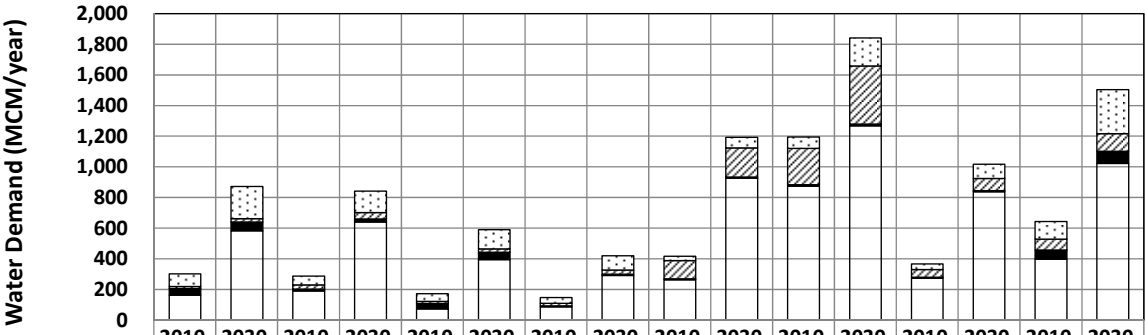
The water demand for surface water source by each sector for each HA and that for groundwater are presented in Figures 2-11 and 2-12, respectively.



	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030
	HA-1		HA-2		HA-3		HA-4		HA-5		HA-6		HA-7		HA-8	
Irrigation	389	566	134	532	118	1,524	57	568	20	225	23	325	12	123	694	1,186
AquaCulture	4	7	9	14	4	7	6	9	40	63	79	126	17	27	24	38
Livestock	14	19	5	6	11	16	2	3	2	3	3	4	2	2	20	27
Municipal	81	162	159	476	38	131	38	147	18	181	241	1,242	58	189	82	359

Source: JICA Project Team

Figure 2-11 Water Demand for Surface Water Source



	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030
	HA-1		HA-2		HA-3		HA-4		HA-5		HA-6		HA-7		HA-8	
Irrigation	82	209	57	140	51	126	37	93	28	68	73	182	37	92	114	287
AquaCulture	13	21	27	43	13	21	17	27	119	190	237	379	50	80	71	113
Livestock	42	58	14	19	34	49	6	8	6	8	8	11	5	7	60	81
Municipal	164	583	190	641	75	395	88	292	265	925	875	1,268	275	838	398	1,021

Source: JICA Project Team

Figure 2-12 Water Demand for Groundwater Source

2.4 Evaluation of Water Resources Potential

2.4.1 Meteorology

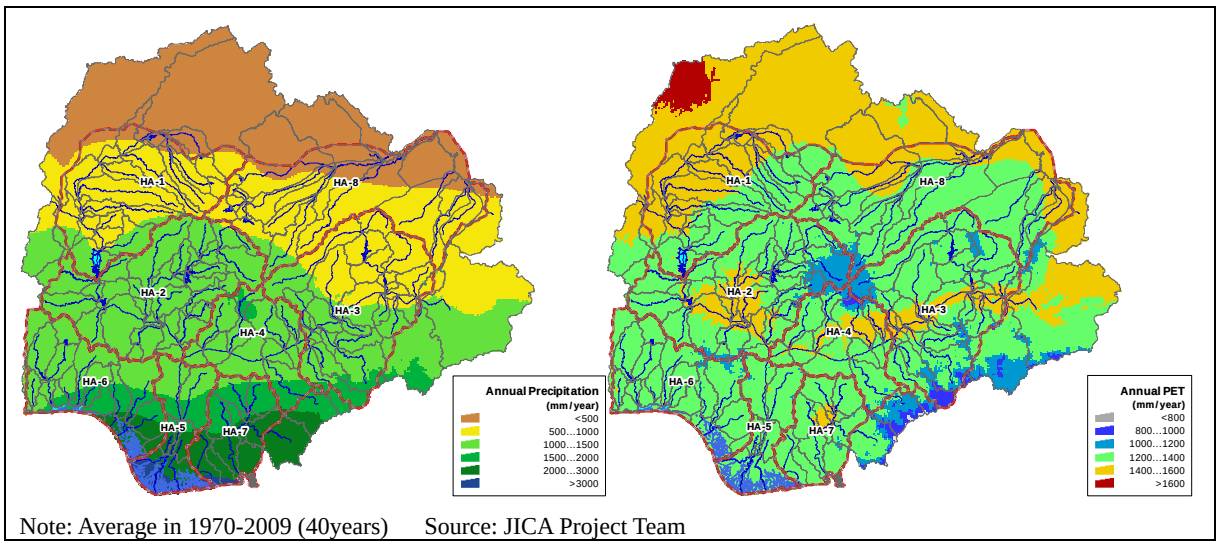
The annual precipitation and annual mean air temperature in Nigeria in the last 40 years (1970-2009) are estimated at 1,150 mm/year and 26.6 degree Celsius in average, respectively.

Figure 2-13 shows the spatial pattern of annual precipitation and annual PET over the county. The annual precipitation varies from over 3,000 mm in Niger delta area to about 400mm in the most northern part of the country. The annual PET is affected by altitude. In the high elevation area along the country border in the south-east as well as around Jos, the annual PET becomes small. Table 2-25 summarizes the spatially averaged annual precipitation, annual mean air temperature and annual PET for each HA.

The annual precipitation for the entire country tends to slightly decrease in the last 50years, and the rate is -1.7% in 50years. The annual mean air temperature for the entire country tends to increase with +3.0% in 50years.

As for the variation of annual precipitation by decades, the 1960s was relatively wet (more precipitation) and 1970s-1980s was dry (less precipitation). 1990s-2000s became wet periods again.

The magnitude of the fluctuation is much larger than the linear change rate of annual precipitation in 50years. On the other hand, annual mean air temperature has been increasing almost constantly without large fluctuation over five (5) decades.



Note: Average in 1970-2009 (40years) Source: JICA Project Team

Figure 2-13 Spatial Patterns of Annual Precipitation and Annual PET

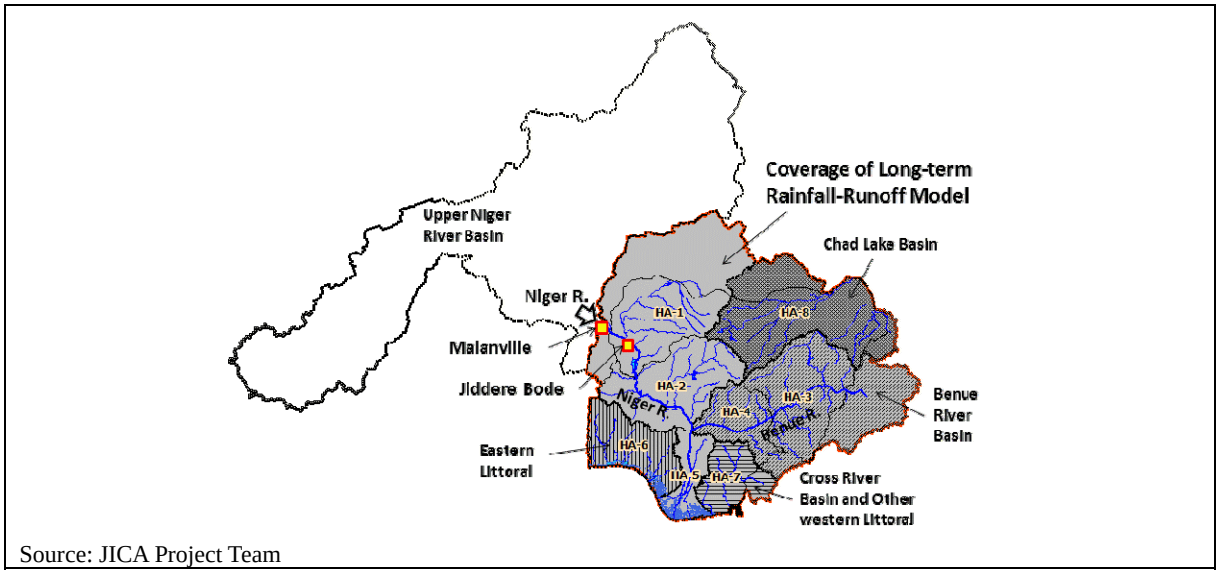
Table 2-25 Spatially Averaged Annual Precipitation, Annual Mean Air Temperature and Annual PET for Each HA

	Nation	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8
Annual P (mm/year)	1,148	767	1,170	1,055	1,341	2,132	1,541	2,106	610
Annual Mean T (degree Celsius)	26.6	27.4	16.5	26.0	26.8	26.7	26.5	26.9	26.5
Annual PET (mm/year)	1,337	1,419	1,318	1,290	1,338	1,325	1,314	1,338	1,347

P:Precipitation, T:Air Temperature, PET: Potential Evapotranspiration Source: JICA Project Team

2.4.2 Surface Water

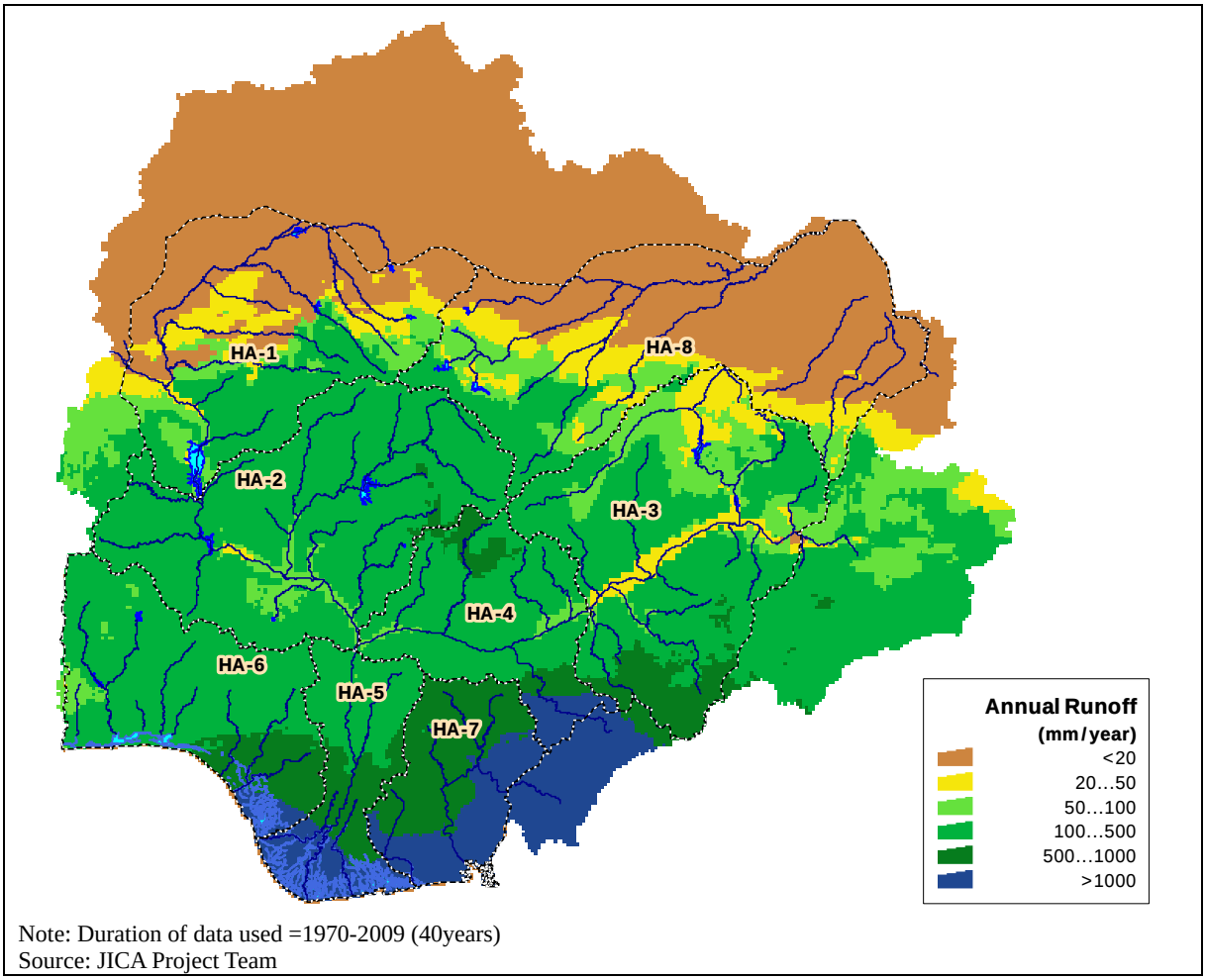
The simulated results of the rainfall-runoff model are used for estimation of surface water resources potential in quasi-natural condition. The simulated results cover the entire Benue river basin, the Niger river basin in the downstream catchment from Malanville in Benin, and other catchment areas whose generated runoff come into Nigeria (see Figure 2-14). To estimate surface water resources potential comprehensively, it is necessary to give the discharge at Malanville as a boundary condition. The observed discharge at Malanville is available after 1970s. Therefore, it is decided to analyze the simulated runoff from 1970 to 2009 (40years), although the rainfall-runoff simulation was conducted from 1960 to 2009 (50years).



Source: JICA Project Team

Figure 2-14 Coverage Area of Long-term Rainfall-Runoff Simulation Model

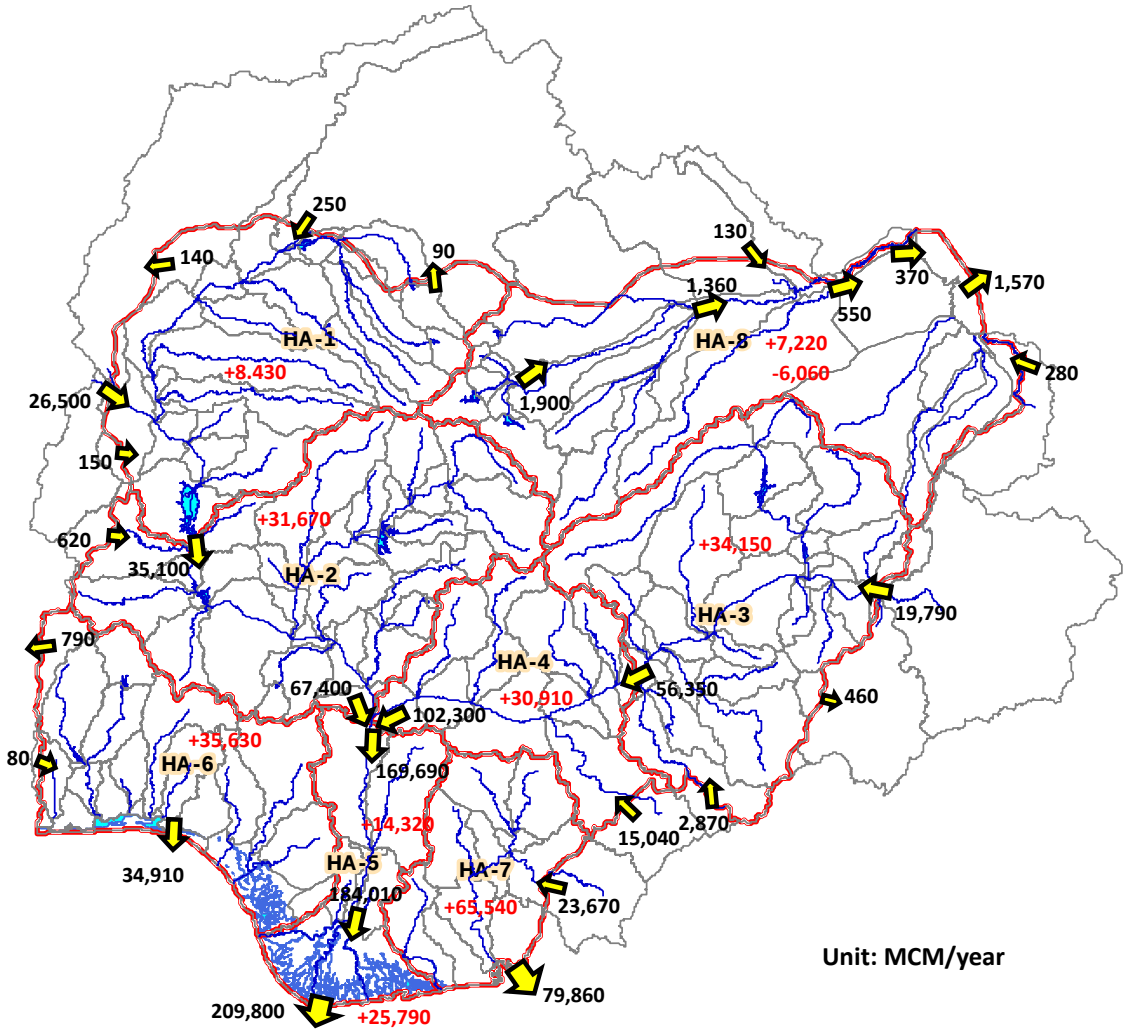
Figure 2-15 show spatial distribution of the average annual runoff yield. The average annual runoff yield (height) varies significantly across the county. In the most northern part of the county, the runoff yield is less than 20mm/year, whereas it becomes more than 1,000mm/year in the southern end.



Note: Duration of data used =1970-2009 (40years)
Source: JICA Project Team

Figure 2-15 Spatial Distribution of Average Annual Runoff Yield

Figure 2-16 shows the long-term averaged water balance in terms of annual total runoff volume across Nigeria.



- At the Niger-Nigeria border along Niger River., the average inflow volume is estimated at 26,500MCM/year. The total annual runoff volume at the HA-1 and HA-2 border becomes 35,100MCM/year by adding the runoff from HA-1. At the outlet of HA-2, it increases to 67,400MCM/year, and after merging with Benue River the total runoff reaches to 169,690MCM/year.
- The Benue River and its tributaries provide larger runoff volume than that in Niger River itself, which is 102,300MCM/year at the confluence with Niger River. The inflow from Cameroon in the Benue River system is also large; 19,790MCM/year through the main channel of Benue River, 2,870MCM/year from upper Donga River, 15,040MCM/year from upper Katsina-Ala River.
- The total annual runoff volume from Cross River and other catchment in HA-7 reaches to 79,860MCM/year, 23,670MCM/year of which is provided from the territory of Cameroon.
- In the delta areas in HA-5, the total annual runoff volume is estimated at 25,790MCM/year. It is considerably large volume.
- In HA-8, the total generated runoff is estimated at 7,220MCM/year. However, only 1,570MCM/year reaches to the outlet of HA-8 that is Lake Chad, due to large amount of loss in the large wetland area along the river system.

Note: Duration of data used =1970-2009 (40years)
Source: JICA Project Team

Figure 2-16 Long-term Averaged Water Balance in terms of Annual Total Runoff Volume

2.4.3 Groundwater

Groundwater potential means groundwater recharge, which is equivalent to maximum amount of groundwater to be developed. On the other hand, amount of groundwater which can be practically developed depends on both groundwater potential and aquifer capacity, in this part, aquifer capacity of Nigeria is mentioned firstly, and groundwater potential is mentioned secondly.

(1) Aquifer Type

Rock Type of Basement Complex and Hydrogeological Characteristics

Basement Rock is classified into three types, namely a) Gneiss and Migmatite Complex, b) Schist Belts, c) Younger Granite. There is not large difference among them. However, items below should be taken into account.

- Crystalline and coarse-grain rocks such as gneiss and migmatite will become sandy and form aquifer when they are weathered.
- Argillaceous meta-sediment rocks will become clayey and impermeable when they are weathered, and they are classified as aquiclude.
- Old granite is intruded by Younger Granite, which is usually fractured to be promising as aquifer.

Sedimentary Rocks (layer)

Sedimentary rock consists of sandstone and shale (claystone) of the Cretaceous, the Tertiary and the Quaternary (unconsolidated sand, silt and clay). Sandstone with good lateral continuity and large thickness usually forms aquifer of large scale. Large amount of groundwater can be extracted from sandstone aquifer with large scale and high permeability. More groundwater can be extracted from aquifer than amount of groundwater recharge. As a result, groundwater in aquifer, which has been accumulated during long period of time, will be rapidly consumed, causing continuous lowering of groundwater level year by year. Amount of groundwater extraction must be less than amount of groundwater recharge for sustainable groundwater usage.

(2) Groundwater Recharge

Groundwater recharge was analyzed as the late component of Surplus (S) of the rainfall-runoff model. Result of analysis is shown in Table 2-26. Result should be interpreted as explained below:

- The Surplus is classified into two parts. The first part is those that flow into rivers within one month, and the second part is those that will flow into river after next month. For example, groundwater flowing in weathered basement rock will flow into river earlier within one month after rainfall. On the other hand, some groundwater flowing in sedimentary rock will take more than several months to flow into river, depending on hydrological structure of aquifer.
- Groundwater will finally flow into rivers, so it is considered that groundwater recharge is part of river runoff.

Table 2-26 Groundwater recharge by HA

Item	Nation wide	Hydrological area							
		HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8
Area(km2)	909,979	135,128	154,616	156,546	74,519	53,914	99,333	57,440	178,483
Average precipitation (mm/year)	1,148	768	1,170	1,055	1,341	2,132	1,541	2,106	610
Average groundwater recharge (mm/year)	171	37	132	123	250	592	236	570	24
Same (%)	14.9	4.8	11.3	11.7	18.7	27.7	15.3	27.1	3.9
Same (BCM/year)	155.8	5.0	20.5	19.3	18.6	31.9	23.4	32.8	4.3

Source: JICA Project Team

2.4.4 Effect of Climate Change

In order to assess the effect of climate change on runoff, the scenarios for change in precipitation and air temperature are set as shown in Table 2-27, based on the output from the GCMs. The target year is set at 2050 and the outputs of GCMs for 30years around 2050 are utilized for setting the scenario.

Table 2-27 Scenarios for Change in Precipitation and Air Temperature

Case	Item	Season	HA-1	HA-2	H-3	HA-4	HA-5	HA-6	HA-7	HA-8	HA-1e	HA-3e	HA-8e
1	P (%)	ANN	0	0	0	0	0	0	0	0	0	0	0
	T (^{o}C)	ANN	+2.5	+2.4	+2.4	+2.3	+2.1	+2.2	+2.2	+2.5	+2.6	+2.4	+2.5
2	P (%)	DJF	+1.1	+0.9	+3.3	+2.7	-8.3	-3.2	-2.6	+12.3	+4.7	+10.0	+33.3
		MAM	-0.5	-4.3	-2.8	-4.2	-6.3	-7.5	-3.2	-0.5	+0.7	-2.2	+0.6
		JJA	+5.3	+3.2	+3.4	+3.4	+3.2	+1.9	+6.0	+7.9	+9.7	+2.8	+12.5
		SON	+7.6	+4.2	+5.2	+1.8	+1.9	+2.3	+4.0	+7.6	+13.1	+5.2	+11.8
	T (^{o}C)	ANN	+2.5	+2.4	+2.4	+2.3	+2.1	+2.2	+2.2	+2.5	+2.6	+2.4	+2.5

Remarks:
1) P = Precipitation, T=Air Temperature
2) HA-1e: Catchment area outside Nigeria whose runoff comes into HA-1, HA-3e: Catchment area outside Nigeria whose runoff comes into HA-3, HA-8e: Catchment area outside Nigeria whose runoff comes into HA-8
3) DJF= December, January, February, MAM=March, April, May, JJA=June, July, August, SON= September, October, November, ANN=Annual

Source: JICA Project Team

The long-term rainfall-runoff simulation model was utilized for estimating the effect of the change in precipitation and air temperature on runoff. In the simulation, only the precipitation and PET were modified, based on the scenarios shown in Table 2-27. The response of internal annual runoff volume, which is generated in the territory of Nigeria, to the change in precipitation and air temperature, on the basis of the simulated results, are summarized as follows.

- The expected change in air temperature could bring about the reduction of annual runoff with about 20% (Case-1).
- The response of runoff against the expected change in precipitation is more sensitive in the area with less precipitation. It could mitigate the impact of the expected change in air temperature in the northern area (Case-2).
- The decreasing rate of the 80, 90% dependable annul runoff volume is larger than that of the average runoff volume in general, which indicates that the drought condition would become severer.

Groundwater recharge seems to reduce due to influence of the Climate Change. Groundwater recharge will decrease by 20% in case-1, 14% in case-2 in nationwide average. Amount of decrease in groundwater recharge is different area by area. It should be noticed that area with smaller groundwater recharge will have lager influence than the area with higher groundwater recharge even though amount of the decrease in groundwater recharge is the same. For example, in Niger North (HA-1) and Chad Basin (HA-8), the amount of the decrease in groundwater recharge is not as large as those in the other areas. However, they will receive more serious influence by the Climate Change because their current groundwater recharge is much smaller than the other areas.

Lowering of groundwater level due to reduce in groundwater recharge will be small around river because groundwater level will be almost constant at river beds. However, decrease in groundwater level will become larger in place far from rivers. Therefore, inland area in the plateau far form rivers will affect more influence by decrease in groundwater recharge. Countermeasures against the Climate Change will take account of such a condition mentioned above.

2.4.5 Water Resources Potential

The estimated water resources potential is summarized in Table 2-28. The basis on estimation of water resources potential is as follows.

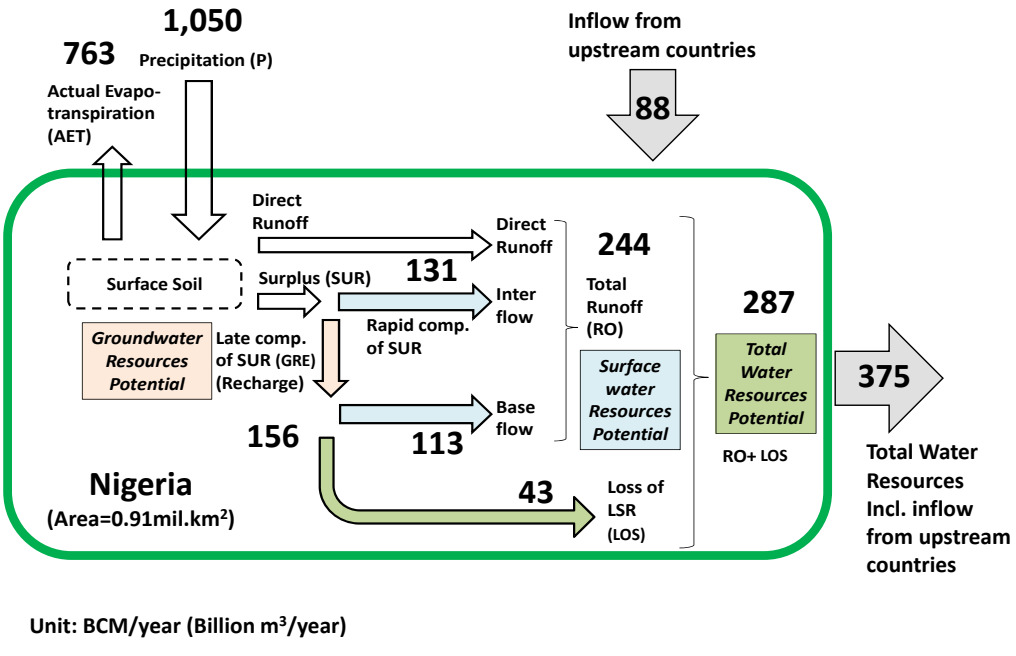
- The output of long-term rainfall-runoff model with the input data of precipitation and air temperature for 40years from 1970 to 2009 is used.
- The long-term rainfall-runoff model is setup based on the available observed discharge data at main hydrological stations, which covers the catchment area of rivers flowing into Nigeria except the upper Niger River as well as the territory of Nigeria.

The average precipitation over the country is about 1,150mm. Only 24% of the precipitation becomes runoff and the rest are lost as evapotranspiration and/or others. Total internal generation of the runoff is 244BCM/year and the surface water resources potential is estimated at about 333BCM/year. The total water resources potential can be evaluated by adding the component that is lost without becoming surface runoff among recharge. The internal generation of total water resources potential is estimated at 287BCM/year and the total water resources potential with inflow flow neighbor countries is estimated at 375BCM/year. 88BCM/year of water comes from neighboring countries, which roughly indicates that almost 24% of surface water resources in Nigeria relays on neighboring countries. The total groundwater resources potential is estimated at 156BCM/year as a renewable source on the basis of the estimated groundwater recharge.

Table 2-28 Estimated Water Resources Potential

		HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Water Resources Potential										
Total Water Resources Potential [1)]										
Including inflow from outside Nigeria	(BCM /year)	37.4	40.9	60.2	47.9	50.7	43.7	84.0	10.3	375.1
Only internal generation in Nigeria	(BCM /year)	10.7	40.3	37.9	32.8	50.7	43.6	60.3	10.3	286.6
Surface Water Resources Potential										
Including inflow from outside Nigeria	(BCM /year)	35.1	32.3	56.4	46.0	40.1	35.7	79.9	7.2	332.7
Only internal generation in Nigeria	(BCM /year)	8.4	31.7	34.1	30.9	40.1	35.6	56.2	7.2	244.2
Groundwater Resources Potential										
Groundwater Recharge	(BCM /year)	5.0	20.5	19.3	18.6	31.9	23.4	32.8	4.3	155.8
Runoff Condition（Only internal generation in Nigeria）										
Precipitation (P)	(mm/ year)	767	1,170	1,055	1,341	2,132	1,540	2,106	609	1,148
Total Runoff (RO)	(mm/ year)	62	205	218	415	744	359	978	40	268
Groundwater Recharge (GRE)	(mm/ year)	37	132	123	250	592	236	570	24	171
Loss of Recharge (LOS)	(mm/ year)	18	56	24	25	197	80	72	17	47
Runoff Rate (RO/P)	(%)	8.1	17.5	20.7	30.9	34.9	23.3	46.4	6.6	23.4
Recharge Rate (GRE/P)	(%)	4.8	11.3	11.7	18.7	27.7	15.3	27.1	3.9	14.9
Loss Rate (LOS/P)	(%)	2.3	4.8	2.3	1.9	9.2	5.2	3.4	2.9	4.1
Total Water Res. Rate ((RO+LOS)/P)	(%)	10.4	22.3	22.9	32.8	44.1	28.5	49.8	9.5	27.4

Note:
1) **Total Water Resources Potential**
= Surface Water Resource Potential + Groundwater Recharge – Base Flow Runoff
= Surface Water Resource Potential + Loss of Groundwater Recharge
2) Water Resources Potential in HA-5, 6 include the runoff in the delta area.
3) Water Resources Potential in HA-8 shows the total runoff generation without the loss in the large wet land area.



Source: JICA Project Team

2.5 Water Balance between Demand and Supply

2.5.1 Overall Water Balance between Total Water Demand and Water Resources Potential

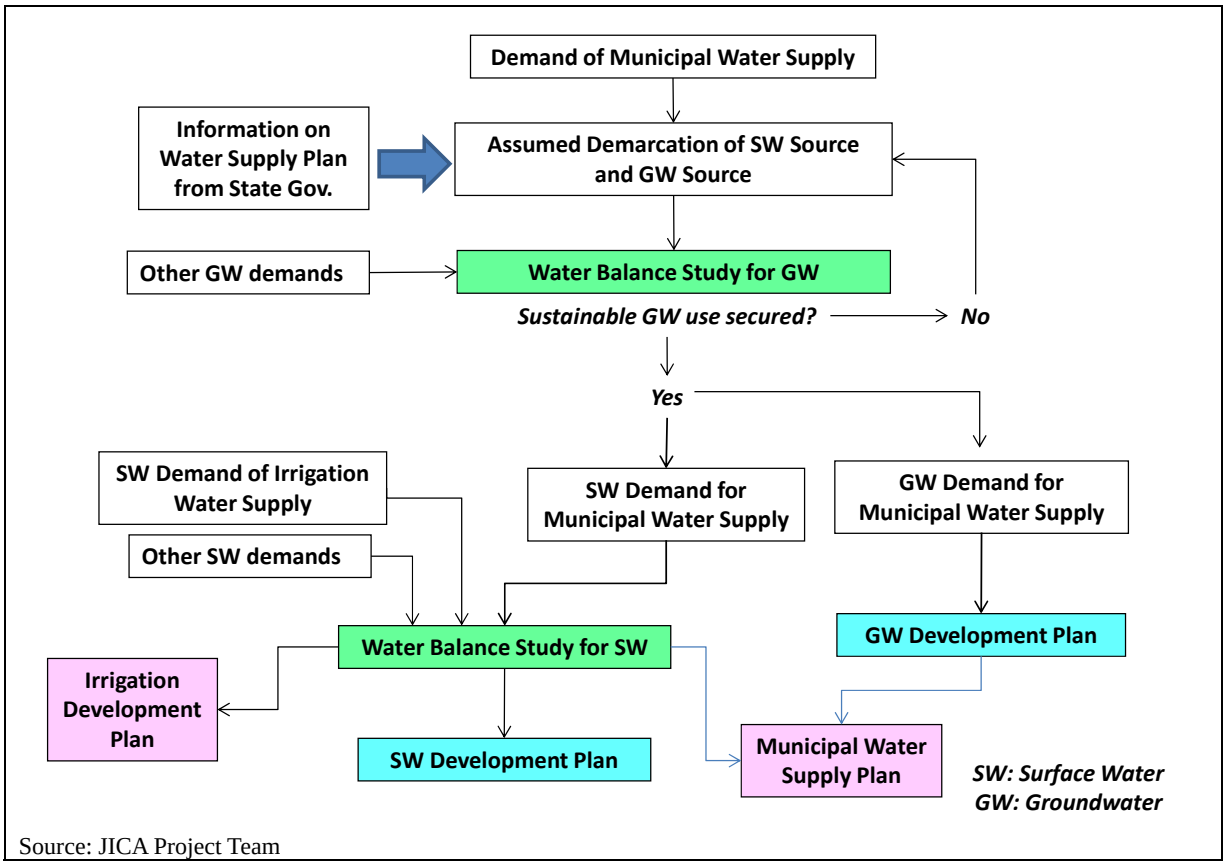
As shown in Section 2.3, the existing total water demand is estimated at 5.93BCM/year. It is expected to increase to 16.58BCM/year in 2030.

The water use rate varies from HA to HA. The rate in HA-8 in 2010 is 14%, which is much higher than the other HAs. In 2030, the water use rate in HA-8 may reach to about 30%, whereas the ratio in other HAs may be less than 10%.

The total water demand in 2030 is still much less than the total water resources potential. However, it should be noted that the currently usable water with stable manner to supply for the demand is also much smaller than the surface water resources potential. Furthermore, because the water demand and water resources are unevenly distributed, the necessity of water resources development should be examined by the water balance between supply and demand al local level.

2.5.2 Procedure of Water Balance Study

The current demarcation of water source in Nigeria is estimated that 40% for groundwater and 60% for surface water. The share of groundwater in municipal water supply is high. This nature would be kept even in 2030, although the usage of surface water would increase in urban area. Considering this situation, the sustainability of groundwater use would be firstly examined. Then, the water balance for both groundwater and surface water would be studied. Figure 2-17 shows the procedure of the water balance study.



Source: JICA Project Team

Figure 2-17 Procedure of Water Balance Study

2.5.3 Balance of Groundwater Recharge and Groundwater Demand

(1) Potential Supply Capacity by Existing Groundwater Supply Facilities

The existing groundwater supply facilities nationwide are as follows.

- Borehole with motorized pump : 19,758
- Boreholes with hand pump : 44,736
- Shallow hand-dug wells : 13,108

According to survey results, total number of boreholes (motorized pumps and hand pumps) is 64,494. Amount of groundwater extraction is estimated about 6,340,000 m3/day.

(2) Balance of Demand and Supply by Groundwater

Balance between groundwater recharge and demands are shown in Table 2-29. Ratio of groundwater demand/recharge is 5% in national average. However, it is 1 to 86% state by state showing large difference among states. This is because of difference in groundwater recharge state by state. Ratio of groundwater demand/recharge is higher in the northern part of Nigeria, where there is sedimentary rocks distributed, and groundwater recharge is smaller than the other area. However, aquifer expands in wide area crossing state boundary, where groundwater can be extracted from boreholes collecting groundwater from large surrounding area to meet groundwater demand.

Table 2-29 Groundwater Recharge and Groundwater Demand (2030)

No	State	Groundwater recharge (MCM/year)	Groundwater demand (2030) (MCM/year)					
			Water supply	Private irrigation	Live stock	aquaculture	total	Groundwater demand/ recharge
1	Abia	2,810	165	9	1	7	182	6%
2	Adamawa	3,707	96	26	17	4	142	4%
3	Akwa Ibom	5,759	221	12	1	8	242	4%
4	Anambra	1,728	125	8	2	5	140	8%
5	Bauchi	3,970	205	69	13	3	290	7%
6	Bayelsa	11,010	100	4	1	2	107	1%
7	Benue	10,655	152	50	1	3	206	2%
8	Borno	570	197	47	26	2	272	48%
9	Cross River	14,620	84	24	0	52	160	1%
10	Delta	13,056	260	19	3	344	626	5%
11	Ebonyi	2,174	43	12	3	0	58	3%
12	Edo	6,867	187	38	1	2	228	3%
13	Ekiti	863	59	11	0	11	82	9%
14	Enugu	2,504	171	15	1	1	188	8%
15	Gombe	943	83	20	13	1	117	12%
16	Imo	3,135	195	9	1	9	214	7%
17	Jigawa	349	207	70	14	9	301	86%
18	Kaduna	8,446	157	53	7	8	225	3%
19	Kano	1,028	354	66	23	102	545	53%
20	Katsina	670	231	74	14	4	324	48%
21	Kebbi	1,626	126	40	7	8	180	11%
22	Kogi	4,142	148	46	3	5	202	5%
23	Kwara	2,521	87	26	1	12	126	5%
24	Lagos	736	425	5	1	10	441	60%
25	Nasarawa	4,657	67	29	2	11	109	2%
26	Niger	8,402	156	57	7	4	224	3%
27	Ogun	1,928	106	38	1	14	159	8%
28	Ondo	3,973	145	27	0	5	178	4%
29	Osun	888	100	18	1	68	187	21%
30	Oyo	1,329	154	46	6	81	287	22%
31	Plateau	3,917	113	31	10	27	181	5%
32	Rivers	9,957	370	8	2	41	421	4%
33	Sokoto	315	131	42	27	2	202	64%
34	Taraba	13,147	81	41	4	0	127	1%
35	Yobe	421	118	51	13	1	183	44%
36	Zamfara	1,539	126	51	12	5	195	13%
37	FCT Abuja	1,374	216	7	1	2	226	16%
	Total	155,736	5,964	1,199	241	875	8,276	5%

Source：JICA project Team

Balance of groundwater recharge and demand is shown in Table 2-30 in case of the Climate Change (scenario case-1). Ratio of groundwater demand/recharge is 7% in national average, which is small increase from 5% of the case without Climate Change. However, it is 1 to 136% state by state, showing large difference. Effect of the Climate Change will make difference lager in water balance among states.

Table 2-30 Groundwater Recharge and Demand by Effect of Climate Change (2030)

No	state	Groundwater recharge (MCM/year)	Groundwater demand(2030) (MCM/year)					
			Water supply	Private irrigation	Live stock	aquaculture	total	Groundwater demand/ recharge
1	Abia	2,415	165	10	1	7	183	8%
2	Adamawa	2,567	96	29	17	4	145	6%
3	Akwa Ibom	5,086	221	13	1	8	243	5%
4	Anambra	1,383	125	9	2	5	141	10%
5	Bauchi	2,841	205	78	13	3	299	11%
6	Bayelsa	9,892	100	5	1	2	108	1%
7	Benue	9,182	152	55	1	3	211	2%
8	Borno	295	197	53	26	2	278	94%
9	Cross River	13,067	84	26	0	52	162	1%
10	Delta	11,372	260	20	3	344	627	6%
11	Ebonyi	1,776	43	13	3	0	59	3%
12	Edo	5,462	187	42	1	2	232	4%
13	Ekiti	572	59	12	0	11	83	14%
14	Enugu	2,037	171	16	1	1	189	9%
15	Gombe	586	83	23	13	1	120	20%
16	Imo	2,739	195	10	1	9	215	8%
17	Jigawa	229	207	78	14	9	309	135%
18	Kaduna	6,511	157	61	7	8	233	4%
19	Kano	679	354	74	23	102	553	81%
20	Katsina	405	231	83	14	4	333	82%
21	Kebbi	965	126	45	7	8	185	19%
22	Kogi	2,719	148	52	3	5	208	8%
23	Kwara	1,335	87	30	1	12	130	10%
24	Lagos	531	425	14	1	10	450	85%
25	Nasarawa	3,349	67	32	2	11	112	3%
26	Niger	5,616	156	65	7	4	232	4%
27	Ogun	1,298	106	97	1	14	218	17%
28	Ondo	3,005	145	32	0	5	183	6%
29	Osun	593	100	20	1	68	189	32%
30	Oyo	747	154	52	6	81	293	39%
31	Plateau	2,945	113	34	10	27	184	6%
32	Rivers	8,856	370	9	2	41	422	5%
33	Sokoto	152	131	47	27	2	207	136%
34	Taraba	10,723	81	46	4	0	132	1%
35	Yobe	265	118	57	13	1	189	71%
36	Zamfara	1,017	126	58	12	5	202	20%
37	FCT Abuja	964	216	9	1	2	228	24%
	Total	124,178	5,964	1,409	241	875	8,486	7%

Source: JICA Project Team

(3) Analysis of Groundwater Balance by Groundwater Simulation

(3-1) Prediction of Groundwater lowering in 2030

Groundwater balance was analyzed State by State in the previous section. However, distribution of groundwater recharge and demand is not even within a state. Groundwater simulation was performed to analyze more precisely un-even distribution of groundwater recharge, groundwater demand and aquifer. Sustainable groundwater development will be examined whether calculated groundwater level stays in the depth from which planned boreholes can pump up groundwater or not.

According to Figure 2-18, maximum draw-down of groundwater level is less than 5m in most of Nigeria. Consequently, proposed groundwater development can be available by adjusting borehole depth to meet future draw-down of groundwater level.

(3-2) Effect of Climate Change

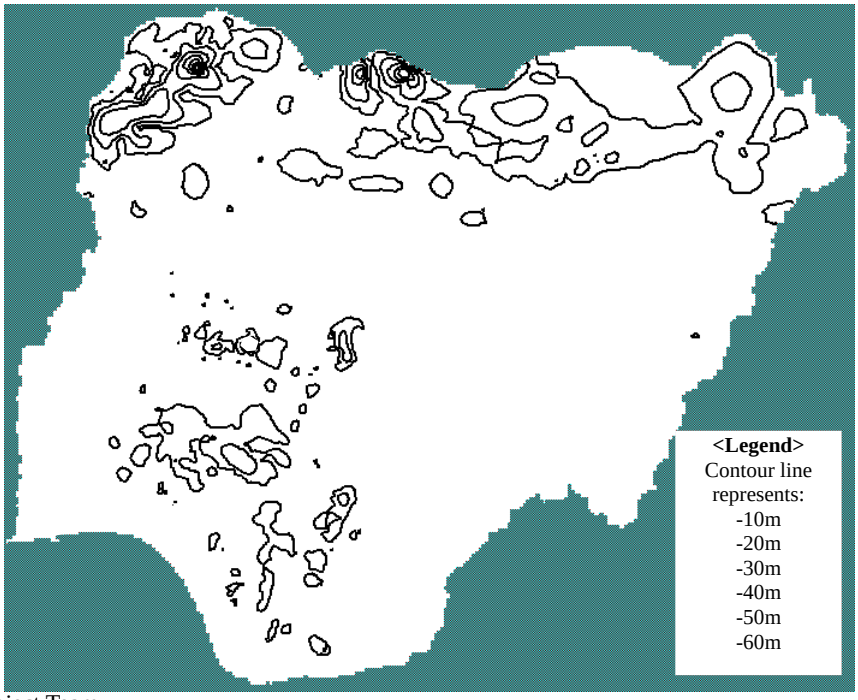
Lowering of Groundwater level in 2030 under the influence of Climate Change (scenario Case-1) was predicted by groundwater simulation. Simulation result is shown in Figure 2-19.

Compared with Figure 2-18, groundwater level in 2030 shown in Figure 2-19 is additionally 5 to 20m lower in the entire Nigeria due to decrease in groundwater recharge under the influence of the Climate Change. In some area in 2030, groundwater extraction cannot be continued with the current borehole depth, due to serious lowering of groundwater level by the Climate Change, even though groundwater

recharges is larger than groundwater pumping. Measures below can be proposed for future borehole planning, considering lowering of groundwater level by Climate Change.

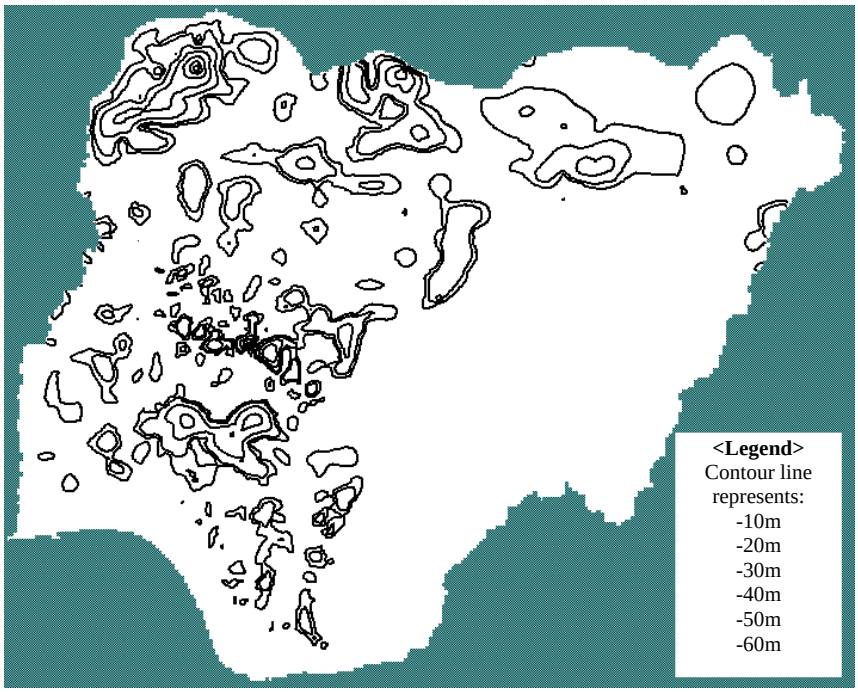
- To drill borehole 20m deeper than current depth
- To make depth of pump location 20m deeper than now. Such arrangement should be considered in borehole construction plan.

Impact of the lowering of groundwater level under the influence of Climate Change will be enlarged by over pumping. To prevent such situation, responding to the influence of Climate Change, groundwater pumping must be controlled where there are many boreholes. Legal and institutional framework must be established to support groundwater monitoring system for pumping control.



Source: JICA Project Team

Figure 2-18 Predicted Lowering of Groundwater Level in 2030



Source: JICA Project Team

Figure 2-19 Predicted Lowering of Groundwater Level in 2030 by Influence of Climate Change

2.5.4 Balance between Demand and Supply Capacity for Groundwater

(1) Comparison between Water Demand and Water Supply Capacity at Scale of HA

The usable water throughout a year is limited in quasi-natural condition. The installation and operation of storage dams can increase the stably usable water. In Nigeria, more than 150 dams, which are confirmed in the present project, have been constructed. The supply capacity of surface water source with the storage dams is approximately estimated by assuming a constant demand throughout a year.

The comparison between water demand and water supply capacity at the representative point of HA (downstream end of HA) at the scale of HA is presented in Table 2-31. The table shows the case without large hydropower dams (Kainji, Jebba and Shiroro). For all HAs, the supply capacity with 90% yearly dependability is larger than the water demand. It should be understood that the water demand in 2030 could be supplied by existing dams and those under-construction, if one sees the balance in the scale of HA.

However, the distance between existing water source and demand site is usually far, some of the existing sources would not be able to be fully utilized for the demand. It is thereby necessary to examine local water balance between supply capacity and demand within HA. If the lack of water is expected at local water balance, new water source development may then be necessary to propose.

Table 2-31 Comparison between Water Demand and Water Supply Capacity at Scale of Entire HA

HA	Ref. Points	Supply Capacity – MSFR (without Large hydropower dams (Kainji, Jebbe and Shiroro) ***				Water Demand (MCM/year)	
		90%Yearly Dependable (MCM/Year)		80%Yearly Dependable (MCM/Year)			
		with existing dams	with existing & UC dams	with existing dams	with existing & UC dams	Existing (2010)	Future (2030)
HA-1	Downstream end of HA-1	1,190	1,208	1,665	1,666	489	754
HA-2	Downstream end of HA-2	2,032	2,466	3,218	3,492	796	1,783
HA-3	Downstream end of HA-3	2,195	2,306	2,421	2,594	172	1,679
HA-4	Downstream end of HA-4	2,496	4,177	3,993	5,097	275	2,405
HA-5	Sum outlet of rivers in HA-5	2,098	3,069	6,000	6,402	1,150	4,660
HA-6	Sum outlet of rivers in HA-6	1,306	1,840	2,086	2,324	345	1,697
HA-7	Sum outlet of rivers in HA-7	459	556	1,427	1,502	89	341
HA-8	Before wet land area*	1,107	1,107	1,348	1,348	411**	870**

Note: MSFR=Minimum Stream Flow Requirement, UC=Under-Construction
* Sum of the values at the downstream end of SHA 802_i, 80401, 806, 807, 808061, 8080741, 808075
** The water demand whose source is Lake Chad is not included.
***The developed water volume by Lagdo dam is not included.
Source: JICA Project Team

(2) Detail Water Balance Study

(2-1) Outline

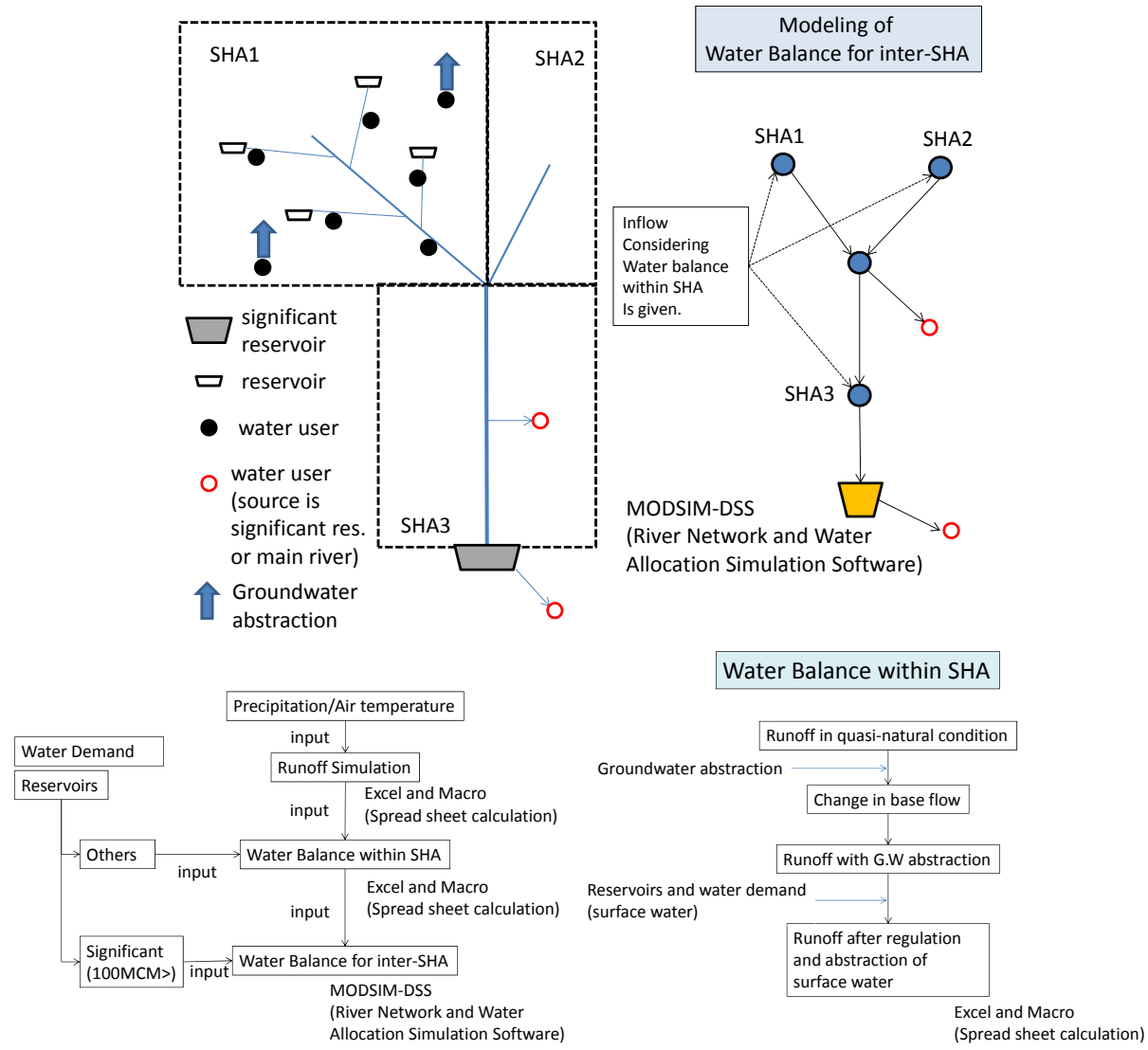
The items shown in Table 2-32 are considered for the detail water balance study.

Table 2-32 Items considered in Detail Water Balance Study

Item	Contents
Consideration of Groundwater Abstraction	The change in base flow due to abstraction of groundwater is approximately estimated on the basis of the simulated quasi-natural runoff and it is incorporated into the detail water balance study.
Classification of Water Use Facilities	It is inefficient to deal with all water use facilities that scatter in nationwide and have various scales in same manner. In the present project, the water balance is examined by classifying the water use facilities into the following two (2) categories (refer to Figure 2-20). ● Water use facilities whose source is either significant dams or main rivers which flows across SHA ➢ Directly modeled by the model network in MODSIM-DSS; The nodes for inflow are basically given by SHA unit and the significant reservoirs whose total storage capacity is more than 100MCM is directly modeled by the model network. ➢ 43 locations for municipal water supply, 49 locations for irrigation water supply ● Water use facilities whose source is in the catchment area of SHA

Item	Contents
	➢ Aggregated in SHA, and modeled by spread sheet. The output of the spread sheet model is used for the input data for the model network in MODSIM-DSS
Water Balance Study for Water Use Facilities whose source is in the Catchment Area of SHA	For the relatively large scale water use facilities whose source is in the catchment area of SHA, individual water balance is examined and accordingly necessary water resources development is proposed. ● Municipal Water Supply: water purification plants whose volume of water source is more than 3MCM/year (58 locations in total) ● Irrigation Water Supply: Existing large scale irrigation scheme whose planed area is more than 500ha (75 locations in total)
Water Balance Study for Potential Water Resources Development Sites	The water balance study for the potential water resources development sites (288 sites in total) shown in Section 2.6 is also conducted. The results of the water balance study, together with roughly estimated cost for the construction, is utilized for evaluating economic efficiency of each site. The following is considered for the water balance study.

Remarks: Other than the above items, water balance study for Inter-SHA is considered.
Source: JICA Project Team



Source: JICA Project Team

Figure 2-20 Detail Water Balance Study for Surface Water

(2-2) Results of Water Balance Study

Water Source for Municipal Water Supply

As the results of the water balance study for the relatively large scale water purification plants, it is evaluated that some water sources could experience the deficit for supplying necessary water volume for 2030 with 90% year dependability. The estimated total deficit is 387.6MCM/year. The recommended measures against those deficits are proposed on the basis of the results of the water balance study.

Water Source for Irrigation Water Supply

As the results of the water balance study for the existing large irrigation schemes whose planned area is more than 500ha (126,000ha in total), it is evaluated that the irrigable area in terms of stable water supply with 80% yearly dependability is less than the planned area in some schemes (39,000ha in total). The irrigation development plan as well as surface water development plan refers the evaluated results.

Hydropower Generation by Significant Dams

On the basis of the simulated results by the water balance study for the water demand in 2030, the hydropower generation by the significant dams as well as large hydropower dams (Kainji, Jebba, Shiroro) is estimated. The results are shown in Table 2-33.

Table 2-33 Estimated Hydropower Generation by Significant Dams

Dam		Install Capacity (MW)	Average Generated Energy (GWh/year)	80% year dependable Generated Energy (GWh/year)
Dams under FMWR	Gurara, Oyan, Ikere Gorge,Bakolori, Dadin Kowa, Tiga, Kiri, Jibiya, Challawa Gorge, Zobe, Omi, Kashimbilla	162	522	445
Hydropower dams under FMP	Kainji, Jebba, Shiroro	1,590	5,260	4,104

Remarks:
1) It is assumed that overall efficiency is 0.7.
2) As for Ikere Gorge, Bakolori, Dadin Kowa, Kiri, Kainji, Jebbea, Shiroro dams whose H-V-A relation is available for the present project, the fluctuation of water level is taken into account for estimating hydropower generation. For other dams, the head is approximated at 50% of the maximum water depth for estimating hydropower generation.

Source: JICA Project Team based on information from FMWR and FMP

Excess Storage Volume in Significant Dams

It is clarified that there could be excess storage volume in some significant dams, even if the demand for irrigation and municipal water supply in 2030 is considered. The possible additional water supply volume with 90% yearly dependability is 5.7BCM/year. The excess storage volume can be utilized for several different purposes such as irrigation, municipal water supply, enhancement of firm energy of hydropower generation, reduction of peak flood discharge and enhancement of river environment. It is necessary to discuss how to use the excess storage volume by stakeholders in each of hydrological area. It would be one of important topics during formulation of the Catchment Management Plan.

(3) Estimation of Risk Associated with Climate Change and Trans-boundary Water

(3-1) Risk related to Water Supply-Demand Balance Associated with Climate Change

In order to estimate the risk on water supply-demand balance associated with climate change, the water balance study with the runoff and water demand considering under the climate change scenario of Case-1 shown in Section 2.4. The Case-1 considers only changes in air temperature and gives smaller runoff compared to Case-2.

As the results of the water balance study for the relatively large scale water purification plants whose abstraction volume is more than 3MCM/year under the climate change scenario of Case-1, it is expected that the safety level of water supply for several water purification plants could be lower than 90% year dependability. There could be many intake points whose safety level is expected to be lower than 80% year dependability in HA-3 and 8. The impact of climate change on municipal water supply tends to be larger in these HAs.

As the results of the water balance study for the existing large irrigation schemes whose planned area is more than 500ha under the climate change scenario of Case-1, it is expected that the available irrigation area in terms of stable water supply with 80% year dependability could decrease in some irrigation schemes. The significant reduction could be expected in HA-8, in which both irrigation and municipal water demand are large.

The hydropower generation by the significant dams as well as large hydropower dams (Kainji, Jebba, Shiroro) could be reduced to 60-90% of the base climate condition, in case of climate change scenario of Case-1.

(3-2) Risk related to Water Supply-Demand Balance Associated with Trans-boundary Water

As mentioned in Section 2.4, about 24% of the total water resources potential in Nigeria relies on trans-boundary water. Because most of the trans-boundary water is the inflow through the Niger and Benue rivers, the impact of trans-boundary water would mainly appear along the main course of the Niger and Benue rivers.

There are large hydropower dams constructed along the main course of the Niger River. It is possible that hydropower generation by these dams be affected by the change in inflow from the upstream countries. The effect on the hydropower generation is estimated by water balance study under the scenario that only average inflow volume is reduced by 10, 30 and 50%, with the flow pattern unchanged with the past 40years (1970-2009) at Malanville in Benin. The evaluated reduction rate of generated energy is almost same as that of inflow to Nigeria when the reduction rate is small, however, the higher reduction rate the lower impact on generated power.

In addition to the long-term regime change of inflow, sudden change in flow due to operation of dams in upstream countries should be taken care. In order to flexibly cope with the sudden change in flow condition, the real-time monitoring of flow condition as well as close communicant and information exchange with neighboring countries should be established.

2.6 Water Sources Development Plan

2.6.1 Groundwater Development Plan

(1) Current Situation of Groundwater Development

(1-1) Merit of Groundwater Use in Nigeria

Merit of groundwater resources should be considered as mentioned below:

- Groundwater is stored in aquifer, which is distributed in every place in Nigeria.
- Groundwater can be used even in dry season. In this point, groundwater is superior to surface water and rain-harvesting water.
- Cost of groundwater development and usage is less expensive than that of surface water in case where amount of groundwater development is small. Therefore, groundwater is suitable for rural water supply and small town water supply, which cannot expect large investment.
- Generally, groundwater has better water quality than surface water and does not need high level treatment even for drinking.

(1-2) Issue on Groundwater Use

According to survey by FMWR on water supply infrastructure in 2006, 37% of the existing boreholes are currently not used. Breakdown of hand pumps and motorized pump is main reason. User's organizations are in charge of maintenance of pumps for small town and rural water supply. However, most of the user's organizations are not functioning. As a result, many broken pumps are left non-operational without any repair. Such situation should be improved.

(2) Optimum Method of Groundwater Development

Optimum groundwater development by aquifer was examined based in groundwater recharge using borehole filed theory. Amount of newly available groundwater was calculated for six (6) aquifer types shown in Table 2-34, based on groundwater recharge, number of boreholes and distance between boreholes within borehole field, applying borehole field theory.

Table 2-34 Groundwater Development Potential

Aquifer type			Yield per Borehole (m^3/day)	
			Average	Range
WH	**W**eathered **H**igh permeability	Weathered Basement rock and weathered part of the other type rocks	480	100～1,000
WM	**W**eathered **M**iddle permeability		380	300～500
WL	**W**eathered **L**ow permeability		150	100～300
MH	**M**ultiple **H**igh permeability	Sandstone or sandy formation within alternation of sandstone and shale	990	700～1,500
MM	**M**ultiple **M**iddle permeability		560	500～900
ML	**M**ultiple **L**ow permeability		280	200～500

Source: JICA Project Team

(3) Groundwater Development Plan by Aquifer

(3-1) Basic Policy

Basic policy of groundwater development is as follows:

- Groundwater development should be sustainable in view pint of water balance
- Groundwater development should be efficient in economic view point

Groundwater will be developed for municipal water supply, private irrigation, livestock and aqua-culture. Policy for groundwater development for municipal water supply, which is a key water use, is as follows:

(3-2) Concept of Groundwater Development for Municipal Water Supply

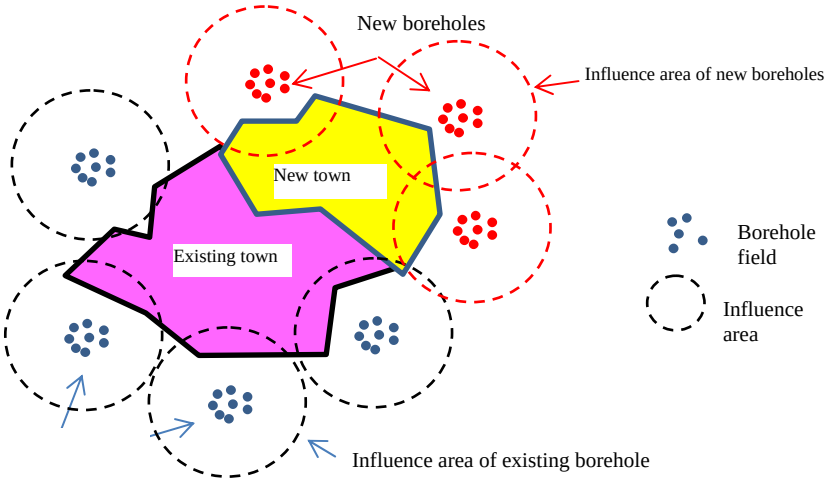
Concept of groundwater development for municipal water supply is proposed as shown in Table 2-35.

Table 2-35 Concept of Groundwater Development for Municipal Water Supply

Classification	Concept of Groundwater Development
Urban/semi-urban, small town	Well fields will be constructed around urban/semi-urban/small town area, supplying water by independent water supply system with well field. See Figure 2-21.
Rural	Boreholes will be constructed individually for water supply for communities using hand-pumps and motorized pumps. Ratio between hand pumps and motorized pumps is estimated as 4:6. This ratio is assumed to be kept until year of 2030.

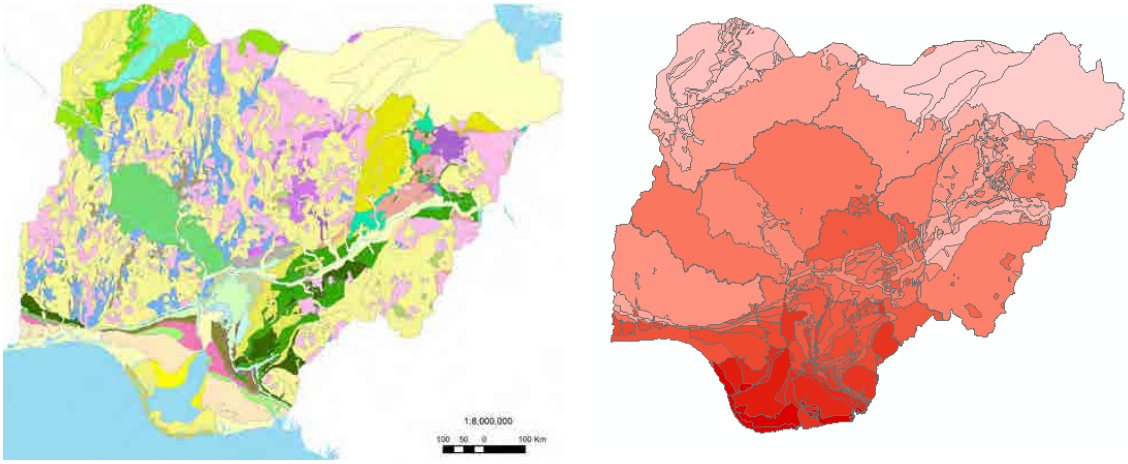
Source: JICA Project Team

Borehole field will be planned for each LGA, with the conceptual scheme shown in Figure 2-21. The factors to be considered in planning borehole field are shown in Figure 2-22. Distribution of groundwater recharge and aquifer was considered by LGA.



Source: JICA Project Team

Figure 2-21 Conceptual Scheme of Municipal Water Supply by Borehole Field



(a) Aquifer classification (b) Groundwater recharge

Source: JICA Project Team

Figure 2-22 Content of Factors to be considered in Groundwater Development Plan

Optimum Yield of Borehole Field

Optimum yield of borehole field is shown in Table 2-36. Number of boreholes will be made minimum by optimum yield.

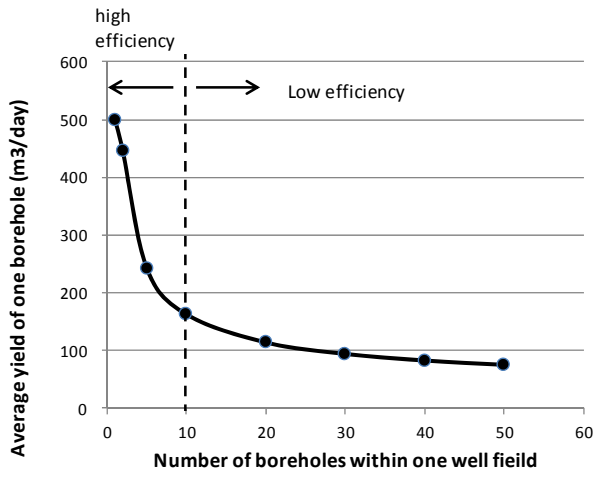
Table 2-36 Optimum Yield of Borehole Field

Aquifer type		Urban/semi urban/small town		Rural			
		Motorized pump		Motorized pump		Hand pump	
		Optimum yield of boreholes field (m^3/day)	Population to-be-supplied (persons)	Optimum yield of boreholes field (m^3/day)	Population to-be-supplied (persons)	Independent borehole (m^3/day)	Population to-be-supplied (persons)
WH	Weathered rocks	1,000	10,000	Less than 150	Less than 5,000	10	Less than 300
WM		500	5,000				
WL		400	4,000				
MH	Sedimentary rocks	1,500	15,000				
MM		1,000	10,000				
ML		900	9,000				

Note) Optimum borehole yield for rural water supply will be decided not by aquifer capacity but by community population
Source: JICA Project Team

Number of Boreholes by Borehole Field

As number of boreholes increases, available yield from each borehole will decrease as shown in Figure 2-23. Therefore, 10 boreholes should be max in each borehole filed for high efficiency in economical view pint.



Source: JICA Project Team

Figure 2-23 Number of Boreholes and Yield from each Borehole in Borehole Filed

Borehole Specification

Borehole specification is shown in Table 2-37. Borehole specification depends on aquifer type.

Table 2-37 Borehole Specification

Aquifer Type	Urban/small urban/small town		Rural			Note
	Motorized pump		Motorized pump	Hand pump	Borehole diameter (inch)	
	Borehole Depth (m)	Borehole Dia. (inch)	Borehole Depth (m)	Borehole Dia. (inch)		
WH	50	6	50	50	6	Distance between boreholes in borehole filed is 200m
WM	50	6	50	50	6	
WL	50	6	50	50	6	
MH	200	6	200	50	6	
MM	200	6	200	50	6	
ML	200	6	200	50	6	

Source: JICA Project Team

Relationship between Yield by Rehabilitated Boreholes and Newly Drilled Borehole

Amount of groundwater by newly drilled boreholes will be estimated form relationship below, considering available yield by borehole rehabilitation

Amount of groundwater by newly drilled boreholes	=	Amount of groundwater to be developed by 2030	-	Amount of groundwater by rehabilitated boreholes

Borehole Drilling and Rehabilitation Plan

Based on method explained above, optimum borehole construction plan was examined by LGA and finally arranged by State as shown in Table 2-38.

Table 2-38 Number of newly Drilled Boreholes and Rehabilitated Boreholes to meet Water Demand of 2030

State		Number of newly drilled borehole							Number of rehabilitated borehole		
		Urban/SU./ST			Rural				Urban/SU/ST.	Rural	
		Motorized pump			Motorized pump			Hand pump	Motorized pump	Motorized pump	Hand pump
		200m	50m	total	200m	50m	total				
1	Abia	108	215	323	78	63	140	1,217	170	14	73
2	Adamawa	29	546	575	50	295	345	3,116	43	3	179
3	Akwa Ibom	133	45	178	215	34	249	2,242	214	34	0
4	Anambra	71	76	147	189	54	243	2,266	144	11	40
5	Bauchi	141	333	474	234	270	504	4,661	170	20	332
6	Bayelsa	208	0	208	56	0	56	542	32	59	0
7	Benue	16	218	234	23	326	349	3,066	71	18	620
8	Borno	353	303	656	311	106	418	3,910	172	11	165
9	Cross River	18	161	179	40	145	185	1,595	186	98	0
10	Delta	208	0	208	178	0	178	1,612	94	10	269
11	Ebonyi	0	0	0	4	203	206	1,867	0	4	180
12	Edo	145	234	379	139	95	234	2,078	0	0	204
13	Ekiti	0	101	101	0	88	88	792	25	11	123
14	Enugu	95	1,180	1,275	79	165	244	2,087	70	19	59
15	Gombe	33	525	558	53	169	221	2,011	419	8	873
16	Imo	212	243	455	226	98	324	3,014	233	49	102
17	Jigawa	317	210	527	176	49	225	2,044	147	0	1,697
18	Kaduna	2	168	170	1	246	248	2,298	105	71	897
19	Kano	26	542	568	115	596	711	6,804	281	15	886
20	Katsina	335	975	1,310	143	325	468	4,328	234	61	709
21	Kebbi	228	278	506	161	109	270	2,317	240	55	750
22	Kogi	95	374	469	79	154	233	2,085	127	19	219
23	Kwara	19	200	219	13	73	85	759	91	16	422
24	Lagos	0	0	0	33	0	33	286	0	1	335
25	Nasarawa	22	110	132	29	90	119	937	242	50	340
26	Niger	179	184	363	129	134	263	2,272	36	5	749
27	Ogun	0	0	0	154	73	226	1,925	0	12	77
28	Ondo	20	185	205	54	153	206	1,869	189	51	341
29	Osun	0	146	146	0	140	140	1,200	34	19	208
30	Oyo	2	89	91	6	251	258	2,386	0	28	510
31	Plateau	12	347	359	25	299	324	2,926	39	6	180
32	Rivers	322	0	322	309	0	309	2,956	111	8	346
33	Sokoto	246	539	785	150	45	195	1,580	294	89	409
34	Taraba	15	430	445	33	238	270	2,470	39	6	84
35	Yobe	183	99	282	183	20	203	1,808	511	61	422
36	Zamfara	39	337	376	64	194	258	2,408	37	6	280
37	FCT Abuja	25	1,397	1,422	10	74	84	804	80	1	284
Total		3,857	10,790	14,647	3,736	5,369	9,105	82,538	4,880	949	13,364

Remarks: SU: Semi-Urban, ST: Small Town
Source: JICA Project Team

Number of newly drilled boreholes for motorized pump is 15,361 for water supply of urban/small urban/small town, 9,105 for rural water supply. On the other hand, number of hand pumps is 82,538 for rural water supply.

(4) Issues on Groundwater Development and Management

Groundwater is mainly used for sources for water supply in Nigeria. Issues of groundwater development and management are described below:

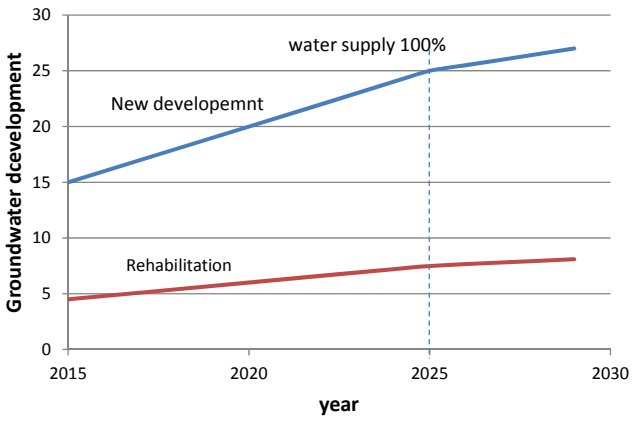
- Groundwater recharge (by means of recharge dams along rivers in the northern part affected by little precipitation and high evapotranspiration)
- Issue in rural water supply
  Low successful rate of borehole (50-70% in basement complex area), groundwater contamination (high Cl and NO_3 due to domestic waste water)
- Issue in urban water supply

Lowering of groundwater level and land subsidence by over pumping (coastal plain of southern part. no monitoring data), sea water intrusion (coastal line in southern part. over pumping in large cities), groundwater contamination (waste water in industrial zone, such as Lagos)

- Salty groundwater within sedimentary rocks in Benue Basin
- Groundwater contamination of mining area (harmful mining residue)
- Groundwater level lowering and drought
- Shift from Hand Pump to Motorized Pump (maximum utilization of groundwater potential)

(5) Project Implementation Schedule

After the preparation period of in 2014, groundwater development will be implemented during 2015 to 2029 with the same rate, and will be completed in 2030. Conceptual scheme of groundwater development is shown in Figure 2-24.



Source: JICA Project Team

Figure 2-24 Conceptual Scheme of Groundwater Development by Step

Amount of groundwater development is different state by state. Annual average number of rehabilitated boreholes and new drilled boreholes by year is shown in Table 2-39 and Table 2-40 respectively.

Table 2-39 Annual Average Number of Rehabilitated Boreholes by Year (Nationwide)

Urban/small urban/small town	Rural	
Motorized pump	Motorized pump	Motorized pump
325	62	892

Source: JICA Project Team

Table 2-40 Annual Average Number of Newly Drilled Boreholes by Year (Nationwide)

Urban/semi urban/small town			Rural			
Motorized pump			Motorized pump			Hand pump
200m	50m	Total	200m	50m	Total	
255	719	978	252	359	611	5,502

Source: JICA Project Team

2.6.2 Surface Water Development Plan

(1) Current Condition of Surface Water Development

(1-1) Existing Surface Water Development Facilities

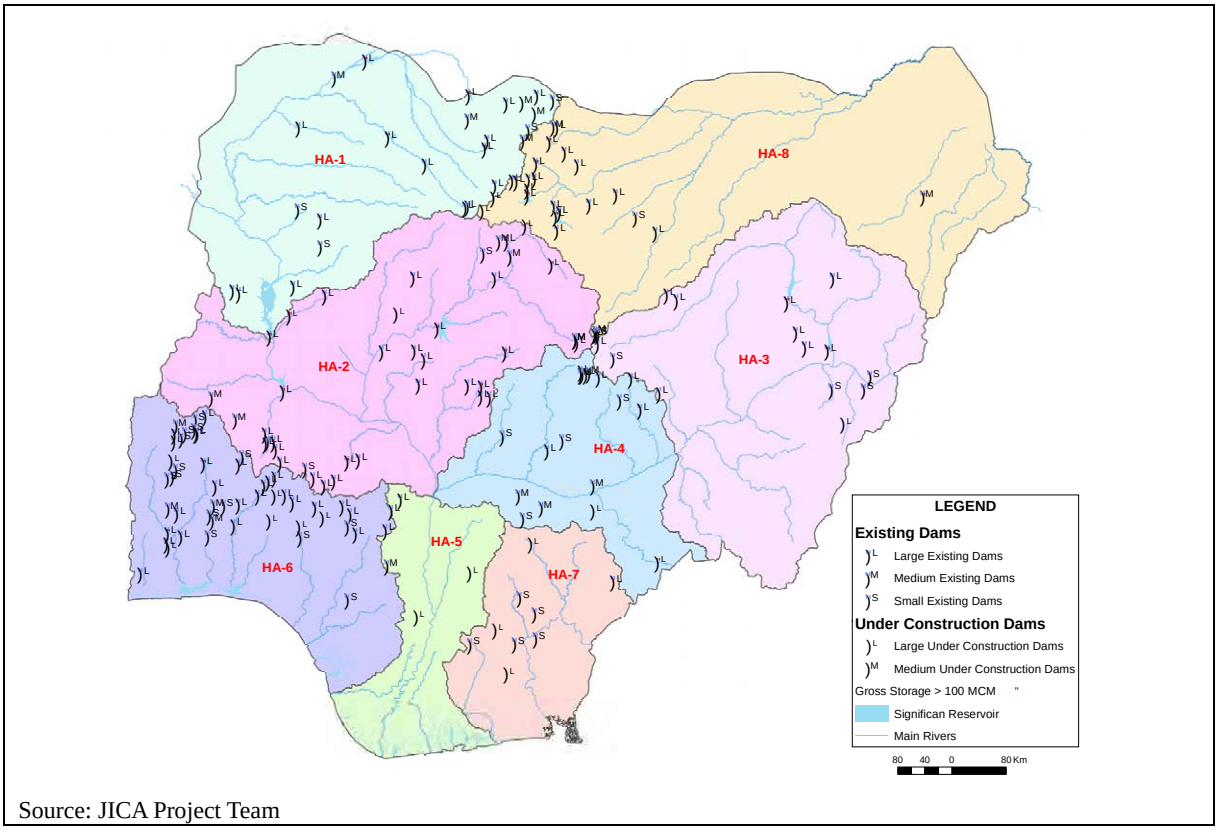
The total number of existing dams in Nigeria, which the project could confirm mainly on the basis of the following documents, is 171. The location of these dams is shown in Figure 2-25.

- FMWR: Nigeria Register of Dams, 1995.
- FMWR: Compendiums of Nigerian Dams, 2007.
- NIWRMC: Inventory of Water Infrastructure Project in Nigeria, Appendix II, 2010.

The total storage capacity is 37.4BCM. Among it, 25.8BCM is associated with large hydropower dams such as Kainji, Jebbe and Shiroro. The remaining storage of 11.6BCM is mainly used for irrigation and municipal water supply. The average effective storage is about 78% of the total storage capacity.

(1-2) Dams under Construction

According to Dam Department of FMWR, the number of dams under construction is about 30 and their total storage volume is 1.5BCM. It coincides the incremental storage volume that is set at mid-term target in Water Sector Roadmap. The representative dams of which storage volume is large are Kashimbilla, Galma and Kontagora (Auna) dams. The location of dams under construction is shown in Figure 2-25.



Source: JICA Project Team

Figure 2-25 Location of Existing and Under-Construction Dams

(1-3) Survey on Management Status of Selected Existing Dams

The results of the survey on management status of selected existing dams (26 dams) for the MP2013 and CMPs are summarized in Table 2-41.

Table 2-41 Summary of Survey on Management Status of Selected Existing Dams

Item		Status
Management status of operation data		Many important data has not been managed and recorded except for the part of the dam
Status of dam body, facilities and reservoir	The water quality of reservoir	Recognition for water quality is high.
	Sedimentation of reservoir	Recognition for sedimentation is high.
	The safety of the dam body	There are some problems of dam crack and the vegetation in many dams. Heavy damage in the arid HA-1 and HA-8 is found particularly
	Spillway	The structure of the spillway itself and related facilities seems to have been managed relatively well. However, the discharge capacity needs to be checked carefully.
	Administrative road	Some of the dam is in poor conditions.
Reservoir operation record		Supplying capacity for the dry season is determined by the storage of the rainy season, the storage operation is forced to operate difficultly. There is also a dam that does not recover to full water although the turnover rate is low.

Source: JICA Project Team

(1-4) Related Mattes on Large Dams

There are two on-going large scale hydropower development projects by FMP: Manbilla HPS (Max power: 3,050MW), Zungeru HPS (Max power:700MW).

On the other hand, the discussion on the possibility of the construction of Dasin Hausa dam at around border between Nigeria and Cameroon has been starting. It is a multi-purpose water resources

development project including hydropower, irrigation and inland water navigation, of which pre-feasibility study was conducted in 1982. In 2008, a feasibility study was conducted and economic evaluation was done except for irrigation component. The storage capacity and surface area of the dam is 16BCM and 1,530km^2, respectively. About 70% of the inundation area by the dam is located in the territory of Cameroon. It is said that there could be almost 100,000 people who are required to be resettled.

After the severe flood along the Benue River in 2012, the buffer function of Dasin Hausa dam against flood is attracted. The discussion between Nigeria and Cameroon Government on possibility of construction of Dasin Hausa dam has just started for exploring mutual benefit for both countries.

(2) Issues on Surface Water Development

The issues on surface water development are described below:

- Increasing water demand (population growth, revitalization of industry activities)
- Unevely distributed water resources (hydrological condition varies very much area by area.)
- Existing dams without keeping original function (poor operation and maintenance)
- Non-implementation of water resources development proposed in M/P1995

(3) Strategy on Surface Water Development

The strategy on surface water development is set based on the issues as shown in Table 2-42.

Table 2-42 Strategy on Surface Water Development

Objective	Strategy
Effective Utilization of Existing Dams	Many of the existing dams do not keep their original functions, because of lack of proper operation and maintenance including management of information on reservoir operation. It is necessary to revive these dams urgently, for preparing the expected increase in the water demand. The followings are considered. ● Enhancement of dam management, including preparation of manual for dam management ● Rehabilitation of dams ● Enhancement of dam operation
Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country	The necessary water resources development would be proposed by utilizing the proposed dams in M/P1995 as the potential dams as well as the other potential sites. ● By examining water balance for the potential dam sites, efficiency of each site is roughly evaluated. The priority for development should be given to the sites with higher efficiency. ● In the area where water resources is very limited and the future demand is expected to be more than the supply capacity of water source, the demand control such as reduction of the planned irrigation area and/or changing the crop should be considered as one of options for managing the available water, in order to avoid the conflict among water users. ● The integrated development with hydropower generation and irrigation components is proposed in order to promote self-reliant project.

Source: JICA Project Team

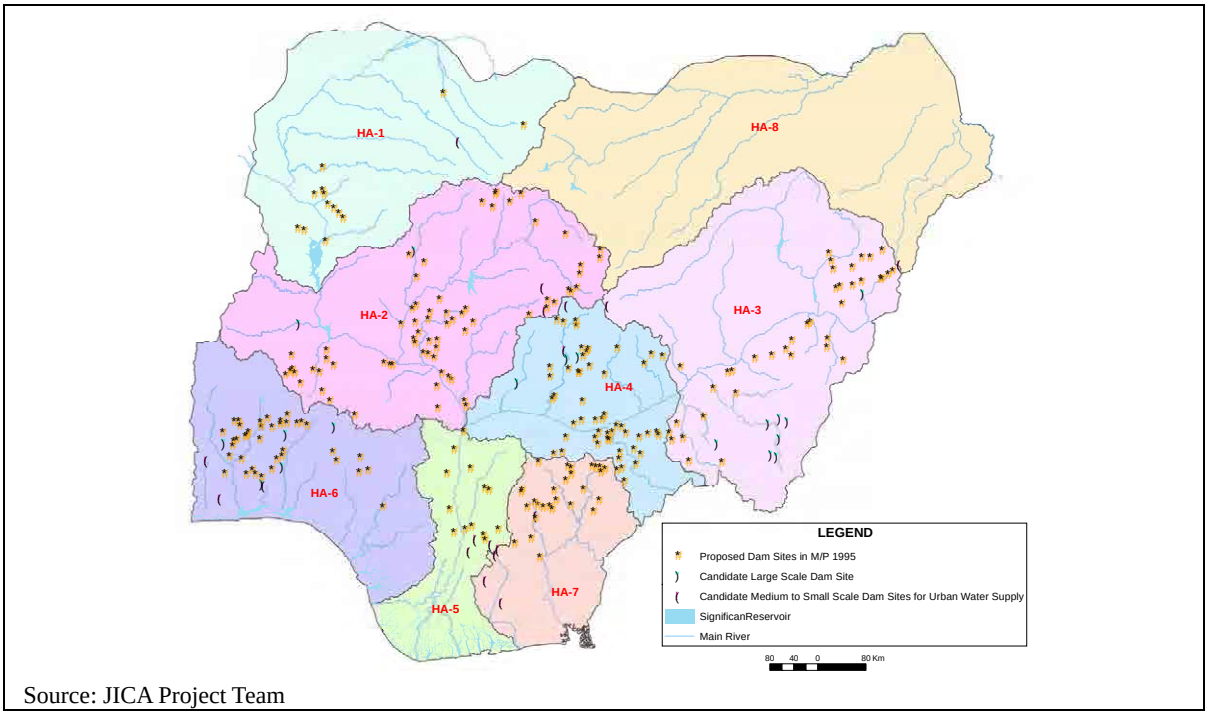
(4) Potential Sites for Surface Water Source Development

In addition to the proposed dam sites in the M/P1995, i) candidate sites for large scale dam, ii) candidate small to medium scale dams sites for municipal water supply, were examined and added as potential sites for surface water source development. The total number of the potential sites is 288 in total (refer to Table 2-43). The location of potential sites is shown in Figure 2-26.

Table 2-43 Potential Surface Water Source Development Sites

Type	Number	Total Storage Capacity (BCM)
Proposed dam sites in the M/P1995	252	7.35
Candidate sites for large scale dam	18	7.46
Candidate small to medium scale dam sites for municipal water supply	18	0.24

Source: JICA Project Team



Source: JICA Project Team

Figure 2-26 Location of Potential Sites for Surface Water Development

(5) Proposed Projects

The proposed projects are shown in Table 2-44, in consideration of the strategy.

Table 2-44 Proposed Surface Water Development Project

Objective	Proposed Project	
Effective Utilization of Existing Dams	1-1	Capacity development of dam management
	1-2	Rehabilitation of equipment for proper operation of major dams
	1-3	Rehabilitation of deteriorated dams
Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country	2-1	Surface water development for municipal water supply
	2-2	Surface water development for irrigation development
	2-3	Integrated surface water development

Source: JICA Project Team

Project 1-1: Capacity Development of Dam Management

The direction of improvement of dam management is discussed in Section 2.8 as one of important elements of water resources management. This project is to enhance the capacity of dam department of FWMR, as well as dam owners such as RBDAs, SWA on dam management. The duration of the project is proposed to be three years.

Project 1-2: Rehabilitation of Equipment for Proper Operation of Major Dams

This project is to rehabilitate the equipment for proper operation of dams such as meteorological, hydrological mentoring, monitoring for reservoir operation. The integrated usage of monitoring data of river flow by NIHSA and dam operation data by dam owner should be considered.

Project 1-3: Rehabilitation of Deteriorated Dams

This project is to rehabilitate deteriorated dam which may threaten the downstream area. The rehabilitation would be implemented case by case up to 2030. The detail conditions should be studied for individual dam and accordingly the countermeasure would be implemented.

Project 2-1: Surface Water Development for Municipal Water Supply

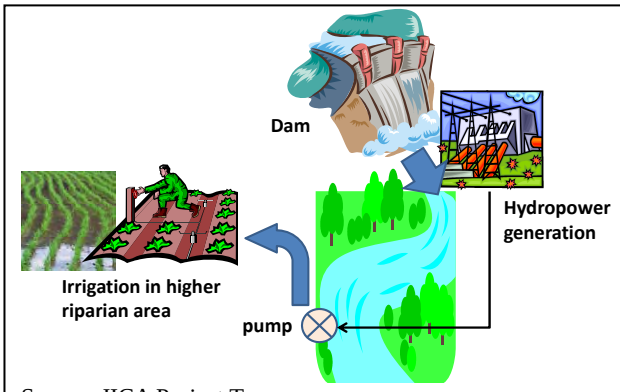
This project is to prepare stable water source for municipal water supply against the water source where the safety level is expected to be lower than 90% year dependability in 2030. On the basis of the results of water balance study shown in Section 2.5, the surface water source development projects (23dams/weir) are proposed. The total storage capacity of the proposed dams is 381MCM.

Project 2-2: Surface Water Development for Irrigation Development

This project is to secure necessary water volume for irrigation development, according to irrigation development plan proposed in the M/P2013. On the basis of the results of water balance study shown in Section 2.5, the surface water source development projects (21 dams) are proposed. The total storage capacity of the proposed dams is 969MCM.

Project 2-3: Integrated Surface Water Development

This is an integrated project to combine hydropower generation and irrigation development. Necessary energy for pumping for supplying irrigation water is provided internally by the generated energy in the project so as to secure self-reliance and sustainability of the project (refer to Figure 2-27). Three project sites along the Benue River are proposed as shown in Table 2-45. The total storage volume of the proposed dams is 960MCM. It should be noted that the scale of dam and hydropower equipment are tentatively set at this moment. In the next step, the optimum scale and combination of component should be examined in detail.



Source: JICA Project Team

Figure 2-27 Schematic Drawing on Integrated Surface Water Development

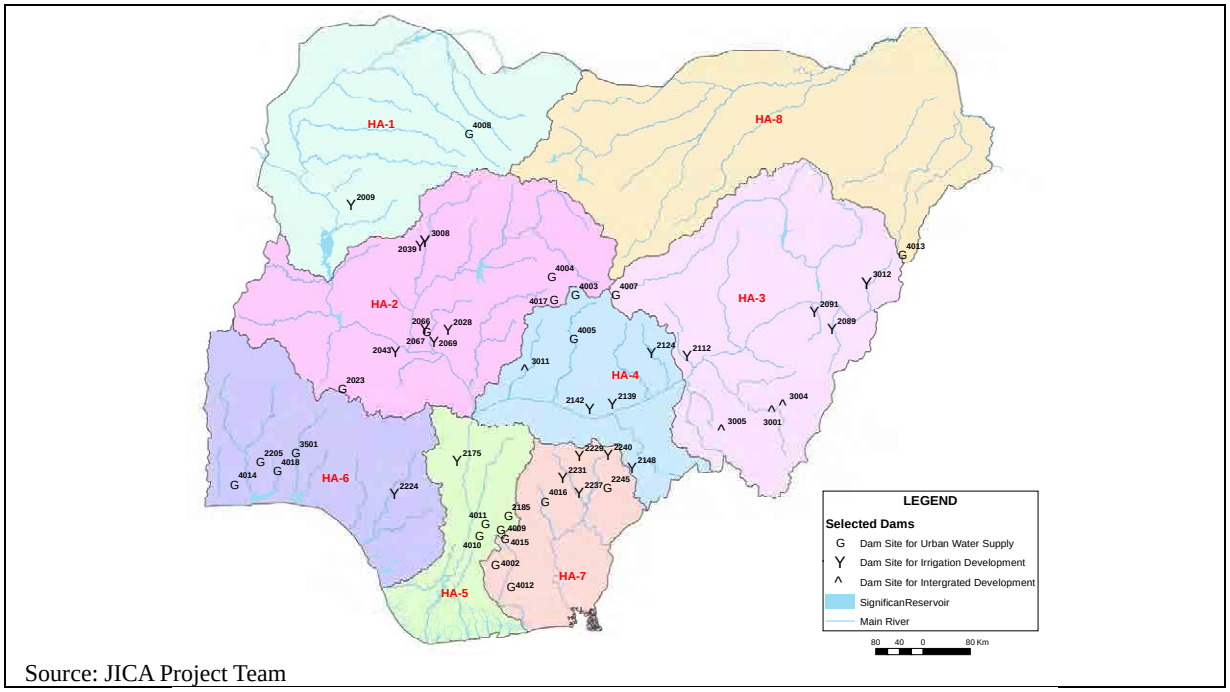
Table 2-45 Integrated Surface Water Development

No	Project	HA	State	Irrigation/Hydropower scheme	Dam SN	H (m)	GS(MCM)
1	Nasarawa Integrated Project	4	Nasarawa	New Irrigation scheme: 19,000ha Hydropower 4MW ; Total generate energy 29GWh/year Required energy for irrigation 2GWh/year Excess energy 27GWh/year	3011	24	30
2	Taraba integrated project	3	Taraba	New Irrigation scheme: 45,000ha Hydropower 9MW ; Total generate energy 67GWh/year Required energy for irrigation 22GWh/year Excess energy45GWh/year	3001 3004	37 39	240 290
3	Donga-Suntai Integrated project	3	Taraba	New Irrigation scheme: 35,000ha Hydropower 9MW ; Total generate energy 60GWh/year Required energy for irrigation 37GWh/year Excess energy 23GWh/year	3005	78	400

Remarks:
1) The size of dam is set so as to provide necessary water for hydropower generation for pumping as well as irrigation water supply with 1/5 safety level.
2) The capacity of hydropower equipment is set so as to maximize the net benefit (benefit-cost) under the following assumptions with keeping the necessary capacity for pumping of irrigation water.
Assumptions: a) Overall efficiency of hydropower generation=0.7, b) project cost of installation of hydropower equipment=2.53mil.US$/MW, c) Project duration=50year, d) Replacement of equipment=every 20year, e) O&M cost=0.5% of project cost /year, f) Discount rate=10%, and g) Selling price of electricity=0.05US$/kWh.
SN=Serial number of dam, H=Height of dam, GS=Gross storage
Source: JICA Project Team

Remarks on Selected Dams Sites

The selection of the dam sites is based on the preliminary study during the formulation of the M/P2013 (see Figure 2-28). It should be noted that the proposed schemes are conceptual level, and thereby further detail study would be required for their implementation.



Source: JICA Project Team

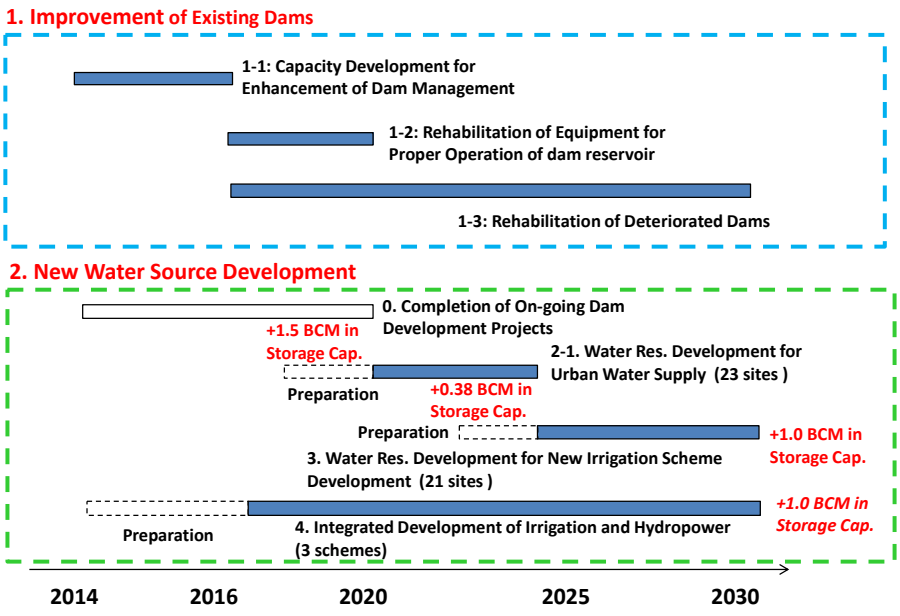
Figure 2-28 Selected Dam Sites for Surface Water Source Development

(6) Possibility of Hydropower Generation in Surface Water Source Development Projects for Municipal Water Supply and Irrigation Development

The dam operation for the water source development projects for municipal water supply and irrigation development basically follows the requirement from municipal and irrigation water users. So, even if hydropower equipment is installed, its operation should follow the release based on the requirement by other water users. How much energy can be generated in these cases is roughly examined by utilizing the results of water balance study. It is assumed that the installed capacity of hydropower equipment is determined so as to maximize the net benefit (benefit-cost). As a result, the total installed capacity and generated energy could be 4.6MW and 30GWh, respectively. It is recommended that more detail study be conducted when each project will be implemented.

(7) Proposed Implementation Schedule

It is proposed that the surface water surface water source development be implemented step by step as shown in Figure 2-29.



Source: JICA Project Team

Figure 2-29 Proposed Implementation Schedule for Surface Water Source Development

2.6.3 Water Resources Conservation Plan

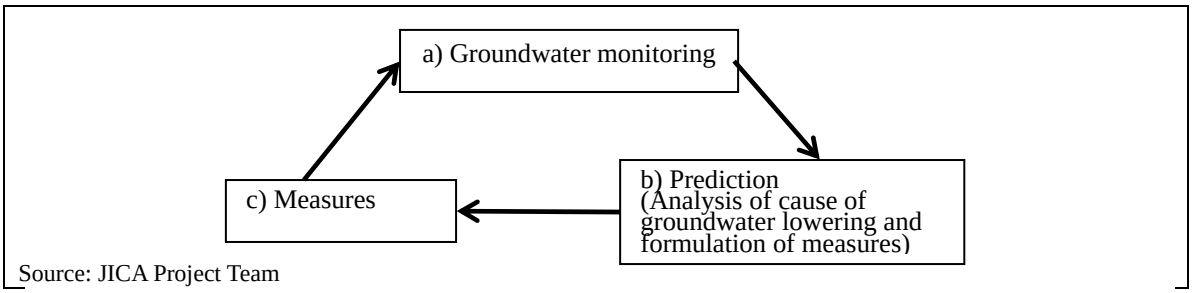
(1) Groundwater Conservation

(1-1) Purpose and Importance of Groundwater Conservation

Groundwater must be conserved in terms of quantity and quality for sustainable groundwater usage. Groundwater management is indispensable for groundwater conservation.

Quantity conservation

When groundwater is extracted more than groundwater recharge, regional groundwater level lowering will occur, which will cause decrease in pumping yield or drying up of boreholes and land subsidence. To prevent such problems, cycle of a) monitoring, b) prediction and c) measures must be continuously implemented as show in Figure 2-30. NIWRMC and CMO should take responsibility of implementation of the cycle below.



Source: JICA Project Team

Figure 2-30 Concept of Groundwater Management Comprising Monitoring, Prediction and Measures

Quality conservation

Groundwater will be contaminated when contaminated surface water infiltrate into aquifer. When sea water has intruded into aquifer, groundwater will become salty. Type of groundwater contamination is shown in Table 2-46.

Table 2-46 Type of Groundwater Contamination and Measures against It

Type of groundwater contamination		Cause	Measures
Man-made contamination	Sea water intrusion into aquifer	Over pumping	Legal control of pumping
	Infiltration of domestic and industrial waste into aquifer	• Lack of sewerage system • Low quality borehole construction work • Illegal dumping waste into borehole	• Improvement of sewerage system • Perfect sealing of borehole casing • Legal control of dumping
Contamination originated from geology	Groundwater contamination by harmful minerals in underground layer	• Shale with salty minerals • Harmful materials by mining activity	Identification of contaminated aquifer and prohibition of extraction from it

Source：JICA Project Team

(1-2) Method of Groundwater Management for Conservation

Method of groundwater management for conservation should be formulated place by place based on local hydrogeological characteristics and water use condition. However, standard method should be employed as basis of groundwater management for each case. It is proposed that groundwater management should be implemented by NIWRMC and NIHSA for entire Nigeria following the standard method as shown below.

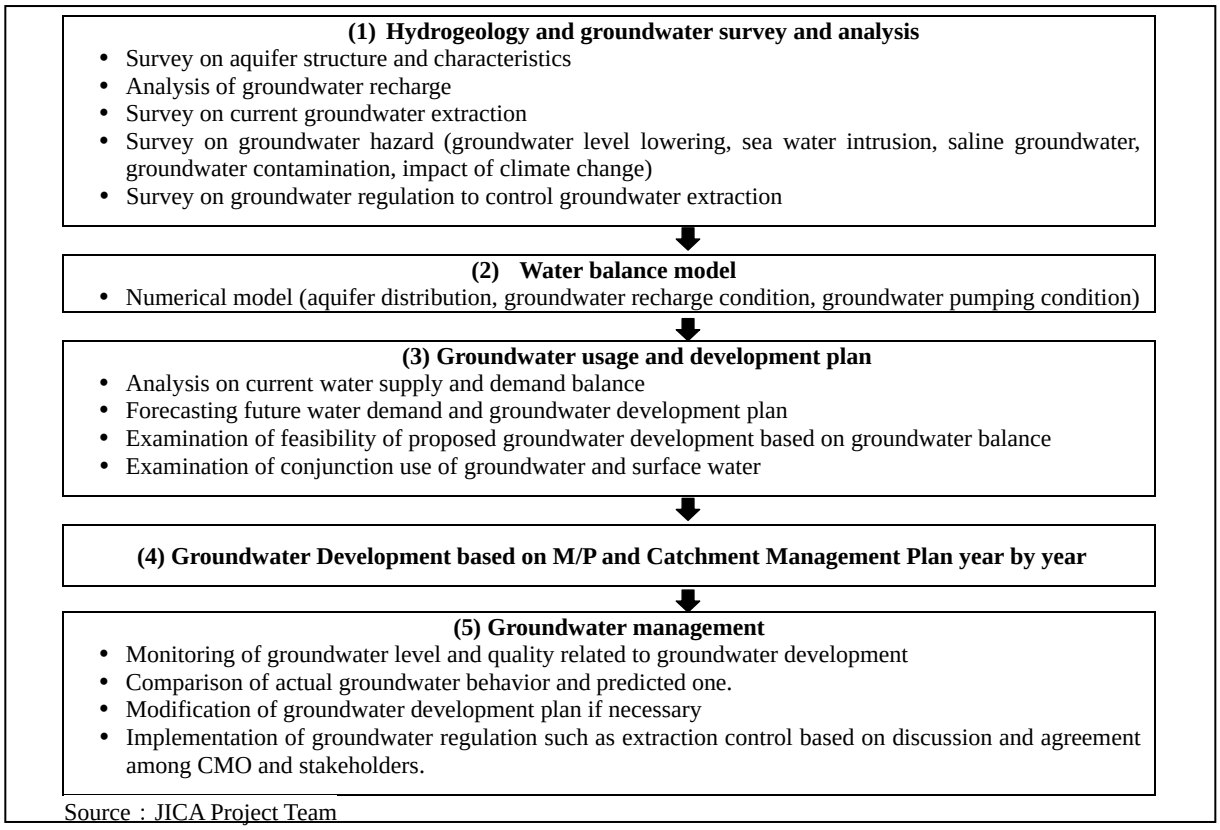
Groundwater management plan should take into account scale of target aquifer. Scale of aquifer can be classified as a) Large, b) Medium, c) Small, d) local, and management method should be decided corresponding to above classification as shown in Table 2-47.

(1-3) Institutional Issue on Groundwater Management

Institutional improvement is necessary to resolve issues above. NIWRMC should implement activities below.

- Registration of borehole
- Permissible groundwater level
- Formulation of Groundwater management manual

- Information sharing among organizations in charge of groundwater management and groundwater users.
- Registration system of borehole drilling company



Source：JICA Project Team

Figure 2-31 Method for Groundwater Management and Development

Table 2-47 Groundwater Management Plan and Responsible Organization

Scale of Area		Plan	Purpose of management	Responsible organization
a) Large	Multiple Catchment level	• National Water Resources MP • CMP	Groundwater Basin Management	• NIWRMC • CMO • NIHSA
b) Medium	Catchment level	State Management Plan	• Allocation of groundwater extraction • Allocation of borehole density • Measures against groundwater hazard (sea-water intrusion, land subsidence, groundwater contamination)	
c) Small	LGA level			• State Gov. • LGA
d) Local	Community level		• Securing necessary yield for communities • Setting adequate yields of individual borehole • Setting enough distance among boreholes to prevent borehole interference • Measures against groundwater contamination	

Source: JICA Project Team

(2) Conservation of Surface Water Source

(2-1) Issues on Conservation of Surface Water Source

Table 2-48 summarizes the issues on conservation of surface water source.

(2-2) Proposed Mechanism for Conservation of Surface Water Source

Conservation of surface water resources would be implemented inside dams and reservoirs as well as in a watershed area (see Figure 2-32). Both activities are related each other. The former is a part of the dam management activities, and will thereby be proposed to be enhanced together with the measures for the recovering and upgrading function of the existing dams. This is mainly implemented by dam owners. On the other hand, the latter needs cooperation among wider range of stakeholders in a watershed, which deals with environment management, water quality management, erosion control and so.

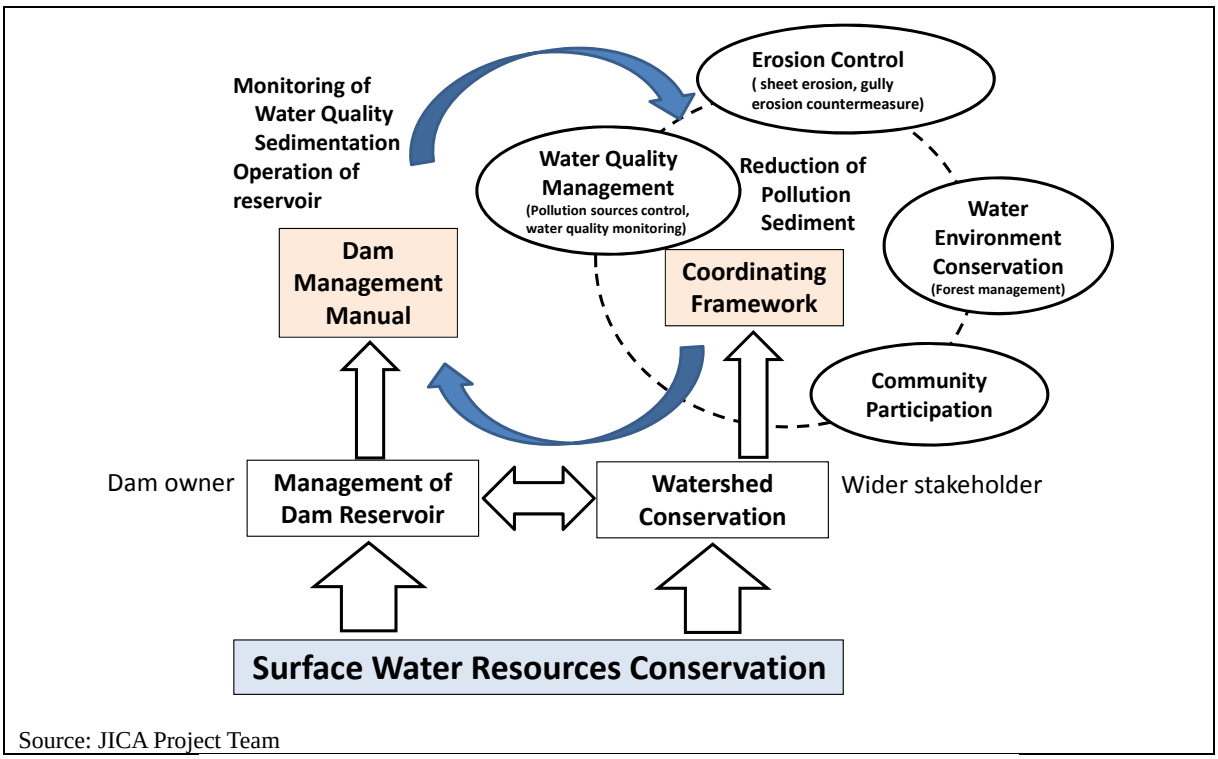
(2-3) Responsibilities of Main Stakeholders in Proposed Mechanism for Conservation of Surface Water Source

It is proposed that NIWRMC be responsible for coordinating the activities by various stakeholders through formulation and implementation of Catchment Management Plan (CMP) at each hydrological area. The workable mechanism on the cooperation among stakeholders in a catchment level should be explored during the formulation of the draft Catchment Management Plan (CMP).

Table 2-48 Issues on Conservation of Surface Water Source

Important Issues	Recommendations
Point Sources of Pollution	
There is a poor enforcement of Laws, regulations and standards to control water pollution in the country	The enforcement of Laws, Regulations and Standards to control discharges of effluents (liquid & solid) into the environment needs to be improved.
Lack of awareness of the people on environmental issues, therefore not collaboration from them to avoid water pollution	Environmental education and awareness campaign on water resources protection from pollution must be implemented for primary & secondary schools and for the general public.
Lack of coordination or cooperation among relevant institutions for water pollution control	A memorandum of understanding should be promoted among FME, FMWR and State Governments to prioritize programs for water pollution control of water sources used as domestic source.
In the rural communities of Nigeria are very common the activities of mining at artisanal and small-scale levels. However, most of these activities do not follow good mining practices resulting in water pollution	A joint-work between NESREA, FMM and FMWR is proposed to assess the impact of mining activities into the water sources, in order to determine possible countermeasures.
Non-Point Sources of Pollution	
Fertilizer and pesticide cause water pollution in surface water and in aquaculture farming ponds	Proper use of fertilizer and pesticides is recommended to diminish pollution of water courses. Drainage of water from farm land should not be discharged into aquaculture farming pond due to its high impact on aquatic life.
In many urban cities of Nigeria can be observed illegal disposal of solid waste which are transported into rivers during heavy rain	Solid waste management needs to be improved in the country to avoid pollution of watercourses or water sources.
Soil Erosion	
The distribution of soil erosion site is sporadic; consequently, it is necessary to carry out a lot of small scale countermeasure in the country, however, often said because of lack of fund not sustainable.	Risk assessment in nationwide in order to prioritize the critical projects to be implemented
Currently, most of the erosion control has been done for the countermeasures in the area related to people's living condition such as keeping of transportation route, protecting of residential area and mitigating soil erosion into drainage. In Nigeria there is few attention to the watershed conservation in which it takes long time the result of countermeasure prevails.	• Environmental education and awareness campaign on water resources protection • Risk assessment in nationwide in order to prioritize the critical projects to be implemented among wide range of watershed size.
Dams/Reservoirs	
The presence of aquatic plants in dams and reservoir is of great concern that must be addressed. It is considered a nuisance since interfere in the normal operation of the dams. The introduction of nutrients such as P and N promotes the proliferation of this nuisance.	Aquatic plant control programme was implemented by FME for many dams until 2011. A continuation of that programme is under preparation by FME. It is proposed to make a joint-work between FME and FMWR for the recovery of affected dams by aquatic plants
Surveyed dams in this Study present problem of sedimentation and this has direct effect in their storage capacity.	Actions to control sedimentation effectively are necessary to be implemented such as: • Risk assessment in nationwide in order to prioritize the critical projects to be implemented among wide range of watershed size. • Economic comparison between dredging in reservoir and soil erosion countermeasures in each watershed

Source: JICA Project Team



Source: JICA Project Team

Figure 2-32 Framework of Conservation of Surface Water Source

2.7 Water Resources Sub-Sector Development Plan

2.7.1 Water Supply and Sanitation Development Plan

In order to correspond to increase in future water demand, the Project plans to improve low production efficiency of existing facilities using surface water in the short term and operating ratio of existing facilities using groundwater in the entire period, and furthermore to develop new facilities to be required additionally.

Water Supply development plan consists of the following two major components.

- Rehabilitation scheme of existing facilities
- New construction scheme of facilities (including expansion)

(1) Current Status of Water Supply and Sanitation

(1-1) Nationwide Water Supply and Sanitation Coverage

Water supply and sanitation coverage published in late years vary in existing policies, studies and documents, as shown in Table 2-49. According to the Water Sector Roadmap 2011, the Federal Ministry of Water Resources (FMWR) accepted the coverage calculated by WHO/UNICEF Joint Monitoring Programme (JMP) in 2008 as the latest coverage.

The Project utilizes the results of Core Welfare Indicators Questionnaire Survey (CWIQ), 2006 for water demand projection, because it shows water supply coverage by water supply category at the state level, and its nationwide coverages do not differ much from JMP, 2008. As a result of summation of population served by Local Government Area (LGA), nationwide water supply coverage estimated by the Project becomes 56.2%, and 72.2% for urban and 39.9% for rural (51.3% for semi-urban/small-town), as baseline values of the Project.

As for Sanitation, the Project applies the results of National Demographic and Health Survey (NDHS) as baseline values of the Project, because it shows sanitation coverage at the state level.

Table 2-49 Recent Water Supply and Sanitation Coverages and Estimate by the Project

Coverage (%)		1990 JMP	2000 NWSSP	2006 JMP	2006 CWIQS	2006 NWSSBS	2007 MICS	2008 NDHS	**2008 JMP**	**2011 JICA-M/P**
Water	Urban	80.0	48.0	65.0	73.4	69.3	75.7	75.0	**75.0**	**72.2**
	Rural	34.0	39.0	30.0	40.0	49.9	37.4	45.0	**42.0**	**39.9**
	National	50.0	-	47.0	51.4	54.3	49.1	56.0	**58.0**	**56.2**
Sanitat	Urban	33.0	-	35.0	77.0	85.2	70.0	31.0	**36.0**	**31.0**
	Rural	22.0	-	25.0	47.6	59.6	31.0	25.0	**28.0**	**25.0**
	National	26.0	-	30.0	57.6	65.6	42.9	27.0	**32.0**	**27.0**

Source:
JMP: Joint Monitoring Programme (WHO and UNICEF)
NWSSP: National Water Supply and Sanitation Policy (FMWR)
CWIQS: Core Welfare Indicators Questionnaire Survey (National Bureau of Statistics: NBS)
NWSSBS: National Water Supply and Sanitation Baseline Survey (FMWR)
MICS: Multiple Indicator Cluster Survey (National Bureau of Statistics: NBS)
NDHS: National Demographic and Health Survey (National Population Commission: NPC)

(1-2) Operational Situation of Public Water Supply Facilities

Common composition of public water supply facilities in Nigeria are generally as shown in Table 2-50, categorized by water supply type based on population size, but these facilities exist often in parallel in urban, semi-urban and small town. Furthermore, a number of household and private estate have or share own water source nationwide, and most of them are facilities rely on groundwater such as borehole equipped with handpump or small motorized pump.

Table 2-50 Common Composition of Public Water Supply Facilities

Water Supply Type		Main Water Source	Common Composition of Facilities
1	Urban	Surface Water mainly but also groundwater	Water treatment works, pump and booster, pipeline, house/yard connections and standpipes.
2	Semi-Urban or Small Town	Groundwater mainly but also surface water or distribution from urban water facilities	Chlorination if needed, motorized pump, reservoir, pipeline, standpipes, and house/yard connections.
3	Rural	Groundwater	Handpump, 250m radius, 250-500 beneficiaries per point. And also, small piped facilities with motorized pump, elevated tank, and standpipes.

Source: JICA Project Team

Water Supply Facilities using Surface Water

Table 2-51 shows summary of existing public water supply facilities using surface or subsurface water, mostly treatment facilities verified by the Project. To a greater or lesser, more than 240 treatment facilities or equivalent of surface or subsurface water exist in Nigeria, and the proportion of actual production to designed capacity, that is, nationwide production efficiency is 45.2% in terms of water production through treatment. This shows us inefficiency of facility operation at least, and the inefficiency has been not necessarily attributable to planned operation but erratic power supply, aging of facilities and equipment, malfunction of equipment such as pump due to inadequate maintenance, and also supposedly oversize design by excess estimate of water demand.

Table 2-51 Existing Water Treatment Facility of Surface Water

	Number of Water Treatment Facility※1			Capacity/Production (LCD)※2		
	Surface	Subsurface	Total	Design	Present	Efficiency
Nigeria (Nationwide)	225	18	243	4,239.8	1,915.8	45.2

*1: As of 2010. Simplified treatment facilities and chlorination only are included.
*2: As of 2012.
Source: JICA Project Team

Water Supply Facilities using Groundwater

Table 2-52 shows the number and operating ratio of existing boreholes through detail check and summarization of raw data of the National Water Supply and Sanitation Baseline Survey (NWSSBS), 2006 by FMWR. As a result, the total number of boreholes is about 38,000 excluding Borno State, and nationwide operating ratio is 54.3%.

Table 2-52 Number and Operating Ratio of Existing Boreholes in 2006

	Handpump			Motorized Pump			Total		
	No.	Function	(%)	No.	Function	(%)	No.	Function	(%)
Nigeria (Nationwide)	25,470	14,748	57.9	12,421	5,836	47.0	37,891	20,584	54.3

Source: National Water Supply and Sanitation Baseline Survey (NWSSBS), 2006. Reanalyzed by JICA Project Team

(1-3) Current Status of Sanitation

Table 2-53 shows both sanitation coverage and sewerage coverage, sourced from National Demographic and Health Survey (NDHS), 2008 and Multiple Indicator Cluster Survey (MICS), 2007. Sewerage systems with proper treatment exist only in a part of major metropolis such as Abuja and Lagos, others probably have not proper treatment even if sewerage networks exist there.

Table 2-53 Sanitation and Sewerage Coverage (%)

	Sanitation (NDHS,2008)	Sewerage (MICS,2007)
Nigeria (Nationwide)	27.0	3.9

Source: National Demographic and Health Survey (NDHS), 2008
Multiple Indicator Cluster Survey (MICS), 2007

(2) Basic Conditions of Development Planning

In view of the above current status, the Project will make a water supply and sanitation development plan based on the following design criteria.

(2-1) Water Supply

Per Capita Consumption

The National Water Supply and Sanitation Policy, 2000 defines standard per capita consumption according to category of water supply and settlement type based on population size, as shown in Table 2-54. The Project conforms to this standard per capita consumption for sector development plan as well as basic conditions for water demand projection.

Table 2-54 Per Capita Consumption by Water Supply Category

	Water Supply Type	Per Capita Consumption (lit/cap/day)
1	Urban	120
2	Semi-Urban / Small Town	60
3	Rural	30

Source: National Water Supply and Sanitation Policy, 2000, FMWR

Designed Capacity and Yield of Water Sources

To make up a development plan of water supply against future growing water demand, capacity or yield of water source should be specified. For water supply facilities using surface water, water demand within available capacity of water source corresponds to designed capacity by considering surface water potential. Meanwhile, for water supply facilities using groundwater, designed yield is subject to hydrological features and pumping capacity.

Rehabilitation Scheme of Existing Facilities

As to existing water supply facilities using surface water, the Project assumes that all the facilities have production efficiency at across-the-board 45.2% in 2010, the baseline year of the Project, which were obtained from nationwide efficiency of 2012, and also that the efficiency will be recovered to 80% by 2020 through rehabilitation and sustained until 2030. This water volume to be recovered by rehabilitation scheme becomes required development in both hydrological balance and facility planning.

On the other hand, as to existing water supply facilities using groundwater, out of groundwater development as remaining balance of total required water development after deduction of surface water development, the volume to be rehabilitated to the maximum extent possible is reactivated through rehabilitation scheme.

New Construction Scheme of Facilities

As to the water supply facilities using surface water to be newly constructed, the Project assumes that

water development is 80% of design capacity, as production efficiency, of newly planned water treatment works and sustained until 2030 in hydrological balance. Water development in facility planning is full design capacity of newly planned water treatment works.

On the other hand, as to the water supply facilities using groundwater to be newly constructed, the remaining balance of groundwater development after deduction of groundwater development by rehabilitation scheme is covered by newly construction in hydrological balance. Water development in facility planning is 125% (inverse of production efficiency at 80%) of water development in hydrological balance.

Composition of Water Supply Facilities

The Project standardizes composition of water supply facilities by the categories mentioned in Table 2-55. However, urban settlement and semi-urban / small town settlement are conveniently combined together because they cannot be distributed by category of water source.

Table 2-55 Composition of Water Supply Facilities in Development Plan

Category-1	Category-2	Category-3	Composition of Water Supply Facilities (Standard)
Rehabilitation or New Construction	Urban and Semi-Urban / Small Town	Surface W.	Water treatment works – Pumping main – Reservoir – Distribution – House connection and public standpipe
		Groundwater	Borehole equipped with motorized pump – Pumping main – Reservoir - House connection and/or public standpipe
	Rural	Groundwater	Borehole equipped with motorized pump – Reservoir - public standpipe
			Borehole equipped with handpump

Source: JICA Project Team

(2-2) Sanitation

Sanitation Service Level

The National Water Sanitation Policy, 2004 defines standard sanitation service level guaranteed for all citizens according to settlement category based on population as well as water supply, as shown in Table 2-56. The Project conforms to this standard sanitation level for sector development plan.

Table 2-56 Standard Sanitation Service Level

Category of Sanitation		Population	Service Level (at least)	Remarks
Urban	Urban	20,000 <	Pour-Flush Toilet	each household, using suitable and affordable water conveyance systems
	Semi-Urban / Small Town	5,000 - 20,000	SanPlat Latrine or equivalent	each household, improved latrine slab and superstructure harmonizing with surroundings
Rural		< 5,000	Upgraded Pit Latrine	each household, reduction of flies and odour, etc.

Source: National Water Sanitation Policy, 2004, FMWR

Components of Sanitation Development Plan

Sanitation development projects are shown in Table 2-57.

Table 2-57 Components of Sanitation Development Plan

Project	Settlement Category	Description
Public toilet	Urban	in Market, bus terminal, etc. 4 places per 20,000 persons
	Semi Urban / Small Town	in Market, bus terminal, etc. 2 places per 20,000 persons
Final disposal facility/site	Urban	Disposal of septage/sludge collected and transported from septic tanks
Sewerage system	Urban	Sewerage treatment plant, sewer
Hygiene promotion	Semi Urban / Small Town	Conventional hygiene promotion and education
	Rural	Community-Led Total Sanitation Approach

Source: JICA Project Team

(3) Water Supply and Sanitation Development Plans

(3-1) Water Supply Development Plan

To meet the future water demand projected in Section 4.2, the Project calculates nationwide water supply development for both hydrological balance and facility planning in the target year 2030, as shown in Table 2-58 and Table 2-59.

Both water supply development target demand growth for 20 years from 2011 to 2030 because

baseline year of water demand projection is 2010. But water supply development plan targets demand growth from 2015 to 2030, which is also ground for project cost estimation. Assuming development projects have been implemented at the development pace expected by the M/P2013 from 2011 to 2014, water supply development by both rehabilitation and new construction projects proposed in the M/P2013 is 12,620 million liter per day (MLD) in hydrological balance and 14,880 MLD in facility planning. Figure 2-33 shows nationwide demand and supply graph in water development plan in facility planning.

Table 2-58 Water Supply Development Plan for Hydrological Balance

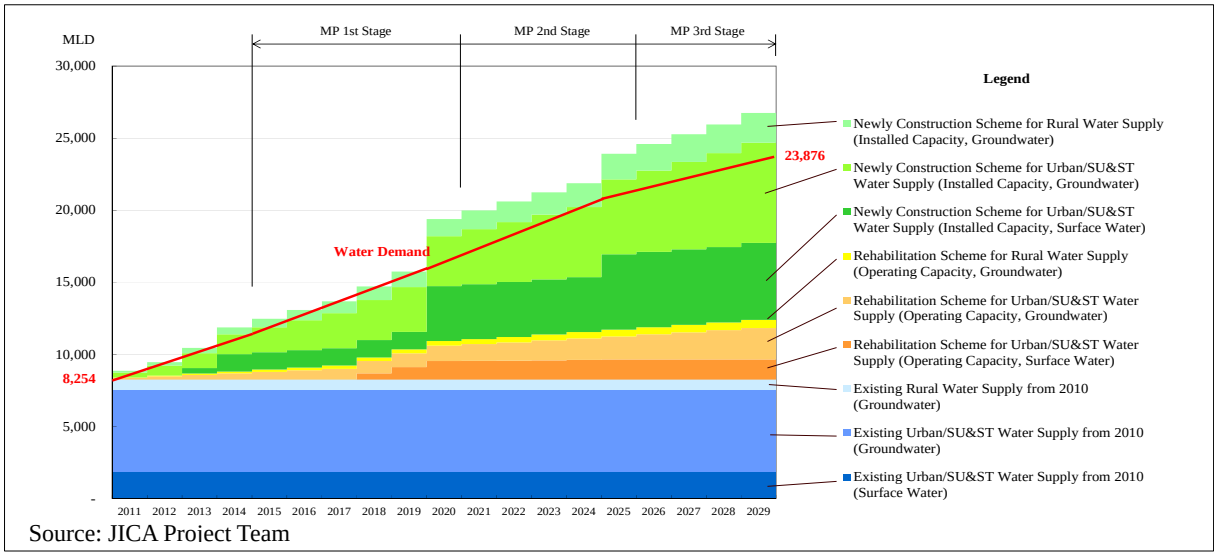
Scheme	Category	Existing Capacity (2010)	Pre-MP Period (2011-2014)	MP Period (2015-2030)	**Grand Total (2030)**
Rehabilitation	Urban, SU/ST (SW)	1,870	-	1,388	**3,257**
	Urban, SU/ST (GW)	5,667	425	1,761	**7,852**
	Rural (GW)	718	126	430	**1,274**
	Sub-Total	**8,254**	**551**	**3,578**	**12,383**
Newly Construction	Urban, SU/ST (SW)		964	3,317	**4,280**
	Urban, SU/ST (GW)		1,109	4,449	**5,558**
	Rural (GW)		379	1,276	**1,655**
	Sub-Total		**2,452**	**9,041**	**11,493**
Grand Total	**(MLD)**	**8,254**	**3,003**	**12,620**	**23,876**

Source: JICA Project Team

Table 2-59 Water Supply Development Plan for Facility Planning (Installed Capacity)

Scheme	Category	Existing Capacity (2010)	Pre-MP Period (2011-2014)	MP Period (2015-2030)	**Grand Total (2030)**
Rehabilitation	Urban, SU/ST (SW)	1,870	-	1,388	**3,257**
	Urban, SU/ST (GW)	5,667	425	1,761	**7,852**
	Rural (GW)	718	126	430	**1,274**
	Sub-Total	**8,254**	**551**	**3,578**	**12,383**
Newly Construction	Urban, SU/ST (SW)		1,204	4,146	**5,350**
	Urban, SU/ST (GW)		1,386	5,561	**6,947**
	Rural (GW)		474	1,595	**2,069**
	Sub-Total		**3,065**	**11,302**	**14,367**
Grand Total	**(MLD)**	**8,254**	**3,616**	**14,880**	**26,750**

Source: JICA Project Team



Source: JICA Project Team

Figure 2-33 Demand and Supply in Water Supply Development Plan for Facility Planning

(3-2) Sanitation Development Plan

Based on current sanitation coverage as of baseline year 2010, the Project formulates sanitation development plan to meet demand in the target year 2030, which sanitation coverage should reach 100%. But sanitation development plan targets demand growth from 2015 to 2030, which is also ground for project cost estimation. Assuming development projects have been implemented at the development pace expected by the M/P2013 from 2011 to 2014, sanitation development by the projects proposed in the M/P2013 are shown in Table 2-60.

Table 2-60 Sanitation Development Plan (2015-2030)

Project	Settlement Category	Required Development
Public toilet	Urban	8,564 places
	Semi Urban / Small Town	11,762 places
Final septage disposal facility/site	Urban	For 9,325,745 households
Sewerage system	Urban	For 876,758 households (Treatment : 473,266m3/day)
Hygiene promotion	Semi Urban / Small Town	For 16,650,716 households
	Rural	For 13,406,807 households

Source: JICA Project Team

Sanitation development plan includes projects for septage disposal and sewerage, but formulation of the following master plans is necessary to promote realization of the projects.

- National Master Plan on Sanitation (including septage management)
- National Master Plan on Sewerage Development (for major urban areas)

On the other hand, the Project estimates required development of domestic sanitation facilities (toilet or latrine) at 36.8 million totally in the target period of sanitation development plan from 2015 to 2030.

Table 2-61 Required Development of Domestic Sanitation Facilities

(x1,000)	Settlement	Existing (2010)	Pre-MP Period (2011-2014)	MP Period (2015-2030)	**Grand Total (2030)**
Population	Urban	7,018	6,105	29,614	**42,736**
	Semi-Urban/Small-Town	20,649	16,827	79,971	**117,447**
	Rural	16,812	13,997	66,823	**97,632**
	Sub-Total	44,479	36,928	176,407	**257,815**
Household	Urban	1,511	1,396	6,739	**9,646**
	Semi-Urban/Small-Town	3,989	3,510	16,651	**24,149**
	Rural	3,149	2,813	13,407	**19,369**
	Sub-Total	8,649	7,719	36,796	**53,164**

Source: JICA Project Team

2.7.2 Irrigation and Drainage Development Plan

(1) Current Condition of Operation and Maintenance in Irrigation Scheme

The operation and management of public irrigation schemes is mainly in charge of RBDAs and state, a part of farmer group in the scheme has been supporting the maintenance of irrigation facilities. However the irrigation infrastructure are dilapidated in most of the irrigation schemes with many pumps in need of repair/replacement and conveyance structures damaged or deteriorated, weed infested and silted up.

(2) Basic Policy for Development

(2-1) Basic Policy

The promotion of irrigation sector should be schemed in accordance with national development policy, regional feature such as climate, hydrology, terrain and habitant, economical efficiency, and situation of existing public irrigation scheme.

(2-2) Development policies

Development Policies of irrigation sector are follows and development will be extended step by step according to priority.

- To complete early on-going public irrigation schemes,
- To implement rehabilitation and expansion on public irrigation schemes which FMWR identifies as high priority,
- To develop new water resource for high priority public irrigation schemes,
- To utilize existing dams for public irrigation schemes and expand its system developed area,
- To develop new proposed irrigated farmland, and
- To formulate effective structure for operation and maintenance to run schemes.

(2-3) Category of Public Irrigation Scheme

The existing and proposed public irrigation schemes are categorized as follows;

Table 2-62 Category of Public Irrigation Scheme

No.	Category	Description
1.	Existing Irrigation Scheme	Scheme which is existing before the M/P2013
1.1	Completion with No Extension Scheme	Scheme which has already completed or suspended, and which has no extension plan in future.
1.2	Ongoing Scheme	Scheme which has been on-going and has a sure plan to implement in future.
1.3	Extension Scheme	Scheme which is recommended to expand planned irrigation area more
2.	New Irrigation Scheme	New Scheme which is proposed after the M/P2013
2.1	Supplementary Irrigation Scheme	Scheme which comprises of land reclamation and supplementary irrigation. Scheme is specified in HA-5 and HA-7 owning much precipitation.
2.2	Dam Irrigation Scheme	Scheme which has irrigation dam considered in the M/P1995 and the M/P2013 in order to assure full-year irrigated farmland.
2.3	Integrated Development Scheme	Scheme which is extensively developed by multipurpose dam, utilizing water and hydropower deriving from that dam

Source: JICA Project Team

(3) Development Plan

(3-1) Completion with No Extension Scheme

Out of existing public irrigation scheme of 301 sites, there are 177 schemes which has already completed or suspended, and which has no extension plan in future. Subject to the proposed cropping pattern and safety level for water supply (1/5 years safety level), future irrigation area is evaluated by irrigation scheme. In case of insufficient water volume from water resources in general against planned irrigation areas or limitation utilizing to irrigation water due to prioritize to domestic water supply in future. As a result, system developed area 43,403ha developed so far by FMWR is evaluated at 38,018ha due to lack of water potential against water demand for irrigation.

Table 2-63 Completion with No Extension Scheme

	Number of Scheme			System Developed area(ha)			Planned Irrigation Area(ha)			Future Irrigation Area (ha)
	L	M	Total	L	M	Total	L	M	Total	
Total	66	111	177	34,980	8,423	43,403	107,605	17,102	124,707	38,018

Note) L: Large Scale Scheme, M: Medium and Small Scale Scheme

・Future irrigation area means irrigable area subject to the proposed cropping pattern and safety level for water supply (1/5 years safety level), and Future irrigation area is identified with system developed area due to no expansion plan.

Source: JICA Project Team

(3-2) Ongoing Scheme

There are 32 sites of on-going irrigation scheme implemented by FMWR in the country, and those schemes should be completed early. According to evaluation based on surface water potential, number of irrigation scheme become 9 sites of which future irrigation area evaluated fall below planned irrigation area.

Table 2-64 Ongoing Scheme

	System Developed Area (ha)	Planed Irrigation Area (ha)	Future irrigation Area (ha)
Total	37,170	116,039	98,897

Note)・Future irrigation area means irrigable area subject to the proposed cropping pattern and safety level for water supply (1/5 years safety level)

Source: JICA Project Team

Reference : 1) FMWR budget document 2) Utilization of Natural Resources Fund for Water Resources and Agricultural Development, FMWR, FMARD

(3-3) Extension Scheme

According to Proposed Master Plan for Irrigation and Dam Development for 2009-2020 (FMAWR), numbers of irrigation scheme for only rehabilitation and for expansion with partial rehabilitation are 37 sites and 45 sites respectively. According to the surface water potential evaluation, almost the scheme for rehabilitation only have a plenty amount of water, and then it is possible to expand the system development area up to the planned irrigation areas. To expand the irrigated farmlands it is recommended to expand the development to 37 schemes not only that rehabilitation but the planned irrigation areas.

Table 2-65 Extension Scheme

	System Developed Area (ha)	Planed Irrigation Area (ha)	Future irrigation Area (ha)
Total	47,524	200,357	103,937

Note)・Future irrigation area means irrigable area subject to the proposed cropping pattern and safety level for water supply (1/5 years safety level)
Source: JICA Project Team
Reference： 1)Baseline studies for National Water Resources Draft Final Report, ENPLAN, 2009
2) Masterplan for Irrigation and Dam Development for 2009- 2020, FMAWR

(3-4) Supplementary Irrigation Scheme

Economical irrigation development is possible utilizing regional characteristics of HA-5 and HA-7. The southern regions locate at tropical rainforest climate zone and then rain-fed rice cultivation has been active. However, it is necessary enough water in the initial stage of rice cultivation and then it is desire to keep the supplemental water resources for unstable rainfall condition in this season. Accordingly, land reclamation and supplementary irrigation facilities are planned utilizing farm ponds and groundwater. In this case, irrigation water is for only rainy season because of small scale of water resources. However, it is convinced to increase rice yield due to irrigation effectively. The cost of development method minimizes comparing with other development menu, also this method is applied as small scale irrigation scheme by state government.

Possible available farmlands in HA-5 and HA-7 are vast. In case terrain is flat and soil is suitable to rice cultivation in the area, this development method is easily applied to all over the place. New development areas are 19,000 ha for HA-5 and 29,000 ha for HA-7 corresponding to the irrigation areas omitted at the dam selection stage mentioned in the item (3-5) below.

(3-5) Dam Irrigation Scheme

Nigerian agriculture depend on rain-fed cultivation nationwide, however it is imperative to enhance irrigated agriculture emphatically for national food security. Possible merit expected from irrigation in the case of converting rain-fed cultivation into irrigated one include 1) yield improvement by avoiding drought damages, 2) extension of cropping period from only wet season to throughout the year.

New proposed irrigation scheme development is planned possible to irrigate through a whole year at the downstream of dam, which water resources to be groups of dam projected in the M/P1995 and dams newly proposed. Location of dam will be selected considering economy, possibility of suitable irrigation area at downstream of dam, dam efficiency, avoidance of competition among water supply and the existing irrigation scheme, and possibility of resettlement. The sites of new proposed irrigation schemes owing to dam are 17 sites (total planned irrigation area: 80,900ha).

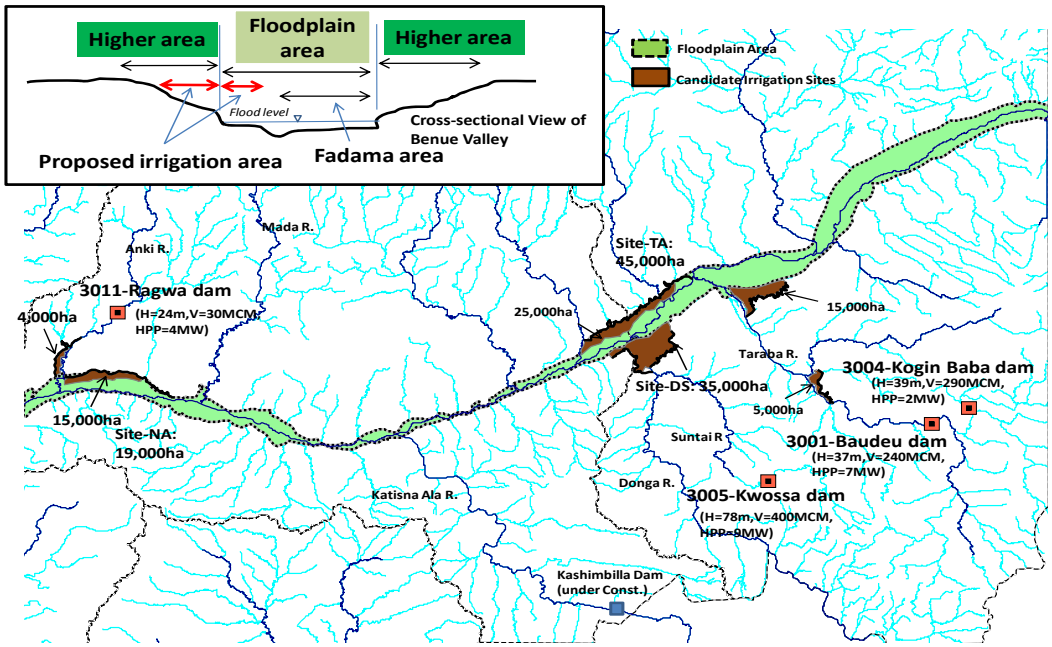
(3-6) Integrated Development Scheme

The long term target of irrigation sector is to convert irrigable potential area of 3.14 million hectares lying in this country to irrigated farmland. Herein it is a plan developing large scale irrigation scheme including pump operation which utilize electricity created by the hydraulic power generation in the multi-purpose medium and large scale dams constructed in the branch river of Benue River.
This development system takes long implementation period to complete the dam construction. Therefore, considering easiness and cheapness of management and maintenance and immediate effectively, private small scale irrigated farming should de preceded as a group in the irrigation development area. At the time keeping water resources after completion of late dam construction the public irrigation scheme is transferred.

Table 2-66 Integrated Development Scheme

No	HA	Name	New Proposed Dam	Planned Irrigation Area (ha)
1	3	Donga-Suntai Integrated Scheme	Kwossa Dam(3005):H=78m, V=400 MCM, P=9MW	35,000
2	3, 4	Taraba Integrated Scheme	Baudeu Dam(3001) :H=37m, V=240MCM, P=7MW Kogin Baba Dam(3004):H=39m, V=290MCM, P=2MW	HA-3: 5,000 + 7,500 + 25,000 = 37,500 HA-4: 7,500
3	4	Nasarawa Integrated Scheme	Ragwa Dam(3011):H=24m, V=30 MCM, P=4MW	4,000+15,000= 19,000
			Total	99,000

H: Dam Height, V: Dam Capacity Source: JICA Project Team



Source: JICA Project Team

Figure 2-34 Integrated Development Location Map

(3-7) Planned Irrigation Area by Hydrological Area

Future irrigation area on existing public irrigation scheme and planned irrigation area on new proposed public irrigation scheme are shown in Table 2-67.

Table 2-67 Planned Irrigation Area as of 2030

	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Existing Irrigation Sch.	**41,041**	**26,946**	**20,265**	**12,494**	**17,700**	**29,398**	**8,410**	**84,598**	**240,852**
Completion with No Extension Scheme	24,441	3,048	905	877	630	1,449	2,250	4,418	38,018
Ongoing	9,750	5,200	11,110	1,100	11,490	24,617	1,000	34,630	98,897
Extension	6,850	18,698	8,250	10,517	5,580	3,332	5,160	45,550	103,937
New Irrigation Scheme	**1,500**	**7,400**	**111,700**	**48,000**	**23,100**	**1,500**	**34,700**	**0**	**227,900**
Supplementary Irrigat.	0	0	0	0	19,000	0	29,000	0	48,000
Dam Irrigation	1,500	7,400	39,200	21,500	4,100	1,500	5,700	0	80,900
Integrated Development	0	0	72,500	26,500	0	0	0	0	99,000
Total	**42,541**	**34,346**	**131,965**	**60,494**	**40,800**	**30,898**	**43,110**	**84,598**	**468,752**

Source: JICA Project Team

2.7.3 Recommendation to Other Sub-Sectors

(1) Hydropower Generation

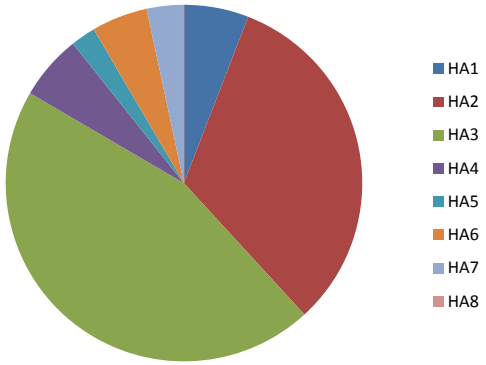
Considering the large environmental and social impacts of constructing a large-scale hydroelectric station, as well as the lack of suitable dam sites with large enough capacities, a more practical choice for the proposed dam sites would be to install small hydropower stations that are driven by water used primarily for irrigation purposes.

In regards to the large-scale hydroelectric dam development projects being planned by Nigeria's Federal Ministry of Power (FMP), it is important for FMWR as the administrator of the river environment to provide FMP appropriate guidance on a continuing basis such as, for instance, teaching them to check the existence of low-flow sections and, if necessary, discharge water to secure the predetermined minimum flow level.

(1-1) Evaluation of Hydroelectric Potential (of Irrigation Waterways)

We estimated the hydroelectric potential of each dam site based on the flow regime and dam height of each site, which were identified by our survey, to examine the possible introduction of hydroelectric stations, and sorted out the approximate results as follows. HA-2 and HA-3 have large potentials, as these areas are blessed with good stream flows and topographical advantages.

HA	Annual Output (MWh)
HA-1	69,722
HA-2	383,971
HA-3	537,402
HA-4	69,929
HA-5	26,900
HA-6	60,359
HA-7	39,934
HA-8	0
Total	1,188,217



Source: JICA Project Team

Figure 2-35 Hydroelectric Potential in HAs

(1-2) Considering the Installation of Low-Head Hydroelectric Stations

While dam-type hydroelectric stations have the advantage of relatively large output, they also have shortcomings such as high construction cost and large impact on the river environment. Low-head hydropower is drawing attention recently as a promising solution to such obstacles, as it generates electricity mostly by the use of river current without relying on a large head and therefore can minimize the alteration of the river environment.

(1-3) Necessity of Trial Installation

The most important aspect of the maintenance of hydroelectric facilities is the removal of dust from the equipment, as it takes in water directly from the river, which naturally contains dust and debris that need to be removed properly. While the intake gates of dam-type hydropower stations are usually situated lower than the river surface, those of low-head stations are at about the same level as the river, which makes it easier for the debris floating on the river surface to flow into the turbines, causing breakage. For this reason, it is desirable to install a turbine in a relatively small river or canal on a pilot basis to test and check the actual output and removal of debris before full-scale installation.

(2) Flood and Erosion Control

The flood control sector in Nigeria has been materialized in three tiers such as Federal, State and Local governments with frameworks on environmental management and disaster management. FMWR has nation-wide hydrological monitoring network and jurisdiction of a lot of dams. In this sense, FMWR should be involved in management of floodplain along the major rivers, especially for the downstream reaches of her multipurpose dams. At the same time, the hydrological monitoring system of FMWR should be improved to monitor more short term phenomenon such as floods. Moreover, FMWR should extensively do flood risk evaluation for the area of floodplain along the major rivers in which irrigation project is/will be implemented or urbanization has been/will be progressed.

Regarding the erosion control in Nigeria, some State governments as implementing body express their desires on proper budget allocation from the Federal Government and technical support from Federal agencies in terms of hydrological analysis. NIHSA of FMWR can contribute to this aspect through hydrological monitoring.

Table 2-68 Prioritized Activities for Flood Control Sector in FMWR

Objective	To enhance the land use of floodplain having high potential for large and small scale irrigation and to improve the future land use to respond flood in riverine areas
Major Activities of FMWR	1. Construction and maintenance of flood control facilities in relevant to large scale irrigation (Main Ministry and RBDA) 2. Regulation of release from multipurpose dam (Main Ministry and RBDA) 3. Consolidation of hydrological monitoring for flood (NIHSA) 4. Flood risk evaluation in floodplain (NIHSA) 5. Dissemination of the above information to State government, NEMA, FMARD, FMEnv, NIWA, etc.

Source: JICA Project Team

Government in charge		State Government / FME			FMWR
Category/Type		Urban Drainage	Flood Control in Lowland (ex. Niger Delta)	Flood Control in Riverine Area (ex. Along the Niger, the Benue)	Flood Control in Floodplain (ex. For irrigation)
Current Measures	Structural Measures	Channelization, Dredging, Dike (Project by Environmental Sector)			Project related to Irrigation Project by RBDA
	Non-structural Measures	Flood Early Warning by FME			Hydrological Monitoring
Proposed Measures	Structural Measures	Channelization, Dredging, Dike (Project by Environmental Sector)		Planning/Design by NIHSA	Project related to Irrigation Project by RBDA
	Non-structural Measures	Flood Early Warning by FME Proper application of landuse control		Enhancement of Flood Monitering, Flood Early Warning , Flood Risk Mapping by NIHSA	
Project Site			Lagos and Delta areas	Lokoja, Yola, Makurdi, Kaduna, Abeokuta, Ibadan, etc.	Niger R., Benue R. Sokoto-Rima R. Kaduna R.

Source: JICA Project Team

Figure 2-36 Technical Field on Management of Floodplain for FMWR

Proposed Actions for FMWR

- Action 1: Flood risk evaluation in floodplain
- Action 2: Flood control for proposed irrigation project in the Benue river floodplain

(3) Inland Navigation

The inland waterways of Nigeria comprise of the main river system (Rivers Niger and Benue which form a confluence at Lokoja), creeks, lagoons, lakes and intra-coastal waters. They are declared by the 1997 degree as Federal navigable waterways. Basically all navigable waterways shall be under the exclusive management, direction and control of NIWA.

FMWR owns and manages dams which may affect flow regimes along navigable river sections in the country. Furthermore, FMWR has to provide necessary information for disaster management in cities along rivers as well as for management of large scale irrigation area in the floodplain which is under jurisdiction of NIWA. It is necessary to consider effects of floodplain management on inland navigation. The followings are proposed to be implemented by FMWR.

- Sharing information on hydrological data and hydraulic parameters with NIWA;
- Sharing information on cross-sectional shape of floodplain area in navigable river sections; and
- Considering the effect of large scale irrigation development in floodplain on inland navigation.

(4) Inland Fishery

Fishery division has launched the following policies in order to promote inland fishery in Nigerian Fisheries Master Plan 1998 (draft).

- Developing and modernizing measures of fishery production, processing, storage, marketing and conservation of resources,
- Improving living standard of fishery communities,
- Enhancing researches on fisheries,
- Consolidating research facilities and developing human resources,
- Prompting private enterprises to participate in and invest to fisheries,
- Organizing viable fisheries cooperatives throughout the country,
- Providing subsidies for purchasing fishing gears,
- Promoting fishermen’s access to public financing organizations,
- Implementing model projects for country-wide diffusion of fish farming techniques,
- Consolidating legal frameworks on fisheries,
- Improving fishery processing techniques and adding higher values to fishery products,
- Collecting information on development of fishrie4s subsector.

Inland fishery basically competes with irrigation sector in terms of water use. However, it is recommendable to apply fish farming in the field of irrigation in such ways as fish farming in dams and reservoirs for agricultural purpose. In particular, it will be possible for local people to create opportunities of subsidiary income sources without competing with water use by agriculture only if they introduce fish farming on the surface of lowland rice fields in such a way as observed in Japan and in China. In this case, they can utilize abattoirs' wastes and livestock droppings. In this way, as development frame of fisheries sub-sector and that of irrigation, agriculture and livestock sub-sectors are closely related each other, it is advisable to closely hold consultation among these sub-sectors for developing their activities by effectively utilizing water resources.

(5) Livestock

Livestock division has launched the following policies in order to promote livestock industry in National Agriculture and Food Security Strategy 2010-2020.

- Accelerating participation of private sector in livestock industry making use of loans provided by "Nigeria Agricultural Cooperative and Rural Development Bank (NACRDB)" so as to establish larger-scaled livestock industry,
- Providing animal feeds, vaccination, livestock medicines, information and resources (loans) so that private management of livestock husbandry can be stabilized and quality and quantity of product supply can be maintained,
- Hatcheries of poultry should be consolidated throughout the country under the collaboration between public and private sectors. Besides, technical research should be promoted for realizing economical hatchery enterprises.
- Promoting dairy industry so as to produce milk for domestic consumption and for exports and
- Increasing highly productive grassland and cropping area under fodder crops through the liaison between public and private sectors so as to increase the production of forage crops and hay.

The above policies do not include water resources development and management for promoting livestock industry. In practice, however, animal water at lakes, ponds, rivers, reservoirs, canals etc is indispensable for livestock maintenance including water spots for seasonal transhumant activities. Also, commercial livestock sub-sector may need means of water supply exclusively provided for livestock. Thus, livestock and irrigation sectors should closely be related mutually, it is necessary to produce efficient use of water resources through communication, coordination and collaboration between them.

2.8 Water Resources Management Plan

2.8.1 General

(1) Objective and Strategy of Water Resources Management

(1-1) Objectives of Water Resources Management

The objective of water resources management is to provide the water services based on 3S&2E (Sufficiency, Safety, Sustainability, Efficiency and Equitability) to the water users who expect "Effective Use of Water", "Mitigation of Flood Damage" and "Conservation of Water Quality", by using the facilities and operation systems installed on the basis of Water Resources Development Plan. The Water Resources Management Plan compiles the methods to achieve the objectives.

(1-2) Strategy of Water Resources Management

Water resources management is implemented based on the following strategies.

- **Strategy-1: Organization and Institution for Water Resources Management**

  As results of the analysis of current organization and institution for water resources development and management, it is clarified that improvement and strengthening of current organization and institution are necessary.
- **Strategy-2: Operation and Maintenance for Provision of Water Services**

  Provision of proper water services is most important item of water resources management. The M/P2013 proposes proper operation and maintenance regarding water resources development facilities such as dam, well, water supply facility and irrigation facility.
- **Strategy-3: Allocation and Regulation of Water Resources Quantity and Quality**

Allocation and regulation are important mandate of NIWRMC newly established. It is necessary to establish necessary institutions and systems required for licensing and regulation of water intake for new users.

- **Strategy-4: Facilitation and Improvement for Water Resources Management**

  This plan includes action plans to support and improve human resources and technology for water resources development / utilization / management, and also to promote effectively water projects.

In order to achieve proper water resources management, in the M/P2013, it is proposed to consider the improvement plan and method analyzing the current issues relating to management items shown in Figure 2-37.

Objectives of Water Resources Management

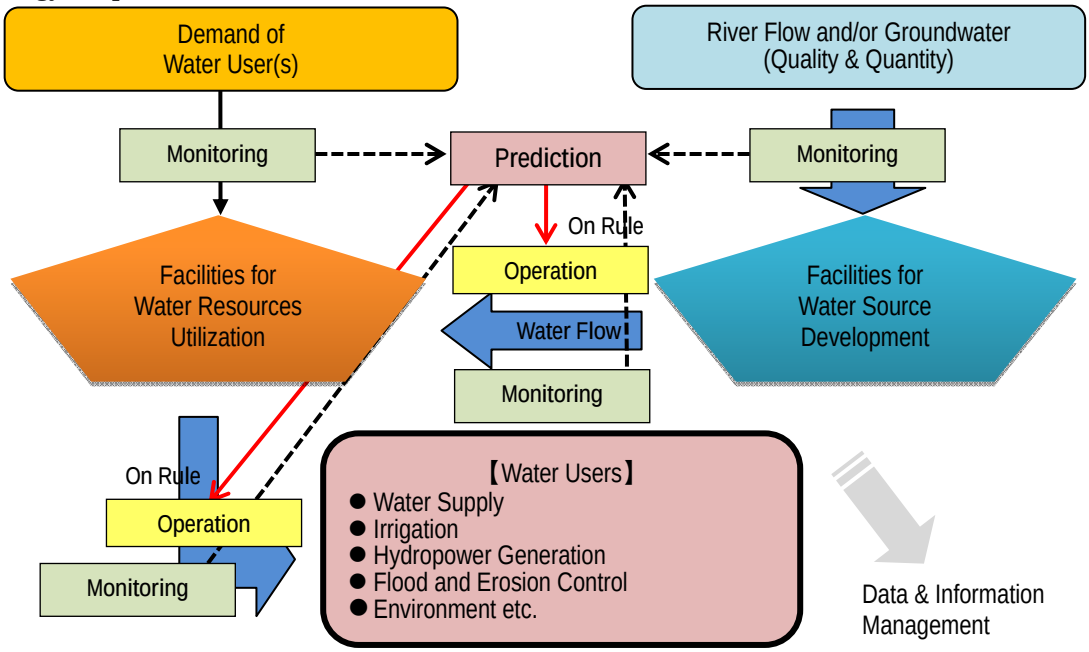
Targets of Water Resources Management in Nigeria, i.e. "Effective Use of Water Resources", "Mitigation of Flood and Sediment Disaster" and "Conservation of Water Quality" will be achieved on the basis of "Sufficiency, Efficiency, Equitability, Safety and Sustainability".

▼

Strategy-1 Organization and Institution for Water Resources Management

Management Item: - Organization and Institution for Public Water Services

Strategy-2 Operation and Maintenance for Provision of Water Services



Management Item:
- Operation and Maintenance for Water Resources Development Facilities
- Hydrological Monitoring
- Data and Information Management
- Management of Floodplain
- Consideration of Risk Associated with Climate Change and Trans-boundary Water
-Water Environment Management

Strategy-3 Allocation and Regulation of Water Resources Quantity and Quality

- Management Item: Water Allocation and Regulation

Strategy-4 Facilitation and Improvement for Water Resources Management

Management Item:
- Public Relations
- Public-Private Partnership (PPP)
- Manpower Development and Capacity Building
- Monitoring and Evaluation

Source: JICA Project Team

Figure 2-37 Targets of Water Resources Management

(2) Framework of Water Resources Monitoring

The water resources monitoring is one of fundamental elements for water resources management. The water resources monitoring is not limited to the hydrological monitoring, but covers other important aspects for proper management of water resources. The water resources monitoring includes the following four major components, and these components are related and support each other.

- Hydrological Monitoring for Water Resources Assessment and Information Dissemination
- Water Quality Monitoring for Water Use
- Monitoring for Daily Activities for Management of Water Resources Facilities
- Control Monitoring for Enforcement of Water Regulation

2.8.2 Organization and Institution for Public Water Services

The specific objective of institutional development and strengthening is to carry out water resources management based on IWRM approach with an aim to efficiently and effectively execute the projects and programs contained in the M/P2013.

To accomplish the objective, we strongly suggest the following basic policies under top policy including National Water Policy and National Water Resources Act, for institutional development and strengthening.

- Basic Policy-1: Cooperative Institutional Arrangement
- Basic Policy-2: Participatory Management Administration
- Basic Policy-3: Fair Regulatory Institutional Framework
- Basic Policy-4: Decentralization and Coordination

Based on the basic policies, the Project suggests the action plans as shown in Table 2-69.

Table 2-69 Action Plan for Institutional Development and Strengthening

No.	Activities	Leading Institutions
	【BASIC POLICY - 1】 COOPERATIVE INSTITUTIONAL ARRANGEMENT	
1.1	【Challenge/Problem】 Incompletion of National Water Policy 【Activity】 ● Completion, Approval, Publication and Dissemination of National Water Policy to replace Water Decree No.101 of 1993	NCWR/Dept. of PRS/ NIWRMC/RBDAs
1.2	【Challenge/Problem】 Incompletion of National Water Resources Act 【Activity】 ● Completion, Approval and Promulgation of National Water Resources Act ● Based on National Water Resources Act, review and revision of relevant laws and regulations to manage the nation's water resources	NCWR/Dept. of PRS/ NIWRMC/RBDA
1.3	【Challenge/Problem】 Lack of Collaboration among Institutions among Relevant Institutions 【Activity】 ● Enlargement and evolvement of collaborative arrangement among relevant institutions in water sector through promotion of periodic meeting among key stakeholders to address common issues for water resources management	NCWR/Dept. of PRS/ NIWRMC/RBDAs
1.4	【Challenge/Problem】 Improvement of Data and Information Management System on Water Resources 【Activity】 ● Establishment of institutional framework to share hydrological data etc. among relevant institutions ● Development and Improvement of institutional framework for Integrated Monitoring and Evaluation System	NCWR/Dept. of PRS/ NIWRMC/RBDAs/ NIHSA/FMEvn/ NIMET/State MDAs
1.5	【Challenge/Problem】 Development of Institutional Framework for Implementation of Comprehensive Projects and Works which call for Integration of Various Sectors 【Activity】 ● Creation of task forces under FMWR for specific national comprehensive projects and programs	NCWR/Dept. of PRS/ NIWRMC/RBDAs/ NWRI/NIHSA/Federal Ministries Concerned
	【BASIC POLICY - 2】 PARTICIPATORY MANAGEMENT ADMINISTRATION	
2.1	【Challenge/Problem】 Promotion of Public Awareness and Social Mobilization for Participatory Management of Water Resources 【Activity】 ● Organization of nationwide survey on public opinion and reaction on water issues, and formulation of data-base on survey results for preparing better awareness programs, etc.	NIWRMC/COMs/ RBDAs/NIHSA/ State MDAs/CBOs

	● Organization of workshops and seminars to incorporate people's awareness for water conservation and management	
2.2	【Challenge/Problem】 Inadequate Catchment Management 【Activity】 ● Creation of comprehensive institutional framework involving all stakeholders for implementation of adequate Catchment Management Plan ● Promotion of Collaboration among partner government and other organizations through closer dialogue and greater interaction of CMOs with other basin organizations (CMCC, etc.)	NIWRMC/COMs/ RBDAs/NIHSA/ State MDAs/CBOs
2.3	【Challenge/Problem】 Mainstreaming of Water Related Issues such as Health, Gender, Poverty, Human Rights, etc. 【Activity】 ● Assistance and support for educative campaign and other tools and policies on water, sanitation, gender, empowerment, etc. in collaboration with relevant institutions (Federal Ministries of Health, Women Affairs, etc.)	PR Unit/ Gender and Human RightsUnit/ Dept. of PRS/ NIWRMC/NWRI/ State MDAs
	【BASIC POLICY - 3】FAIR REGULATORY INSTITUTIONAL FRAMEWORK	
3.1	【Challenge/Problem】 Weak Legal Regulatory Framework (Legal Backing) 【Activity】 ● Completion of legislative process and enactment of NIWRMC Bill as a primary basis of legal regulatory framework ● Review and revision of relevant laws and regulations including powers to grant licenses for water abstractions and allocation (RBDA Act, NIWA Act, Mineral Act, etc.)	NCWR/ Dept. of PRS/ NIWRMC/RBDAs/ FMT/FMM&SD
3.2	【Challenge/Problem】 Weak Regulatory Framework (Powers and Functions of NIWRMC) 【Activity】 ● Establishment of operational procedures for effective regulatory framework of NIWRMC and CMOs considering Catchment Management Plan in collaboration with other relevant basin institutions such as NIHSA, RBDAs, NWRI, etc.	NIWRMC/ CMOs/RBDAs/NIHSA/NWRI/ Dept. of PRS/ State MDAs
3.3	【Challenge/Problem】 Weak Regulatory Framework (Institutional and Human Resources Capacity Building and Enhancement) 【Activity】 ● Strengthening of institutional capacity of NIWRMC and CMOs based on needs assessment and development for capacity building ● Undertaking of recruitment, education and training for the staff (leader, technical and managerial staff, etc.) for IWRM in the basin	NIWRMC/CMOs/ Dept. of HR/ Dept. of PRS/ NIHSA/RBDAs/NWRI
	【BASIC POLICY - 4】DECENTRALIZATION AND COORDINATION	
4.1	【Challenge/Problem】 Improvement of Sustainability and Performance in Water Supply and Sanitation Sector considering Decentralization to State Agencies and LGAs 【Activity】 ● Encouragement of State Agencies (Water Boards, STWSSA, RUWASSA, etc.) and LGAs to boost efficiency of projects and programs through provision of technical assistance and support from federal institutions ● Preparation and dissemination of national technical guidelines and manuals etc. to ensure good quality standards in water supply and sanitation undertakings by states and LGAs ● Assistance and support for development of institutional arrangement at state level on PPP promotion in the Sector in consultation with concerned federal institutions	NCWRI/Dept. of PRS/ PPP Unit/NWRI RBDAs/NIWRMC/ State MDAs/ICRC/NESREA
4.2	【Challenge/Problem】 Optimization of Function of RBDAs in Irrigation and Drainage Sector 【Activity】 ● Improvement in operation and management of RBDAs (budget, water charges system, auditing on operation, etc.) ● Promotion of collaboration between RBDAs and the stakeholders such as farmers, Water User Association, etc. with respect to water resources for irrigation and agriculture development ● Updating of RBDAs functions in consistence with national policy documents such as National Water Policy	NCWR/RBDAs/ NIWRMC/ Dept. of PRS/PPP Unit/ ICRC
4.3	【Challenge/Problem】 Inadequate Skilled and Experienced Technical Staff 【Activity】 ● Establishment of National Water Resources Capacity Building Network (NWRCBNet) in various states of the country under the coordination of NWRI ● Capacity development for PPP capacity at various level of government to cope with inadequate funding of the water sector due to lack of private sector participation	NWRI/ Dept. of HR/ Dept. PRS/ PPP Unit/ State MDAs/ICRC

Source: JICA Project Team

2.8.3 Operation and Maintenance for Water Resources Development Facilities

(1) Surface Water Development Facilities

"Study on the present conditions of the dams" and the analysis of the results thereof under this Project revealed that almost all dams and reservoirs in Nigeria needed improvement toward more "proper operations, maintenance, and management." Consequently, the Project makes suggestions for the followings;

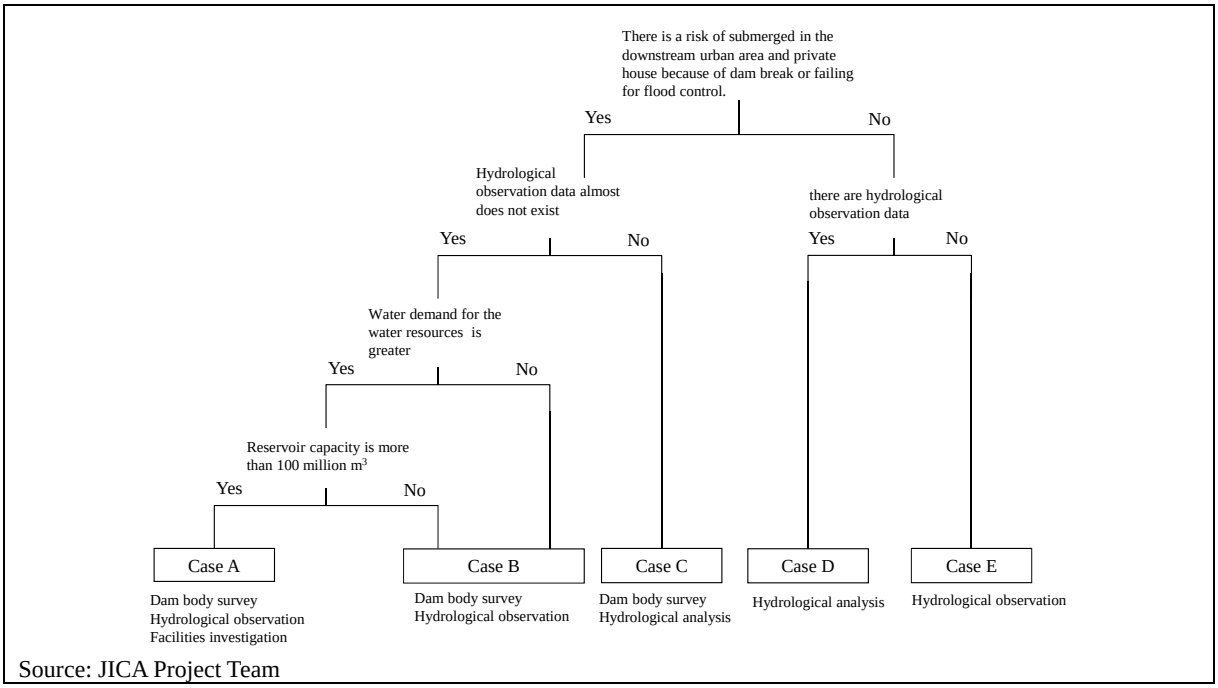
(1-1) Enhancement of Dam Management

As the management statuses of the existing dams are extremely poor, the Project proposes to improve the management system starting with high priority dams by following the workflow shown in Table 2-70 and Figure 2-38.

Table 2-70 Necessary Survey for Dam Management

Case	Survey& Investigation	Explanation
A	- Dam Body Survey - Hydrological Observation - Facility Investigation	As the dam (Large scale and important for water resources development) has a risk of dam break or failing and no hydrological observation data, it is recommendable to implement immediately "Dam Body Survey", "Hydrological Observation" and "Facility Investigation"
B	- Dam Body Survey - Hydrological Observation	As the dam is smaller scale than Case-A, it is recommendable for the moment to "Dam Body Survey" and "Hydrological Observation" to confirm dam safety and accumulate hydrological data.
C	- Dam Body Survey - Hydrological Analysis	As the dam has risk of dam break or failing, immediately start "Dam Body Survey". Also it is recommendable to make a "Hydrological Analysis" by using accumulated hydrological data, for optimum dam operation.
D	- Hydrological Analysis	As the dam has accumulated hydrological data and a few risk of dam break or failing, it is recommendable to make a "Hydrological Analysis" for optimum dam operation.
E	- Hydrological Observation	Dam has no hydrological observation data. Immediately start "Hydrological observation"

Source: JICA Project Team



Source: JICA Project Team

Figure 2-38 Study Flowchart of Priority for Improving Ripeness of Dam Management

Also, the Project proposes that all the dams must prepare "Dam Management Manual" and manage properly the daily operation and maintenance according to the manual.

(1-2) Operations of Dams and Reservoirs

Table 2-71 shows the future directions to be taken for improving water resource facilities.

Table 2-71 Directions for Future Improvement of Water Resource Facility Operations

Theme	Future Directions for Improvement
Relation between water users and dam administrators	Dam administrators and water users need to make a conscious effort to have close daily communication and establish a system to allow such communication.
Water rights	Careful discussions are needed for determining various issues regarding water rights, including the granting thereof, as water rights are important factors in water supply control.
Coordinating agency	In light of the legal and administrative systems of Nigeria, it should be discussed as to which river administrator, such as the Ministry of Land, Infrastructure, Transport and Tourism in case of Japan, should act as the coordinator.
Hydrological data management	As collection, analysis, and transmission of hydrological data are essential for low-water management, it should be discussed as to how to establish a new water resource information management system based on the problems of the current system.
Dam measuring equipment	Hydrological equipment of each dam needs to be rehabilitated.

Source: JICA Project Team

(1-3) Dam Safety Management

Safety Management of Dam Structures

Most of the dams in Nigeria are earth-fill dams. In ensuring the safety of fill dams, we need to pay the greatest attention to piping, which is caused by deformation of or damage in the dam structures. As pointed out in the results of the subcontracted survey, cracks or shrubs that could cause cracks were found in many dams. Also, seepage is measured at almost no dams. In order to ensure safety, the structures of the high-priority dams need to be investigated. High-priority management works are as follows:

- Measure seepage
- Remove (crack-causing) shrubs
- Check the upstream side of dam structure

Safety management of these facilities, including spillway facilities, backup power systems for outages, and hydrologic equipment, need to be studied extensively along with that of dam structures, especially with regard to high-priority dams.

Safety Management of Reservoirs

The Project could not obtain data regarding yearly sedimentation or hydrological observation. It is likely that periodic measurements are not taken at these dams. According to the personnel of each dam we interviewed, their greatest concerns were aquatic grass and hyacinth followed by sedimentation. Aquatic grass, etc. are probably caused by eutrophication of reservoir water, against which various measures need to be implemented to improve both stored and inflow waters. At any rate, it is important to measure and accumulate data on the water quality of dam lakes, as they provide important information for examining possible improvement measures.

Safety Management of Dam Reservoir Operation

A dam reservoir operation is an operation to control the volume of water released from a dam through its discharge facilities. There are two types of discharge control.

High water operation: Performing flood control, to protect the downstream region from flood damage

Low-water operation: Controlling the mount of inflow and discharge during non-flood period, irrigation supply, and while performing the operation to recover reservoir level quickly if possible

For implementing such advanced high-water/low-water operations as described above, effective operation manuals, which are supported by the analysis of long-term actual data, need to be established (as part of the above-mentioned dam management manuals). However, none of the dams studied by the subcontracted survey have operation manuals that provide specific instructions as to how to control discharge during the high-water and low-water periods. The urgent task at hand is to draft such dam operation manuals (as part of the above-mentioned dam management manuals), for which, needless to say, long-term data on reservoir water level, inflow, precipitation, and outflow, as well as those of existing dams nearby, if any, are indispensable.

(2) Groundwater Development Facilities

From the analysis on operation and maintenance of facilities for groundwater use, the followings were made clear and need improvement.

(2-1) Aquifer management

Over pumping and groundwater contamination is taking place due to inadequate aquifer management. Groundwater monitoring and the pumping control based on the result of the monitoring is necessary.

(2-2) Operation and maintenance of borehole facilities

Borehole operation rate is low due to poor operation and management of boreholes facilities. Proposal for improvement for the issues are as below:

- Adequate selection of prioritized community for borehole construction
- Hygiene and sanitation education for communities
- Establishment of system for water fee collection
- Strengthening of supporting system for LGA
- Provision for spear part

(2-3) Pumping capacity of boreholes

Capacity of boreholes is not fully utilized due to use of hand pumps whose capacity is only $10m^2$/day. It is necessary to use full capacity of aquifer by shifting pump type from hand pump to motorized pump to meet future groundwater demand.

(2-4) Borehole construction system

There are so many organizations which take responsibility of borehole construction project for rural water supply that project implementation is inefficient due to poor coordination among the organizations. Issues below should be examined for better implementation of the projects.

- It should be abolished that many organizations implement borehole construction for rural water supply independently. Implementation agency should be unified to one organization, State RUWASSA.
- Implementation agency will formulate long term plan for borehole construction for efficient project implementation.

For more efficient groundwater development, the matters below should be examined.

- To improve technical and institutional capacity of State Agency.
- To strengthen capacity and function of State Agency as main responsible organization for rural water supply.
- To improve capacity of private drilling companies under direction of State Agency.
- To make cooperation with Federal Organization such as NIWRCM and NIHSA for establishment of i) registration system of private borehole companies and ii) technical transfer system for new groundwater development.

2.8.4 Hydrological Monitoring

(1) Hydrological Monitoring for Surface Water

Considering the identified problems and issues, the strategy on improvement of surface water monitoring is set as shown in Table 2-72.

On the basis of the strategy, the following projects are proposed to be implemented by NIHSA.

Project-1: Improvement of Surface Water Monitoring Network

The monitoring network on surface water is setup step by step. Considering the existing Niger-Hycos network, the monitoring stations are categorized into four types; Primary, Priority Secondary, Secondary and Tertiary.

Project-2: Enhancement of Data Management Capacity in NIHSA

This project is to enhance the data management of hydrological monitoring.

Project-3: Establishment of Hydrological Modeling Center within NIHSA

In order to make use of hydrological monitoring data and assure high quality of those data, it is proposed that Nigerian Government establish Hydrological Modeling Center within NIHSA.

Project-4: Enhancement of Awareness on Importance of Hydrological Monitoring

This project is to promote awareness on importance of hydrological monitoring by NIHSA staffs.

Table 2-72 Strategy on Improvement of Surface Water Monitoring

Item	Strategy
Classification and layout planning of monitoring stations based on primary purpose and importance	− The monitoring should have clear objective for those usage. Accordingly, methodology of observation, necessary quality of data, timing of data reading/transferring etc. would be decided. − Layout plan is prepared by categorizing the observation stations into i) primary stations, ii) secondary stations, and iii) tertiary stations. − The budget for establishing, operating and maintaining the monitoring stations are limited. The priority stations should be kept in good condition in order to keep continuous long-term observation, even in the limited budget condition.
Securing sustainability of stations	− Collaboration with local people as a gauge keeper should be introduced as a back -up observation system even if automatic device is introduced when establishing, rehabilitating the stations. − Any other possible measures to secure the sustainability should be considered.
Establishing and maintaining good rating curve	− The rating curve should be prepared urgently and be updated periodically. − The establishment of the rating curve should start from the priority stations. − The discharge measurement during flood events should be conducted. − The capacity development for discharge measurement and preparing the rating curve are also important.
Simultaneous observation on hydrological and meteorological data	− The responsible organization for meteorological data is NIMET in Nigeria. However, the number of their synoptic stations managed by NIMET is very limited, which may not be enough for proper hydrological service combined with hydrological data. − It is recommended that the key meteorological data such as precipitation be monitored simultaneously at the same place where hydrological station is set. It will supplement to the data provided by NIMET. The data exchange mechanism between NIMET and NIHSA should also be considered in future.
Simultaneous observation with sediment and water quality	− From the viewpoints of management of rivers and floodplains, the simultaneous monitoring with water quantity and sediment transport should be conducted when periodical discharge measurement at primary stations is executed, in order to grasp the overall dynamics of sediment and water quality. NIHSA is responsible for sediment measurement, whereas water quality and sanitation dept. of FMWR is responsible for water quality measurement.
Establishment of quality assurance mechanism	− NIHSA should establish the proper mechanism of data management such as collecting, processing, storing and disseminating. Necessary capacity development should also be considered.
Developing capacity for hydrological modeling	− The hydrological modeling can supplement to the observed data for water resources assessment. During the process of the modeling, the quality checking of the observed data are also available. − To disseminate the information related to hydrology such as flood warning, long-term predication of surface flow condition is a fundamental hydrological service. The hydrological modeling is necessary tool for it − NIHSA should develop the capability of the hydrological modeling.
Establishing collaborating mechanism on water resources monitoring	− Although NIHSA's primary responsibility is the monitoring for water resources assessment, the contribution to the activities on water resources monitoring is also necessary hydrological service. The collaborating mechanism to the other organizations such as RBDAs, NIWRMC and water quality dept. of FMWR should be established. − The reservoir operation data should be integrated to surface water monitoring data.
Information and Education Campaign on Hydrological Monitoring	− Importance of hydrological data should be recognized and understood by public. − Information and education campaign related to hydrology should be conducted by NIHSA staff. It will eventually support the proper water resources monitoring.

Source: JICA Project Team

(2) Hydrological Monitoring for Groundwater

NIHSA has installed groundwater automatic recorders into 11 boreholes and is implementing groundwater level observation. These boreholes are drilled in sedimentary rock areas with borehole depth of 80 to 100m observing confined groundwater level. The purpose of monitoring is to know the groundwater fluctuation in aquifers that are the main water sources for urban water supply. Data accumulation is still not enough to analyze the tendency of long term groundwater fluctuation. It is expected that this monitoring should continue and new monitoring boreholes should also be established.

Clarification of Purpose and method of monitoring

Monitoring activities will be made more efficient by clarification of monitoring purpose and method. Purpose of monitoring is defined as below:

- To assess groundwater development potentials
- To judge whether groundwater environmental problems is taking place or not, and to examine its cause and measures against it.

Clarification of responsibility of related organization and strengthening of institutional and technical capacity

NIHSA is in charge of groundwater monitoring in the Federal level. NIHSA should implement technical transfer to NIWRMC and State Agencies such as Water Board/Corporation and RUWASSA. For this purpose, their responsibility must be clarified and institutional and technical capacity of them must be improved.

2.8.5 Data and Information Management

(1) Vision of Data and Information Management

Vision for the data and information management on hydrological data are as follows;

- Through sharing knowledge, allow people to make "INFORMED DECISION".
- NIHSA and NIWRMC should be focal Agencies of the database maintenance and operation.

Currently, observing stations' operation is very weak in Nigeria. Therefore it often faces difficulty to maintain continuity and quality of observed data.

In order to avoid improve current condition, especially for important observing point, adding redundancy with human-powered observation is recommended (e.g. Automatic hydrological observing station equipped with water level sensor, also requires water-level gauging with human-power). By utilizing redundant data, quality of observation data (continuance and validity) shall be improved.

(2) Management on Data Acquisition and Archiving

In the Vision of Data and Information Management, observation data and inventory data shall be archived at focal agencies after going through utilization and external checking. However, even before establishment of those data circulating environment, it is necessary to develop data validating mechanism inside of focal agencies such as NIHSA, NIWRWC and other related agencies.

Current management needs monitoring progress of data acquisition and archiving, for management (Evaluation / Judgment). The Project recommends to management level of focal agencies to understand and direct situation through monitoring mechanism.

2.8.6 Management of Floodplain

Considering the issues identified by the JICA Project Team, FMWR should start the basic investigation of floodplain of major rivers such as the Benue, the Niger, the Kaduna and the Sokoto-Rima rivers which have great potential of large scale irrigation.

Table 2-73 Proposed Items of Basic Investigation

Item	Contents
Historical change of river bank	Collecting of map in Colonial era、aerial photos、satellite image、to check the change of river bank and to study the channel stability
River cross section survey	Surveying of floodplain cross section、to prepare cross section drawing indicating of detailed topography. Also surveying of river channel, to confirm the location of thalweg.
Soil profile	To prepare soil profile by boring survey.
Flow capacity	Based on the cross section survey drawing, calculating of waterlevel and flow capacity, to evaluate how frequent the flooding occurs on the floodplain.

Source：JICA Project Team

2.8.7 Consideration of Risk Associated with Climate Change and Trans-boundary Water

Both climate change and trans-boundary water include uncertainty that cannot be controlled by Nigeria. The followings are recommended to cope with the risk associated with climate change and trans-boundary water.

- Refinement of identification of the risk by enhancement of water-related data/information
- Promotion of adaptive management
- Enhancement of emergency management against flood and drought
- Promotion of Water Demand Management

2.8.8 Water Environment Management

Based on the main problems and issues found by the JICA Project Team, the following two plans are proposed for water environment management improvement in Nigeria.

Project-1: National Drinking Water Quality Monitoring Improvement Plan

The objective of the National Drinking Water Quality Monitoring Improvement Program is to generate scientific data of the water source and drinking water quality in Nigeria to safeguard the health of the population. The target samples for this Program shall be the water sources (surface and groundwater) and the treated water consumed by the population and the parameters to be analyzed shall include those necessary to assess the water sources quality and drinking water quality.

Project-2: Water Quality Monitoring Plan for Important Rivers of Nigeria

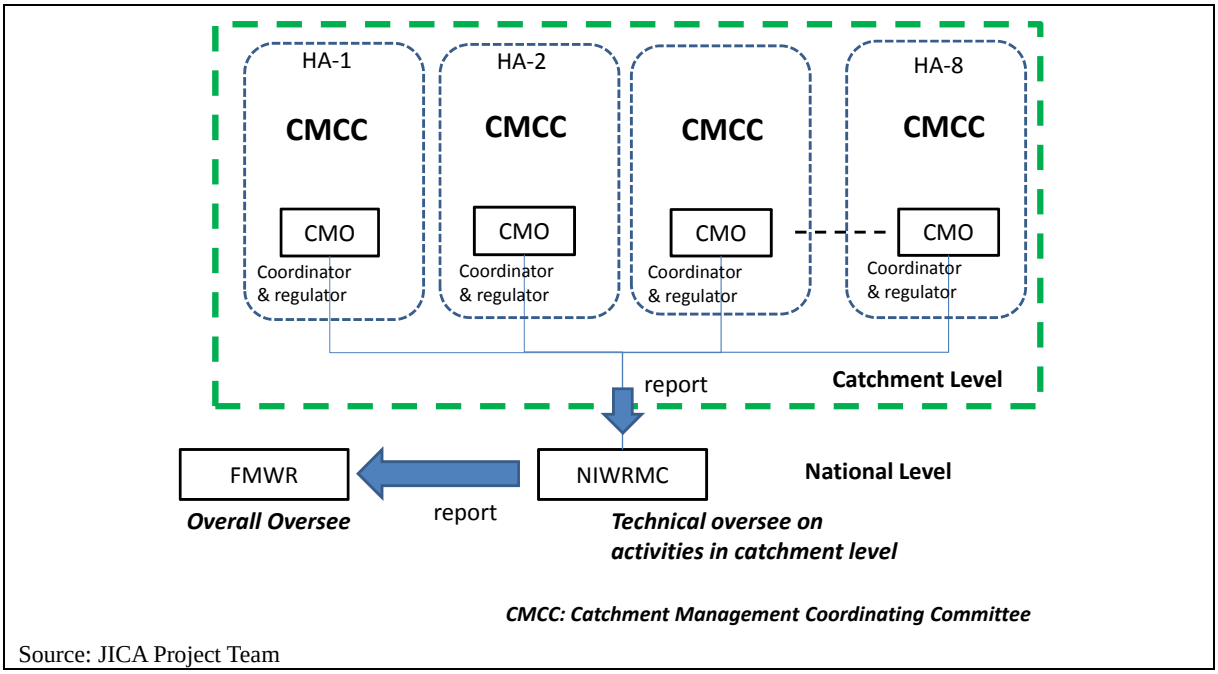
To assess the water quality condition of important rivers in Nigeria, this Plan shall cover main monitoring stations for water quantity along important rives

2.8.9 Water Allocation and Regulation

Although the necessity of obtaining the license for water abstraction and use for commercial scale water use is stated in Water Resources Act, 1993, the implementing framework for it has not yet been introduced.

Nigeria Integrated Water Resources Management Commission (NIWRMC) was established as a responsible organization for management of water use permit and regulation. NIWRMC consists of a central coordinating body as well as Catchment Management Offices (CMOs) at eight (8) hydrological areas. NIWRMC has started its activities from 2008 and waiting official approval for its establishment.

The Basic Policy-3 in Section 2.8.2: Institution and Organization for Public Water Services shows the principle of water resources planning, management and regulation by unit of hydrological area for establishing fair institution for water regulation. The framework on water resources planning, management and regulation by unit of hydrological area is proposed as shown in Figure 2-39.



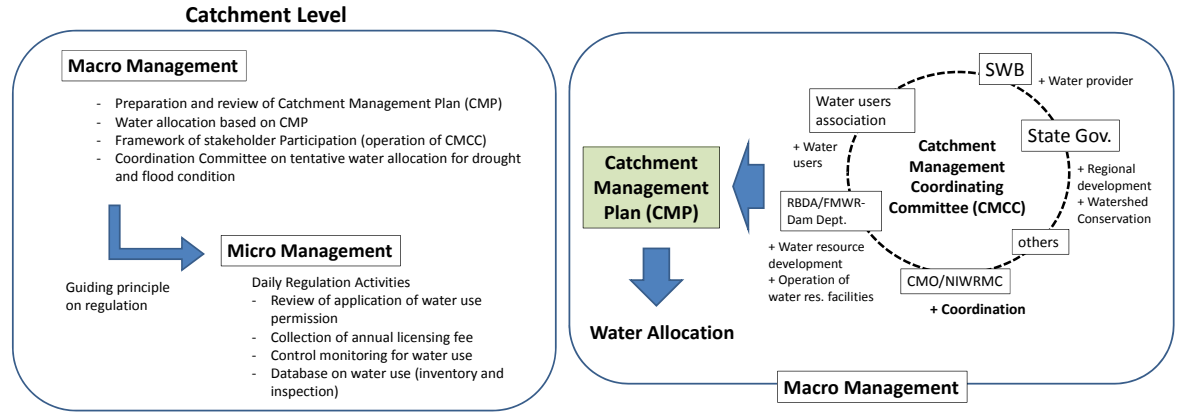
Source: JICA Project Team

Figure 2-39 Framework on Water Resources Planning, Management and Regulation by Unit of Hydrological Area

The basic unit of water resources management is each of eight hydrological areas. The Catchment Management Office (CMO), which is local office of NIWRMC for each hydrological area, acts major role on water resources management in hydrological area. The headquarters of NIWRMC in Abuja oversees the activities of CMO. FMWR further oversees all activities by NIWRMC. NIWRMC reports its activities on water resources planning, management and regulation by unit of hydrological area to FMWR and receives advice from FMWR.

The framework of the activities of CMO at catchment level is proposed as shown in Figure 2-40. The activities of CMO at catchment level can be divided into the following two categories;

- Coordination of stakeholders for macro management; and
- Daily work as regulator of water use for micro management.



Source: JICA Project Team

Figure 2-40 Framework on Activities of CMO at Catchment Level

The following projects are proposed to be implemented by NIWRMC in order to realize the framework on water allocation and regulation.

Project-1: Formulation of Catchment Management Plan for Eight (8) Hydrological Areas

This project is to formulate Catchment Management Plan for each of eight hydrological areas.

Project-2: Enhancement of Capacity on Water Use Permitting and Regulation

This is to enhance the capacity of NIWRMC and CMO on water use permitting and regulation.

Project-3: Promotion of Catchment Management for Eight (8) Hydrological Areas

On the basis of the experiences by Project-1, 2, this project is proposed to be promoting catchment management for all hydrological areas including operation of the water use permitting and regulation system.

Project-4: Preparation of Guideline for Water Pricing

This project is to examine the cost of water use and consequently to prepare the guideline to set proper water license fee and water charge.

2.8.10 Public Relations for Water Sector

The basic policies for effective and sustaining public relations in water sector are discussed below.

- Through PR, demonstrate greater dedications of FMWR, and establish and maintain mutual understanding between FMWR and civil society, ensuring transparency and accountability of all activities of FMWR in water resources development and management
- Through PR, encourage participation of users, planners, decision-makers, etc. in water resources management
- Through PR, enlighten and spread education of water, sanitation and hygiene, gender issue, and environmental conservation at communities

Taking into account the basic policies, the Project suggests the following Action Plan, to be implemented in collaboration with other relevant institutions.

- Strengthen PR, through updating FMWR's quarterly magazine (WATER)
- Strengthen and diversify the tools of PR to include all the media such as newspapers, TV, radio, magazines, etc.
- Strict and efficient management of document files within FMWR (digitalization, etc.)
- Support and assist in participatory process of water resources management considering gender equality, empowerment for women, local behavior practices at households and communities
- Development of workforce and capacity building in the PR-Unit and the Gender and Human Rights Unit

2.8.11 Public Private Partnership (PPP)

Following areas are deemed to be potentially viable and attract the requisite private investment in the water resources sector.

- Irrigation projects (Medium and Large Irrigation)
- Water supply project (Brownfield and Greenfield)
- Hydro-electric power projects
- Water quality management projects
- Aquaculture and Horticulture projects
- Value added projects
- Tourism projects

To promote PPP projects, FGN and FMWR are expected to take the following responsibilities.

- Promotion of PPP through awareness creation, roadshows for private sectors to join public water services by incentives and preferential treatment for source of alternative funding
- Creation of sustainable enabling environment (policy, laws, regulation, etc.) to support PPP
- Identification and development of bankable PPP projects
- Facilitation of issuance of licenses, permits, etc.
- Provision of incentives to encourage the private sector (tax incentives, viability gap funding, etc.)
- Monitoring and evaluation of PPP projects to ensure delivery of intended value for money.

Along with the above government responsibilities, the Project suggests following action plans.

- Strengthening of the PPP Unit of FMWR
- Capacity building for PPP projects preparation and implementation
- Budget allocation for PPP projects preparation
- Establishment of Projects Delivery Teams and Steering Committee
- Regular Partners/Stakeholders Consultation on the PPP process
- Regular updating of policies and strategies to promote private sector participation

2.8.12 Manpower Development and Capacity Building

The Project suggests the following basic policies for HRD for the M/P2013.

- Development and Increase Access to Training Opportunities
- Strengthen Training to Respond to the Needs at River Basin Level
- Strengthening and Enlargement of Training Functions of NWRI

Based on the basic policies, the Project suggests the HRD Plan for the M/P2013. It shall cover all aspects of water resources carried out by various institutions within FMWR, and all relevant institutions such as NWRI, the Dept. of Human Resources, Dept. of Planning, Research and Statistics, etc. shall work under the collaborative system for completing the HRD Plan.

2.8.13 Monitoring and Evaluation

Monitoring and evaluation (M&E), this approach has been used as an effective method for managing the implementation of the projects, is employed to regulate the implementation plan of "Nigeria Vision 20:2020" - Top Plan of the M/P2013. National Planning Commission (NPC) has developed the MDA Scorecard to implementing the M&E to evaluate the performance and contribution of FGN and State Government bodies (Ministry, Department and Agency).

The scorecard is intended to define a consistent format that can be applied to all MDAs, to capture the Key Performance Indicators (KPIs) for Outcomes and Outputs in their strategic sector, and thereby ascertain their progress against annual targets and the efficiency of their strategy.

The role and responsibility of FMWR concerning the M&E is to determine the KPIs of the sub-sectors under the water-related sectors, monitor and evaluate them periodically and submit the results to NPC every year. The Monitoring & Evaluation Sub-department of the Planning, Research and Statistics Department is responsible for M&E of FMWR.

The current M&E system of FMWR is to ascertain the progress of water resources and management strategies, and has undertaken from 2011. Although FMWR intends to reform and improve how to manage the M&E effectively in the future by reflecting the experiences, the JICA Project Team makes

the following recommendations with regard to the M&E.

- To make the DAs of FMWR understand thoroughly the M&E System
- To enhance the M&E System implemented by NIWRM and CMO
- To develop the M&E system particularly for the preparatory stage of project

2.9 Implementation Program

2.9.1 Implementation Schedule

(1) Outline of Projects

Outline of the proposed Project in the M/P2013 is shown in Table 2-74.

Table 2-74 Outline of Proposed Schemes

Project	Outline	Responsible Agency
A. Water Source Development		
A.1 Surface Water Development		
A.1.1 On-going Projects		
● On-going Surface water source development	On-going surface water source development. Number of dams: 30. Total storage capacity: 1,500MCM.	FMWR
A.1.2 Effective Utilization of Existing Dams		
● Capacity development of dam management	This project is to enhance the capacity of dam department of FWMR, as well as dam owners such as RBDAs, SWAs on dam management.	FMWR
● Rehabilitation of equipment for proper operation of major dams	This project is to rehabilitate the equipment for proper operation of dams such as meteorological, hydrological mentoring, monitoring for reservoir operation.	FMWR
● Rehabilitation of deteriorated dams	This project is to rehabilitate deteriorated dam which may threaten the downstream area. The rehabilitation would be implemented case by case up to 2030.	FMWR
A.1.3 New Water Source Development		
● Surface water development for municipal water supply	This project is to prepare stable water source for municipal water supply against the water source where the safety level is expected to be lower than 90% yearly dependability in 2030. Number of dams/weir: 22, Total storage capacity: 207MCM	FMWR
● Surface water development for irrigation development	This project is to secure necessary water volume for irrigation development, according to irrigation development plan proposed in the M/P2013. Number of dams: 21, Total storage capacity: 969MCM	FMWR
● Integrated surface water development	This is an integrated project to combine hydropower generation and irrigation development. Three project sites along the Benue River are proposed. Total storage capacity: 970MCM	FMWR
A.2 Groundwater Development		
A.2.1 Borehole rehabilitation		
● Urban/small-urban/small town	Rehabilitation of 4,880 boreholes with motorized pumps with yield of 2,193,335 m^3/day	SWA
● Rural	Rehabilitation of 949 boreholes with motorized pumps with yield of 422,640 m^3/day, and 13,364 of hand pumps with yield of 133,640m^3/day.	RUWASSA
A.2.2 New boreholes drillings		
● Urban/small-urban/small town	New drilling of boreholes with motorized pumps: 3,858 boreholes with 200m depth, 10,790 boreholes with depth of 50m, total yield of 6,937,613 m^3/day.	SWAs
● Rural	● New drilling of boreholes with motorized pumps: 3,736 boreholes with 200m depth, 5,369 boreholes with depth of 50m, total yield of 1,241,448 m^3/day. ● New drilling of boreholes with hand-pumps: 82,538 boreholes with depth of 50m, total yield of 825,380 m^3/day.	RUWASSA
B. Sub-sector Development		
B.1 Water Supply and Sanitation		
B.1.1 Water Supply Rehabilitation Scheme		
● Urban and Semi-Urban / Small Town	Target: Urban and semi-urban/small town in 36 states and FCT Abuja Scope: Rehabilitation of piped water supply facilities using surface water or groundwater (2015-2030) Beneficiaries: 19,773,000 Development: 3,148 MLD (Surface water : 1,388, Groundwater: 1,761)	FMWR, State Ministries, SWAs, STWSSAs
● Rural	Target: Rural areas in 36 states and FCT Abuja Scope: Rehabilitation of point-source type water supply facilities equipped with motorized pump or handpump using groundwater (2015-2030)	FMWR, State Ministries, RUWASSA

Project	Outline	Responsible Agency
	Beneficiaries: 12,058,000 Development: 430 MLD (Groundwater only)	s
B.1.2 Water Supply Newly Construction Scheme		
● Urban and Semi-Urban / Small Town	Target: Urban and semi-urban/small town in 36 states and FCT Abuja Scope: Newly construction of piped water supply facilities using surface water or groundwater (2015-2030) Beneficiaries: 60,971,000 Development: 9,707 MLD (Surface water: 4,146, Groundwater: 5,561)	FMWR, State Ministries, SWAs, STWSSAs
● Rural	Target: Rural areas in 36 states and FCT Abuja Scope: Newly construction of point-source type water supply facilities equipped with motorized pump or handpump using groundwater (2015-2030) Beneficiaries: 44,725,000 Development: 1,595 MLD (Groundwater only)	FMWR, State Ministries, RUWASSAs
B.1.3 Sanitation Scheme		
● Public Toilet	Target: Urban and semi-urban/small town in 36 states and FCT Abuja Place of installation: Markets, bus terminal and so on (2015-2030) Development: 20,326 places	FMWR, state ministries
● Final Septage Disposal Facility / Site	Target: Urban in 36 states and FCT Abuja Scope: Septage disposal system with considering collection and transportation from domestic septic tanks (2015-2030) Beneficiaries: 6,419,000 households	FMWR, FME, FEPA, SEPA
● Sewerage System	Target: Major urban area of Benin in Edo state, Central in Lagos state, Osogbo in Osun state, Ibadan in Oyo, and FCT Abuja Scope: Sewerage system including sewerage treatment plant and sewer (2015-2030) Beneficiaries: 320,000 households Treatment; 473,266 m3/day	MWR, FME, FEPA, SEPA
● Hygiene Promotion	Target: Urban, semi-urban/small town and rural in 36 states and FCT Abuja Scope: Education and promotion through community-led total sanitation (2015-2030) Beneficiaries: 29,154,000 households	FMWR, state ministries, LGAs
● Domestic Sanitation Facilities	Responsibility: Residents in urban, semi-urban/small town and rural in 36 states and FCT Abuja (2015-2030) Description: Installation of domestic toilet or latrine Households: Urban:16,651,000, Semi-Urban/Small Town: 13,407,0000 Rural: 36,796,000	
B.2 Irrigation/Drainage		
B.2.1 Rehabilitation of Existing scheme	Subject: 37 schemes, Future Irrigation Area 36,163ha,	FMWR, State
B.2.2 New Irrigation scheme		
● Ongoing Scheme	Scheme which has been on-going by FMWR and has a sure plan to implement in future. Subject: 32 schemes, Future Irrigation Area 98,897ha	FMWR
● Extension Scheme	Scheme which is recommended to expand planned irrigation area more in future, even if scheme has already completed or suspended. Subject: 92 schemes, Future Irrigation Area 103,937ha	FMWR, State
● Supplementary Irrigation Scheme	Scheme which comprises of land reclamation and supplementary irrigation. Scheme is specified in HA-5 and HA-7 owning much precipitation. Subject: HA-5 A=19,000ha, HA-7 A=29,000ha	FMWR
● Dam Irrigation Scheme	Scheme which has irrigation dam considered in the M/P1995 and the M/P2013 in order to assure full-year irrigated farmland. Subject: 17schemes, Future Irrigation Area 80,900ha,	FMWR
● Integrated Development Scheme	Scheme which is extensively developed by multipurpose dam, utilizing water and hydropower deriving from that dam, where are Donga-Suntai river, Taraba river and Akini river which are tributary of Benue river. Subject: 3schemes, Future Irrigation Area 90,000ha,	FMWR
B.3 Hydropower Generation		
● Installation in to existing dams	Promotion of installation of hydropower generation facilities into potential existing dams for self-supporting agriculture with irrigation. Survey for availability is necessary from now on.	
● Installation to newly constructed dams	Subordination hydropower generation will be conducted at Nasarawa, Taraba, Donga-Suntai dam.	
C. Water Resources Management		
C.1 Hydrological Monitoring		
● Improvement of Surface Water Monitoring Network	The monitoring network on surface water is setup step by step. Depending on the main purpose of monitoring, the monitoring stations are categorized into four types: primary (18), priority secondary (22),	NIHSA

Project	Outline	Responsible Agency
	secondary (35) and tertiary (93).	
● Improvement of Groundwater Monitoring Network	Project to install groundwater level monitoring: 1) Assessment for groundwater potential (120 sites), 2) Groundwater environmental monitoring such as over-pumping, regional lowering of groundwater level and sea water intrusion (22 sites)	NIHSA
● Enhancement of Data Management Capacity in NIHSA	This project is to enhance the data management of hydrological monitoring. Phase-1 is to enhance the capacity of the following items in a pilot area. In phase-2, the activities conducted in Phase-1 will be expanded continuously by NIHSA with more proactive manner.	NIHSA
● Establishment of Hydrological Modeling Center within NIHSA	In order to make use of hydrological monitoring data and assure high quality of those data, it is proposed that Nigerian Government establish Hydrological Modeling Center within NIHSA. The capacity development project related to hydrological modeling is proposed, in order to consolidate the related activities.	NIHSA
● Enhancement of Awareness on Importance of Hydrological Monitoring	This project is to promote awareness on importance of hydrological monitoring by NIHSA staffs.	NIHSA
C.2 Water Allocation and Regulation		
● Formulation of Catchment Management Plan for Eight (8) Hydrological Areas	This project is to formulate Catchment Management Plan for each of eight hydrological areas.	NIWRMC
● Enhancement of Capacity on Water Use Permitting and Regulation	This is to enhance the capacity of NIWRMC and CMO on water use permitting and regulation.	NIWRMC
● Promotion of Catchment Management for Eight (8) Hydrological Areas	This project is proposed to be promoting catchment management for all hydrological areas including operation of the water use permitting and regulation system, on the basis of the experiences by the above two projects.	NIWRMC
● Preparation of Guideline for Water Pricing	This project is to examine the cost of water use and consequently to prepare the guideline to set proper water license fee and water charge.	NIWRMC
C.3 Water Environment Management		
● National Drinking Water Quality Monitoring Improvement Plan	In order to generate scientific data of the water source and drinking water quality in Nigeria, the capacity development for water quality monitoring is proposed to be conducted. The continuous water quality monitoring is implemented after the capacity development.	FMWR
● Water Quality Monitoring Plan for Important Rivers of Nigeria	This project is to implement the water quality monitoring for important rivers in Nigeria, in order to assess the water quality situation in the important rivers.	FMWR

Source: JICA Project Team

(2) Implementation Schedule

(2-1) Water Source Development

Surface Water Development

On-Going Projects

At least, the on-going projects would be completed by 2020.

Effective Utilization of Existing Dams

It is proposed to implement urgently the capacity development project on dam management for FMWR and relevant agencies. During the capacity development activities, necessary survey such as safety management survey and dam body survey should be implemented as many as possible, so as to materialize the rehabilitation project. Higher priority is given to the rehabilitation of equipment for proper operation of major dams.

New Water Source Development

It is proposed that the stable water source for urban water supply should be achieved by 2025 at which the 100% coverage of the municipal water supply is targeted. The water source development for irrigation development would be implemented according to the irrigation development plan. As for the integrated project, relatively small scale project would be implemented as a pilot case, and then the remaining large projects would be implemented by 2030.

Groundwater Development

Groundwater will be developed by new borehole drilling and rehabilitation of nonoperational boreholes. It is most efficient to develop groundwater following growth of groundwater demand. Therefore, amount of groundwater development, i.e. total yield from new boreholes and

rehabilitated boreholes, will be increased in proportional to increase of groundwater demand, which can be assumed as linear growth during 2014 to 2030. It means that number of new boreholes and rehabilitated borehole is the same every year.

(2-2) Water Sub-Sector Development

Water Supply and Sanitation

Water supply facilities using surface water; the M/P2013 proposes rehabilitation of existing facilities and newly construction of the facilities in the process of concrete designing as priorities in the 1st state, and then continuing newly construction of facilities according to progress of water sources development in the 2nd and 3rd stages. Water supply facilities using groundwater; the M/P2013 proposes rehabilitation of existing facilities and newly construction of facilities in the entire period from 1st to 3rd stage.

As for sanitation, the M/P2013 proposes construction of public toilets in the entire period, construction of final septage disposal facilities and/or sites in the short term, and construction of sewerage systems in the 2nd and 3rd stages.

Irrigation and Drainage

It is proposed that the Ongoing Scheme should be achieved by 2025 considering their high priority. Supplementary Irrigation Scheme, which is expected earlier effective benefit due to comparatively small and economical scale development, would be achieved by 2025. Extension Scheme and Integrated Development Scheme would be prepared on 1st Stage and implemented by 2025 considering their own large scale development. Dam Irrigation Scheme would be implemented by 2030 in accordance with those irrigation dams construction period. Integrated Development Scheme also would be implemented by 2030.

(2-3) Water Resources Management

Hydrological Monitoring

The monitoring network would be improved step by step. As for the hydrological services such as data management and hydrological modeling, the capacity development project would be urgently implemented. Then, the related hydrological services would be continuously implemented. The awareness on importance of hydrology would be promoted continuously for the entire period.

Water Allocation and Regulation

The Catchment Management Plans should be urgently prepared. Simultaneously, capacity on water use permitting and regulation by NIWRMC should be enhanced. Furthermore, guideline for water pricing should be prepared. These should be implemented urgently in short term. On the basis of these experiences, catchment management for Eight (8) hydrological areas would be implemented continuously.

Water Environment Management

The capacity development for water quality monitoring would be implemented firstly. Then, the continuous water quality monitoring for drinking water as well as for important rivers would be implemented.

2.9.2 Cost Estimate

(1) Conditions for Cost Estimate

Table 2-75 presents the conditions for cost estimate applied here.

Table 2-75 Conditions for Estimate

Cost Items	Contents and Conditions
(1) Construction	Labor, materials, machinery, etc.
(2) Equipment	Procurement of equipment not included in the above construction costs: that is, hydropower generators and irrigation pumps
(3) Engineering	10% of the sum of above (1) and (2)
(4) Administration	5% of the sum of above (1) and (2)
(5) Physical Contingency	10% of the sum of above (1) to (4)

Source: JICA Project Team

(2) Project Cost

Cost of high priority projects is shown in Table 2-76 to Table 2-78 with its detail. Total amount of

the Project cost is 376 billion Naira for surface water development, 100 billion Naira for groundwater development, and 476 billion Naira in total. On the other hand, it is 4,117 billion Naira for water supply and sanitation and 1,531 billion Naira for irrigation and drainage. Also it is 29 billion Naira for water resources management.

Of the total project cost, 8% for water supply development and water resources management, 67% for water supply and sanitation and 25% for irrigation and drainage. Water supply and sanitation cost occupies large part of the total cost.

Table 2-76 Project Cost for Water Sources Development Schemes

Project	Content (Million Naira)					Total (Millionaire)
	Construction	Equipment	Engineering	Admini-stration	Physical contingency	
1. Surface Water Development	**295,722**	**1,228**	**29,695**	**14,848**	**34,149**	**375,642**
2 Groundwater Development	**79,124**	**0**	**7,912**	**3,957**	**9,099**	**100,092**
Total	**374,846**	**1,228**	**37,607**	**18,805**	**43,248**	**475,734**

Source: JICA Project Team

Table 2-77 Cost of Sub-sector Development Schemes

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineering	Admini-stration	Physical contingency	
1. Water Supply and Sanitation	**3,254,770**		**325,477**	**162,738**	**374,298**	**4,117,284**
1.1 W. S. Rehabilitation Scheme	186,282		18,628	9,314	21,422	235,646
1.2 W. S. New Construction Scheme	2,409,720		240,972	120,486	277,118	3,048,296
1.3 Sanitation Scheme	658,768		65,877	32,938	75,758	833,342
2. Irrigation and Drainage	**1,180,086**	**30,725**	**121,080**	**60,317**	**139,221**	**1,531,429**
2.1 Rehabilitation of Existing scheme	39,670	568	4,023	2,012	4,627	50,900
2.2 New Irrigation scheme	1,140,416	30,157	117,057	58,305	134,594	1,480,529
Total	**4,465,581**		**446,557**	**223,055**	**513,519**	**5,648,713**

Source: JICA Project Team

Table 2-78 Cost of Water Resources Management Schemes

Project	Content (Million Naira)		Total (Million Naira)
	Equipment	Administration	
1. Hydrological Monitoring	10,512	13,115	23,627
2. Water Environment Management	3,700	2,009	5,709
Total	**14,212**	**15,124**	**29,336**

Source: JICA Project Team

2.9.3 Financial Program for Project Implementation

Financial program is shown in Table 2-79, which was estimated in the previous sections for water sources development, water supply and sanitation and irrigation and drainage.

In water sources development sector (surface water and groundwater), 30% of the total investment is for the 1st Stage, 31% for the 2nd Stage and 39% for the 3rd Stage. Investment is almost the same at every stage though it is a little higher in the 3rd stage.

In water supply and sanitation sector, 45% of the total investment is for the 1st Stage, 34% for the 2nd Stage and 22% for the 3rd Stage. Investment for the 1st Stage is the largest of all the stage. Then investment will gradually reduce afterward.

In irrigation and drainage sector, 23% of the total investment is for the 1st Stage, 50% for the 2nd Stage and 27% for the 3rd Stage. Investment for the 2nd stage is the largest of all the stage.

Table 2-79 Financial Program of Investment for Water Resources Development Schemes

Project	Investment for each Stage (Billion Naira)			Total (Billion Naira)
	1st Stage 2014-2020	2nd Stage 2021-2025	3rd Stage 2026-2030	
A. Water Source Development	**144.0**	**146.8**	**184.8**	**475.7**
A.1 Surface Water Development	98.4	108.8	168.4	375.6
A.1.1 On-going Project	98.4	0	0	98.4
A.1.2 New Water Source Development	0	108.8	168.4	277.2
A.2 Groundwater development	45.6	38.0	16.4	100.1
A.2.1 Rehabilitation of existing boreholes	1.4	1.2	1.0	3.6
A.2.2 New drilling boreholes	44.2	36.8	15.4	96.5
B. Water Supply and Sanitation	**1,836.9**	**1,393.5**	**886.9**	**4,117.3**
B.1 Water Supply Rehabilitation Scheme	142.5	49.8	43.3	235.6
B.2 Water Supply Newly Construction Scheme	1,489.4	994.6	564.3	3,048.3
B.3 Sanitation Scheme	205.0	349.1	279.3	833.3
C. Irrigation and Drainage	**353.8**	**757.6**	**420.0**	**1,531.4**
C.1 Rehabilitation of Existing scheme	14.7	33.8	2.4	50.9
C.2 New Irrigation scheme	339.1	723.8	417.6	1,480.5
Total	**2,334.7**	**2,297.9**	**1,491.7**	**6,124.4**

Source: JICA Project Team

2.10 Evaluation of National Water Resources Master Plan 2013

2.10.1 Evaluation from Economic and Financial Aspects

(1) Economic Evaluation

An economic evaluation on projects such as “B.1 Water Supply” and “B.2 Irrigation and Drainage” proposed as the sub-sector development project in Section 2.9 is carried out.

(1-1) Water Supply Projects

The results vary from state to state. However, from the national viewpoint, the EIRR exceeds the 10% of opportunity cost of capital (OCC) or slightly below it. Accordingly, the water supply projects of the M/P2013 as a whole are judged to be economically feasible.

Table 2-80 Results of Economic Analysis of Water Supply Projects (NPV: Naira in billion)

	Rehabilitation Schemes						New Development Schemes					
	Urban & Semi-urban			Rural			Urban & Semi-urban			Rural		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	50.0%	3.6	314.7	27.6%	2.2	11.1	10.1%	1.01	13.5	9.2%	0.94	-4.9

Source: JICA Project Team

(1-2) Irrigation and Drainage Projects

The results vary from HA to HA. However, from the national viewpoint, the EIRR exceeds the 10% of OCC. Accordingly, the irrigation and drainage projects of the M/P2013 as a whole are judged to be economically feasible.

Table 2-81 Results of Economic Analysis of Existing Schemes (NPV: Naira in billion)

	Rehabilitation Schemes			Irrigation Extension of ongoing Schemes			Irrigation Extension of coming Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	41.8%	4.1	47.9	13.2%	1.3	33.4	10.8%	1.1	5.2

Source: JICA Project Team

Table 2-82 Results of Economic Analysis of New Schemes (NPV: Naira in billion)

	Supplementary Irrigation Schemes			Dam Irrigation Schemes			Integration Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	20.3%	2.0	66.5	9.6%	0.96	-3.9	10.4%	1.0	4.3

Source: JICA Project Team

(2) Financial Consideration

The yearly average budget amount of FGN and state governments over the period of three (3) years from 2009 to 2011 allocated to these two sectors of water supply development and irrigation development were 148billion Naira and 35billion Naira respectively. Assuming that the like budget continues hereafter in the future, the allocations to the project costs of the M/P2013 from the governments are presumed bellow.

1st Stage: year 2014-2020: In consideration of priority and antecedent allocation to the existing and implementing projects for its acceleration and completion, 50% out of the year budget allocation to the projects of the M/P2013, namely 91.5billion Naira
2nd Stage: year 2021-2025: On completion of the existing and implementing projects, 100% to the projects of the M/P2013 out of the year budget allocation, namely 183billion Naira
3rd Stage: year 2026 – 2030: 100% to the projects of the M/P2013 out of the year budget allocation, namely 183billion Naira

(2-1) Water Supply Projects

Firstly, the allocated budget to the M/P2013 would be disbursed to the projects that could achieve the highest economical effectiveness, namely the rehabilitation projects. Secondary, the remaining budget would be spent to the new development projects. However, it is mathematically obvious that the project cost of these new development projects could not be financed entirely with this remaining government budget. Meanwhile, FGN strongly envisages the 100% nationwide coverage with water supply. To attain this national goal, it is earnestly suggested that the government would aggressively finance with an additional budgeting to enable the said uncovered part of the new development project costs to be fulfilled

Particularly, the state governments play the crucial role for the development of water supply sector in Nigeria, currently bearing more than 80% of the water supply development costs of Nigeria. The M/P2013 requires a year average amount of 224billion Naira in 1st Stage, 186billion Naira in 2nd Stage and 100billion Naira in 3rd Stage from the state governments (Project Cost X 80%). Accordingly, a substantial amount of additional budget especially for the respective stage is estimated at 165billion Naira, 68billion Naira and 5billion Naira. As a result, the state governments have to collaborate closely with FGN and also discuss the financial support from FGN on the implementation of the M/P2013.

Table 2-83 Financing to Water Supply Projects (Naira in billion)

Items	1st Stage 2014-2020		2nd Stage 2021-2025		3rd Stage 2026-2030		Total 2014-2030	
	Entire Stage	Year Average	Entire Stage	Year Average	Entire Stage	Year Average	Entire Stage	Year Average
1. Current FGN & State Gov. Budget Allocation (Year ave. of 2009/11)	445	74 100%	741	148 100%	593	119 100%	1,779	105 100%
2. Way of Financing for Project Costs	1,679	280 379%	1,163	233 191%	625	125 105%	3.467	204 194%
1) Rehabilitation (FGN & State Gov. Budget)	145	24	112	22	45	9	302	18
2) New Development (FGN & State Gov. Budget)	300	50	629	126	548	110	1,477	87
3) New Development (Additional Budget)	1,234	206	422	85	32	6	1,688	99

Source: JICA Project Team

(2-2) Irrigation and Drainage Projects

Firstly, the allocated budget to the M/P2013 would be disbursed to the projects that could achieve the highest economical effectiveness, namely the rehabilitation projects and the supplementary irrigation projects. Secondary, the remaining budget would be spent to the new projects. However, obviously, the project cost of these new development projects could not be financed entirely with this remaining budget. Meanwhile, FGN has been challenging the 100% self-supply of rice. To accomplish this national plan, it is strongly proposed that the government would aggressively finance with an additional budget to enable the said uncovered part of the new project costs to be disbursed.

Table 2-84 Financing to Irrigation Projects (Naira in billion)

Items	1st Stage 12014-2020		2nd Stage 2021-2025		3rd Stage 2026-2030		Total 2014-2030	
	Entire Stage	Year Ave.	Entire Stage	Year Ave.	Entire Stage	Year Ave.	Entire Stage	Year Ave.
1. Current FGN Budget Allocation (Year average of 2009/11)	121	17 100%	173	35 100%	138	35 100%	432	27 100%
2. Way of Financing for Project Costs	353	50 294%	776	155 442%	578	144 411%	1,707	107 396%
1) Rehabilitation (FGN Budget)	15	2	33	7	2	0.5	50	3
2) Supplementary (FGN Budget)	94	13	94	19	-	-	188	12
3) Other New Development (FGN Budget)	12	2	46	9	136	34	194	12
4) Other New Development (Additional Budget)	232	33	603	120	440	109	1,275	80

Note：New Development means these 4 schemes: Irrigation Extension of Ongoing Schemes, Extension Schemes, Dam Irrigation Schemes and Integration Schemes
Source: JICA Project Team

2.10.2 Evaluation from Social and Environmental Aspects (IEE)

(1) List of Projects and Brief Description

The list of projects is composed of five (5) sectors which include 64 ongoing and 934 proposed projects as listed in Table 2-85.

Table 2-85 Number of Projects under M/P2013

Sector	Ongoing Projects	Proposed Projects	Total
1. Dam	32	49	81
2. Municipal Water Supply**	0	489	489
3. Irrigation and Drainage	32	114	146
4. Sanitation	-	264	264
5. Water Resources Management and others	-	18	18
Total	64	934	998

Source: JICA Project Team

(2) Categorization of Projects (Screening)

The screening of projects was made based on the Categories List stipulated in the Procedural Guidelines on Environmental Impact Assessment, Decree 86, 1992. The result of the screening is summarized in Table 2-86.

Table 2-86 Categorization of Projects in M/P2013 subjected to IEE/EIA Study

EIA Category	Description	Documents Required For Application to EIA Division	Projects affected	
			Sector	Number
1	Full EIA is required	Submission of Project Proposal or FS and the TOR for EIA Study	Dam	55
			Municipal Water Supply	179
			Irrigation and Drainage	45
			Sanitation	42
			WRM and other	0
			Total Category 1	321
2	Partial EIA may be required	Submission of Project Proposal or FS and the TOR for EIA Study	Dam	25
			Municipal Water Supply	276
			Irrigation and Drainage	96
			Sanitation	74
			WRM and other	0
			Total Category 2	471
3	Not require EIA	Application letter for EIS	Dam	1
			Municipal Water Supply	34
			Irrigation and Drainage	0
			Sanitation	148
			WRM and other	18
			Total Category 3	201
	Disregarded projects*		Irrigation	5
Total Projects in the M/P2013				998

*: Five (5) projects were disregarded in the Sector of Irrigation/Drainage and not proposed in this MP due to unavailability of water for their implementation. Source: JICA Project Team

(3) Identification of Potential Impacts and Its Significance

For projects that have been scoped for IEE study, the identification of potential impacts and its significance were made based on scoping matrix. The summary is shown in Tables 2-87 and 2-88.

Table 2-87 Summary of Matrix for Scoping (Dams and Municipal Water Supply Sectors)

Environmental Component	Nº	Likely Impact Items	Overall Rating										
			Sector Dams				Sector Municipal Water Supply						
			Dams with surface area > 200 has- Group 1	Dams with surface area < 200 has - Group 2	Dam with surface area > 200 has located in Protected Areas- Group 3	Dam with surface area < 200 has located in Protected Areas - Group 4	WS with Treatment Plant Capacity more than 4,500 m3/d- Group 1	WS with Treatment Plant Capacity less than 4,500 m3/d- Group 2	WS with Field Motorized Boreholes Capacity > 4,500 m3/d- Group 3	WS with Single Motorized Borehole- Group 4	WS with Single Borehole with Hand Pump- Group 5	Rehabilitation of Facilities with big scale of activities- Group R1	Rehabilitation of Facilities with smale scale of activities- Group R2
Social Environment	1	Involuntary resettlement	A-	B-	-	-	-	-	-	-	-	-	-
	2	Local Economy such as Employment & Livelihood, etc.	A+	B+	A+	B+	A+	B+	B+	-	-	A+	B+
	3	Land use and utilization of local resources	A-	B-	A-	B-	B-	B-	-	-	-	-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	C-	C-	C-	C-	-	C-	C-	-	-	-	-
	5	Existing social infrastructure & Services such as Traffic/Public Facilities	A-	B-	A-	B-	A-	B-	-	-	-	A-	B-
	6	The poor, indigenous and ethnic people	C-	C-	C-	C-	-	-	-	-	-	-	-
	7	Inequality between beneficiaries and project-affected peoples	-	-	-	-	-	-	-	-	-	-	-
	8	Cultural heritage	-	-	C-	C-	-	-	-	-	-	-	-
	9	Local conflict of interests	C-	C-	A-	A-	-	C-	-	-	-	-	-
	10	Water use right and common land use right	C-	C-	C-	C-	-	-	-	-	-	-	-
	11	Water supply and/or Irrigation with Potential Power generation	A+	A+	A+	A+	A+	A+	A+	A+	A+	-	-
	12	Vector of diseases	A-	A-	A-	A-	-	-		-	-	-	-
	13	Disaster (natural risk) and infectious diseases such as HIV/AIDS	A-	B-	A-	B-	B-	B-	B-	B-	B-	B-	B-
Natural Environment	14	Topography and geographical features	C-	B-	B-	B-	-	-	-	-	-	-	-
	15	Accumulation of sediment into Dams	B-	B-	B-	B-	-	-	-	-	-	-	-
	16	Protected Area	-	-	A-	A-	C-/C+	C-/C+	C-/C+	-	-	-	-
	17	Ground water	C-/C+	C-/C+	C-/C+	C-/C+	-	-	-	-	-	-	-
	18	Soil erosion	B-	B-	B-	B-	B-	B-	-	-	-	-	-
	19	Hydrological situation (flow regime)	B-	B-	B-	B-	B-	B-	C-	-	-	-	-
	20	Coastal zone	-	-	-	-	C-	C-	-	-	-	-	-
	21	Flora, Fauna and Biodiversity	A-	B-	A-	A-	B-	B-	-	-	-	-	-
	22	Meteorology	-	-	-	-	-	-	-	-	-	-	-
	23	Landscape	-	-	-	-	-	-	-	-	-	-	-
	24	Global warming	-	-	-	-	-	-	-	-	-	-	-
Pollution	25	Air pollution	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
	26	Water pollution	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
	27	Soil pollution	-				-	-	-		-	-	
	28	Waste	B-	B-	B-	B-	B-	B-	B-	B-	-	B-	B-
	29	Noise and vibration	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-	B-
	30	Ground subsidence	-	-	-	-	-	-	-	-	-	-	-
	31	Offensive odor	-	-	-	-	-	-	-	-	-	-	-
	32	Bottom sediment	C-	C-	C-	C-	B-	B-	-	-	-	-	-
	33	Accident	C-	C-	C-	C-	C-	C-	C-	C-	C-	C-	C-

Rating Criteria

A+/-: Significant positive/negative impact is expected.

B+/-: Some positive/negative impact is expected.

C+/-: Extent of positive/negative impact is unknown. (A further examination is required in the further project formulation)

・ -: No impact is expected.

Source: JICA Project Team

Table 2-88 Summary of Matrix for Scoping (Irrigation/Drainage and Sanitation Sectors)

Environmental Component	Nº	Likely Impact Items	Overall Rating						
			Sector Irrigation and Drainage				Sector Sanitation		
			Irrigation Schemes with Area > 5,000 ha - Group 1	Irrigation Schemes with Area < 5,000 ha - Group 2	Irrigation Schemes with Area > 5,000 ha located in protected area - Group 3	Irrigation Schemes with Area < 5,000 ha located in protected area - Group 4	Construction of Sewerage- Group 1	Construction of Septage Treatment System- Group 2	Construction of Public Toilets- Group 3
Social Environment	1	Involuntary resettlement	A-	B-	C-	C-	-	-	-
	2	Local Economy such as Employment & Livelihood, etc.	A+	A+	A+	B+	B+	B+	-
	3	Land use and utilization of local resources	A-	B-	A-	B-	B-	B-	-
	4	Social institutions such as social infrastructure and local decision-making institutions	C-	C-	C-	C-	-	-	-
	5	Existing social infrastructure & Services such as Traffic/Public Facilities	A-	B-	A-	B-	B-	B-	-
	6	The poor, indigenous and ethnic people	C-	C-	C-	C-	-	-	-
	7	Inequality between beneficiaries and project-affected peoples		-	-	-	-	-	-
	8	Cultural heritage		-	-	-	-	-	-
	9	Local conflict of interests	C-	C-	C-	C-	A-	A-	-
	10	Water use right and common land use right	B-	B-	C-	C-	-	-	-
	11	Sanitation	-	-	-	-	A+	A+	A+
	12	Vector of diseases	A-	B-	A-	B-	B-	B-	B-
	13	Disaster (natural risk) and infectious diseases such as HIV/AIDS	B-	B-	A-	B-	B-	B-	-
Natural Environment	14	Topography and geographical features	-	-	-	-	-	-	-
	15	Accumulation of sediment into Dams	-	-	-	-	-	-	-
	16	Protected Area	-	-	A-	A-	C-/C+	C-/C+	-
	17	Ground water	-	-		-	-	-	-
	18	Soil erosion	B-	B-	B-	B-	B-	B-	-
	19	Hydrological situation (flow regime)	B-	B-	B-	B-	-	-	-
	20	Coastal zone	-	-	-	-	-	-	-
	21	Flora, Fauna and Biodiversity	A-	B-	A-	A-	B-	B-	-
	22	Meteorology	-	-	-	-	-	-	-
	23	Landscape	-	-	-	-	-	-	-
	24	Global warming	-	-	-	-	-	-	-
Pollution	25	Air pollution	B-	B-	B-	B-	B-	B-	-
	26	Water pollution	A-	B-	A-	A-	B-	B-	B-
	27	Soil pollution	B-	B-	B-	B-	-	-	-
	28	Waste	B-	B-	B-	B-	B-	B-	B-
	29	Noise and vibration	B-	B-	B-	B-	B-	B-	-
	30	Ground subsidence	-	-	-	-	-	-	-
	31	Offensive odor	-	-	-	-	A-	A-	A-
	32	Bottom sediment	B-	B-	B-	B-	B-	B-	-
	33	Accident	C-	C-	C-	C-	C-	C-	C-

Rating Criteria

A+/-: Significant positive/negative impact is expected.

B+/-: Some positive/negative impact is expected.

C+/-: Extent of positive/negative impact is unknown. (A further examination is required in the further project formulation)

・-: No impact is expected.

Source: JICA Project Team

(4) Description of Mitigation Measures against Adverse Impacts

Based on the scoping activities as shown above, the following main mitigation measures are recommended for major adverse impacts in each Sector.

Table 2-89 Recommended Main Mitigation Measures

Sector	Major Impact	Main Mitigation Measures
Dam	Resettlement	Conduct public consultation with Project affected person (PAPs) and local residents to explain the benefits of the project. For PAPs prepare detail analysis for compensation
	Utilization of Local Resources	Prepare utilization and post utilization plan for those areas from where materials will be extracted for construction of the dam
	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction
	Vector of diseases and HIV/AIDS	Implement medical check-up program
	Flora & Fauna	Plantation of forest to be home of the biodiversity and to compensate deforestation due to the construction of the dams.
Municipal Water Supply	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction.
Irrigation and Drainage	Resettlement	Conduct public consultation with Project affected person (PAPs) and local residents to explain the benefits of the project. For PAPs prepare detail analysis for compensation
	Utilization of Local Resources	Prepare utilization and post utilization plan for those areas from where materials will be extracted for construction of the dam
	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction.
	Vector of diseases and HIV/AIDS	Implement medical check-up program
	Flora & Fauna	Plantation of forest to be home of the biodiversity and to compensate deforestation due to the construction of the dams.
	Water Pollution	- Proper management of chemicals and waste oil from equipment maintenance - Implement training and education of farmers on the kind of chemicals they can use rationally - Check that only authorized chemicals are used at the site - Implement water quality monitoring for existing drinking wells. If affected, construct boreholes for affected people
Sanitation	Social Conflict	Conflicts to get approval from citizens for the location of the facility may arise. It is recommended to conduct public consultation with project affected person to arrive to a beneficial agreement. The Agency should make a compromise to manage properly the facility to obtain the consensus of the population on the Project implementation.
	Offensive Odor	Proper management of the facility

Source: JICA Project Team

(5) Conclusions and Recommendations

In general, the projects proposed in the M/P2013 will benefit three main sectors namely municipal water supply, irrigation, drainage and sanitation. As for municipal water supply high positive impacts are expected through the project implementation on the current health level of the beneficiary population by consuming potable water which in turn will allow the exercise of better hygiene practices in the households. As for irrigation/drainage, the socio-economic status of the population will be highly upgraded through the increase of agricultural production and employment opportunities. In addition food security for the population will be improved. As for sanitation, a high positive impact is expected on the public health of the population through the safe disposal of sewage and excreta.

Some adverse impacts on the environment are also expected from the project implementation which shall be diminished through the proposed mitigation measures. In this sense, especial attention must be given to the dam sectors since it involve huge physical intervention and may need the resettlement of people living around the candidate site.

2.11 Recommendations

2.11.1 Practical Use and Periodic Review of National Water Resources Master Plan 2013 (M/P2013)

(1) Practical Use of M/P2013

The M/P2013 shows the road map of water resources development and management up to 2030 and handles a comprehensive development and management of water resources in Nigeria as a whole country. Therefore, for the Federal Ministry of Water Resources (FMWR) responsible for the main trunk water resources development and management, it has become a convenient plan. However, the matters of water resources development and management should be conducted at the state level and hydrological basin level in many cases. In addition, in the water sector, there are many water sub-sectors under the jurisdiction of the other federal ministries other than the FMWR. Therefore, the M/P2013 has been compiled to practically use such matters as follows:

- Catchment Management Plan (CMP) as a master plan by Hydrological Area
- Water Sub-sector Development Plan other than "water supply and sanitation" and "irrigation and drainage"

The M/P2013 has been prepared in the collaboration for about two and a half years with the consultant team dispatched by JICA with the technical cooperation of Japan (JICA Project Team) and “Steering Committee”, “Technical Advisory Committee” and “Counterpart Team” formulated by the members from the FMWR. In other words, this plan is a work produced by enthusiasm for the water vision of Nigeria and technology of Japan on water resources development and management.

In the future, the FMWR is recommended to elaborate and maintain this work (M/P2013) for better utilization of it.

(2) Periodic Review of M/P2013

The M/P2013 has been formulated on the basis of evidence of water resource potential based on a scientific approach and water demand forecast based on economic growth and population projections up to 2030. Future, it is necessary to check the water demand forecast and look at the track record of economic growth and population growth.

In addition, it is necessary also to check water resource potential on a regular basis. The reason is a matter of trans-boundary water. About 1/4 (88BCM/Year) amount of water resources of Nigeria (374BCM/Year) are flowing in from outside the country through the Benue and Niger rivers. Reduction of inflow will take place by water resources development in the basins on both rivers. The other reason is the problem of global climate change. Increase in drought frequency and occurrence of large floods have been foreseen. Some situations, water resource potential also may change.

In view of the above, the FMWR is recommended to carry out periodic reviews (for example, every five years) of the M/P2013.

2.11.2 Implementation of Water Resources Development Plan

As water resources development plan, the M/P2013 shows two (2) development plans for water sub-sectors, namely "Water Supply Development Plan" and "Irrigation and Drainage Development Plan", including the water source development (groundwater development and surface water development).

(1) Water Supply Development Plan

Water Supply Development Plan is a development plan that corresponds to the improvement of water supply rate and new water demand of future population growth (100 million people) to increase to up to 2030. The current water supply rates are: 71% (Urban), 51% (Semi-urban), 40% (Rural) and 56% in the national average. In accordance with the road map of the FMWR (2011), the water supply rate in 2025 is planned to achieve 100% of each.

Water supply system is a critical infrastructure underlying the country. As the investment to water source development facilities (dams and wells), water purification facilities and water distribution networks will be large-scale, investment in government level become essential. Both governments of Federal and State are recommended to implement steadily the projects proposed in the plan.

(2) Irrigation and Drainage Development Plan

Irrigation and Drainage Plan is a development plan with the aim of 100% self-sufficiency rate of rice in conjunction with the promotion of rain-fed rice cultivation by 2030. The projects with high investment efficiency have been selected in the development plan. Areas with a gravity irrigation system and areas with good development efficiency for water source development have been selected. The investment efficiency "Supplementary Irrigation Scheme" proposed in the basins of HA5 HA7 with high rainfall amount is particularly high.

In the case of pump irrigation system, the promotion of sound and self-reliant irrigation with hydroelectric power generation using the dam for water resources development is recommendable. The “Integrated Irrigation Scheme” newly planned at three locations propose multipurpose dam (for irrigation and hydropower generation) and irrigation land reclamation at each location. For the potential of hydroelectric power plant installation at existing dams, future research is needed.

For food security of the country, the promotion of irrigated agriculture with high yield and toughness to drought is of particular importance. Urbanization progresses, there is a tendency for demand for rice will increase. In Nigeria urbanizing, future demand for rice will increase. In addition, large-scale projects such as irrigated agriculture, will contribute significantly to the creation of employment opportunities in rural areas. From these points of view, planned investment of the federal government to irrigation scheme will be necessary. The FMWR is recommended to steadily implement the irrigation scheme proposed in the M/P2013.

(3) Involvement in Other Sub-sectors

Also in water resource-related schemes under the jurisdiction different, involvement of the FMWR becomes more and more important in future. For example, flood management and hydroelectric power generation are important areas.

As noted above, the promotion of sound and self-reliant irrigation with hydroelectric power generation using the dam for water resources development is recommendable. Although the proposed plan covers small scale of hydropower generation only for pump irrigation, multi-purpose dam project with large-scale hydropower generation and irrigation is the subject of future investigation. Future cooperation with the Federal Ministry of Power having jurisdiction over the power becomes necessary.

In the wake of the flood damage in 2012, occurred in the Benue and Niger rivers, involvement in flood management of the FMWR has become important. If the FMWR increases the ability of flood management, the FMWR will be able to contribute to the flood forecasting and warning evacuation or flood management of the floodplain along large rivers. Future cooperation with the Federal Ministry of Environment having jurisdiction over the flood becomes necessary.

Against this background, for water related project which other ministries are under the jurisdiction, the FMWR is recommended to strengthen cooperation with other ministry in order to participate actively.

2.11.3 Implementation of Water Resource Management Plan

Water Resources Management Plan shows the methodology how to provide the water services based on the Sufficiency, Efficiency, Fairness, Safety and Sustainability, to the water users who expect [Effective Use of Water], [Mitigation of Flood Damage] and [Conservation of Water Quality], by using the facilities and operational systems installed on the basis of Water Resources Development Plan.

The FMWR is recommended to implement steadily the projects and action plans which are indicated by Water Resources Management Plan proposed in the M/P2013. Water Resources Management Plan is aiming at the state shown below.

- There is a good plan. There is an appropriate action.
- There are organizations and systems for desirable Water Services.
- Water Services to suffice safety and security are provided for water users.
- Water Services are never delayed. If there is trouble in delivery system for Water Service, someone restores it immediately.
- Water users pay the price gladly for the right price of Water Services.
- Information relating to Water Services is collected and analyzed. This information is managed and utilized to improve Water Services

- People engaging Water Service study every day with the spirit of self-advancement.
- Water Services are always monitored by water users, and the results of services are evaluated.

2.11.4 Steady and Sound Investment

(1) Direct Capital Investment of Federal Government of Nigeria (FGN)

The year 2012 planned expenditure budget of FGN totaled 4.9 trillion Naira, out of which the allocation to capital expenditures amounted to 1.5trillion Naira equal to 28.5% of total budget.

On the other hand, the anticipated revenues of FGN excluding the debts such as the government bonds were estimated at 3.6trillion Naira that largely depended on the oil; meanwhile the revenues from the income taxes and the value added taxes contributed 14% only. The nation revenues cannot be expected to grow largely in the future; under these circumstances FGN is facing a difficult fiscal policy in the midst of increasing population.

The M/P2013 presents investment plans to attain the goal of 100% water supply coverage and100% self-supply of rice. Water supply projects recommended in the M/P2013 require yearly amount of 200billion Naira which is double (194%) of average investment amount spent to this sector by Government in the last three (3) years. Particularly, the 1st phase (2014-2020) requires yearly 280billion Naira, almost four (4) times (380%) more than Government investment in the last three (3) years. Meanwhile, irrigation and drainage projects require yearly amount of 107 billion Naira which is four (4) times (390%) more than investment of Government in the last three (3) years. The 1st phase (2014-2020) requires yearly amount of 50billion Naira, almost triple (290%) of Government investment in the last three (3) years.

Obviously, to achieve national goal of these, the government financial support is indispensable; so that FGN is strongly recommended, despite a severe financial status, to allocate the necessary budget amount preferentially to these two (2) sectors.

On the other hand, the FMWR, as a ministry to supervise and manage directly "Water Supply Projects" and "Irrigation and Drainage Projects", is recommended to take following actions.

- To design the medium-term implementation and financial plan over the period of the 1st stage of the M/P2013 until the year 2020 in line with the Medium-term Sector Strategy (MTSS) and propose it definitely in order to secure the medium-term budgetary framework.
- To put it in action to take the steps of "M&E System for preparatory stage of Project Implementation", in order to secure the budget for implementation of the projects.

(2) Other Sources of Financing

The M/P2013 envisages that the governments will make an intensive capital investment up until 2030: 2 to 4 times of the current capital expenditures of annual average to the water supply projects and to the irrigation & drainage projects. For the smooth financing and implementation of the projects, the efforts to find other source of funds like below are indispensable, apart from relying heavily on the increase of the government direct capital investment.

- **Utilization of Private-sector Funds**
  The FMWR shall promote the introduction of the Public-Private Partnership (PPP) and the privatization of the water supply projects and the irrigation projects currently undertaken by the governments in order to decrease the government direct capital investment.

- **Utilization of International Development Partners' (IDPs) Funds**
  The intensive efforts to get the awards such as the "Grant Technical Aid and Grant Financial Aid" or "Soft Loan" from IDPs are to be made for decreasing the government direct capital investment. Besides, for realizing actually the investment programs efficiently and concretely, it is also requested to share the related information among all IDPs through the actions such as the stakeholders' meetings and the use of the donor's coordination platforms.

- **Promotion of Users' Pay Principle**
  Every user of treated water and irrigation water must pay the charge according to the volume they use. However, most of the users actually don't pay the charge. This causes the quite low level of revenues of these projects. So, it is a crucial matter to improve the revenues through the efforts in making users aware of the importance of payment through such as public awareness

campaign. As a result, the incomes from the projects are expected to grow, which could generate the incremental cash flow for the coming new projects and simultaneously decrease the government direct capital investment.

The FGN, aiming to realize steadily the M/P2013, is recommend to actualize the above three (3) actions which contribute toward decreasing the government direct capital investment.

2.11.5 Establishment of Project Promotion Function/Body

"A beginning of big job is critical. (The first step is always the hardest)"

The FMWR is recommended to establish immediately project promotion function/body, e.g. "Project Promotion Mission Unit (PMU)" in the FMWR, so that the FMWR utilizes the M/P2013 effectively under her ownership, strength implementation system and responds flexibly to future problems and issues. Missions of the PMU are as follow:

- **Follow-up of Dissemination Document**
  To coordinate and take procedures in and out of the FMWR, in order to put the seal on the M/P2013 as a dissemination document.
- **Implementation of Water Resources Development Plan**
  To promote and accelerate immediately the various action plans and projects proposed in Water Resources Development Plan of the M/P2013, such as water source (surface water and groundwater) development plan, sub-sector (water supply and irrigation) development plans and involvement in other sub-sectors.
- **Implementation of Water Resources Management Plan**
  To promote and accelerate immediately the various action plans and projects proposed in Water Resources Management Plan of the M/P2013, in order to adequate provision of water services.
- **Coordination with Related Ministries and Agencies**
  To be liaison for active coordination with the related ministries and agencies in charge of other sectors such as hydropower generation and flood control.

The PMU works under the direct control of the Permanent Secretary of FMWR and composed of about ten (10) members, and can be supported by various departments if necessary. The unit leader is appointed by the Minister of FMWR. In terms of introduction of advanced technology and human resources development, the PMU should be assisted technically by IDPs.

The PMU is a time-limited organization for five (5) years, which is the proposed time frame of periodical review of the M/P2013, and should establish the methodology for project promotion and acceleration in this period.

Besides, PMU's activities should be monitored and evaluated, and then fed back to the M/P2013 for further utilization and improvement.

CHAPTER 3 DRAFT CATCHMENT MANAGEMENT PLAN

3.1 Current Situation of Project Area

3.1.1 HA-1: Niger North

(1) Project Area

It can be judged that the main States in the project area are Katsina, Kebbi, Sokoto and Zamfara, considering the share of area. A part of Jigawa, Kano and Niger are also included in the project area.

(2) Socio-economy

The GRDP of HA-1 shared only 2.8% in Nigeria, which is so small in spite of more than 11% of people in Nigeria living there. The economic activities in HA-1 are dominated extremely by the primary sector, typically by the crop production. The other prominent activities are the livestock farming in Katsina State and the fishery firming in Kebbi State.

(3) Natural Condition

There is relatively high elevation area with about 700m in the southeastern part of HA-1. The area whose elevation is less than 300m widely extends in the remaining part of HA-1. The low land area is widely formed along Sokoto-Rima River. Geology of HA-1 is classified into 2 types, Basement Rocks and sedimentary rocks. The Basement rock constitutes plateau and high land of the eastern half of HA-1. The climate condition in HA-1 is savanna or semi-arid. The average precipitation and air temperature in HA-1 in the last 40 years (1970-2009) are estimated at 767mm/year and 27.4 degree Celsius, respectively, based on the analysis by JICA Project Team. On the basis of the analysis by JICA Project Team on the meteorological and hydrological data during the last 40 years (1970-2009), it is estimated that about 8% of the total precipitation are runoff while the remaining is lost though evapotranspiration and others.

(4) Water Use and Water Resources Development

The total volume of water use in HA-1 in 2010 is estimated at 791MCM/year. The share among municipal, irrigation and other agriculture (livestock and freshwater aquaculture) is 31%, 60% and 9%, respectively. The volume of surface water source and groundwater source are estimated at 489MCM/year (62%) and 302MCM/year (38%), respectively.

(5) Organizations and Institutional Responsibilities in Water Resources Sector

(5-1) Federal Institutions

There are numerous Federal Government Ministries, Departments and Agencies (MDAs) involved in water sector. The nature of their involvement ranges from policy and legal formulation and implementation, through regulatory to services provision.

(5-2) State Institutions

The major institutions in four states of HA-1 responsible for water supply for domestic and industrial uses, irrigation, hydropower generation, flood and erosion control, inland navigation, inland fishery, livestock, farming, water quality conservation, etc. Organizations that have responsibility on water resources are, State Ministry of Water Resources, State Ministry of Environment, State Ministry of Agriculture, State Water Board, State Rural Water Supply and Sanitation Agency (RUWASSA) etc.

(5-3) Institutions at LGA Level

LGAs are responsible for Provision of services to the communities in the areas of water supply and sanitation and other rural infrastructure. Moreover, LGAs provide maintenance of public conveniences, sewerage and refuse disposal. They also assist RUWASSA in coordination with Community-Based Organizations such as WASHCOM/WASCOM or WESCOM activities.

3.1.2 Ogun-Oshun Basin (Western part of HA-6: Western Littoral)

(1) Project Area

It can be judged that the main States in the project area are Lagos, Ogun, Osun and Oyo, considering the share of area. A part of Ekiti, Kwara and Ondo are also included in the project area.

(2) Socio-economy

The GRDP of main four states shared 24.7% in Nigeria. The economic activities in four states are dominated extremely by the primary sector in the states of Osun and Oyo; meanwhile, by the tertiary sector in the state of Lagos and Ogun. The secondary sector can be seen also active in Lagos State and Ogun States, particularly in the manufacturing sectors. The amount of budget of Lagos State is extremely larger than those of other three states.

(3) Natural Condition

There is relatively high elevation area with about 400-500m in the northern part of Ogun-Oshun Basin. The area whose elevation is less than 200m widely extends in the remaining part of Ogun-Oshun Basin. The low land area and lagoons extends along the coastal area. Geology of Ogun-Oshun Basin is classified into Basement Complex and sedimentary rocks. Basement rocks constitute plateau and high land of Ogun-Oshun Basin. The climate condition in Ogun-Oshun Basin is Guinea savanna. The average precipitation and air temperature in Ogun-Oshun Basin in the last 40 years (1970-2009) are estimated at 1,289mm/year and 26.7 degree Celsius, respectively, based on the analysis by JICA Project Team. The annual precipitation varies from 1,600mm/year in the southeastern part of Ogun-Oshun Basin to 1,00mm/year in the northern part of Ogun-Oshun Basin. There are clear dry and rainy seasons. On the basis of the analysis by JICA Project Team on the meteorological and hydrological data during the last 40 years (1970-2009), it is estimated that about 16% of the total precipitation are runoff while the remaining is lost though evapotranspiration and others. The water resources potential within the territory of Nigeria is estimated at 13.0BCM/year.

(4) Water Use and Water Resources Development

The total volume of water use in Ogun-Oshun Basin in 2010 is estimated at 1,111MCM/year. The share among municipal, irrigation and other agriculture (livestock and freshwater aquaculture) is 81%, 5% and 14%, respectively. The volume of surface water source and groundwater source is estimated at 267MCM/year (24%) and 844MCM/year (76%), respectively.

(5) Organizations and Institutional Responsibilities in Water Resources Sector

(5-1) Federal Institutions

There are numerous Federal Government Ministries, Departments and Agencies (MDAs) involved in water sector. The nature of their involvement ranges from policy and legal formulation and implementation, through regulatory to services provision.

(5-2) State Institutions

The major institutions in four states of Ogun-Oshun Basin responsible for water supply for domestic and industrial uses, irrigation, hydropower generation, flood and erosion control, inland navigation, inland fishery, livestock, farming, water quality conservation, etc. There are State Ministry of Water resources in Oyo and Osun State. On the other hand in the other two states, State Ministry of Environment has the function of above ministry. There are other organizations such as State Ministry of Agriculture responsible for irrigation, State ministry of Environment responsible for flood control, Water Corporations and RUWASSAs. Name of Ministry and its function is different state by state.

(5-3) Institutions at LGA Level

LGAs are responsible for Provision of services to the communities in the areas of water supply, sanitation, and other rural infrastructure. Moreover, LGAs provide maintenance of public conveniences, sewerage and refuse disposal. They also assist RUWASSA in coordination with Community-Based Organizations such as WASHCOM/WASCOM or WESCOM activities.

3.2 Framework of Catchment Management Plan

3.2.1 Objective of Catchment Management Plan

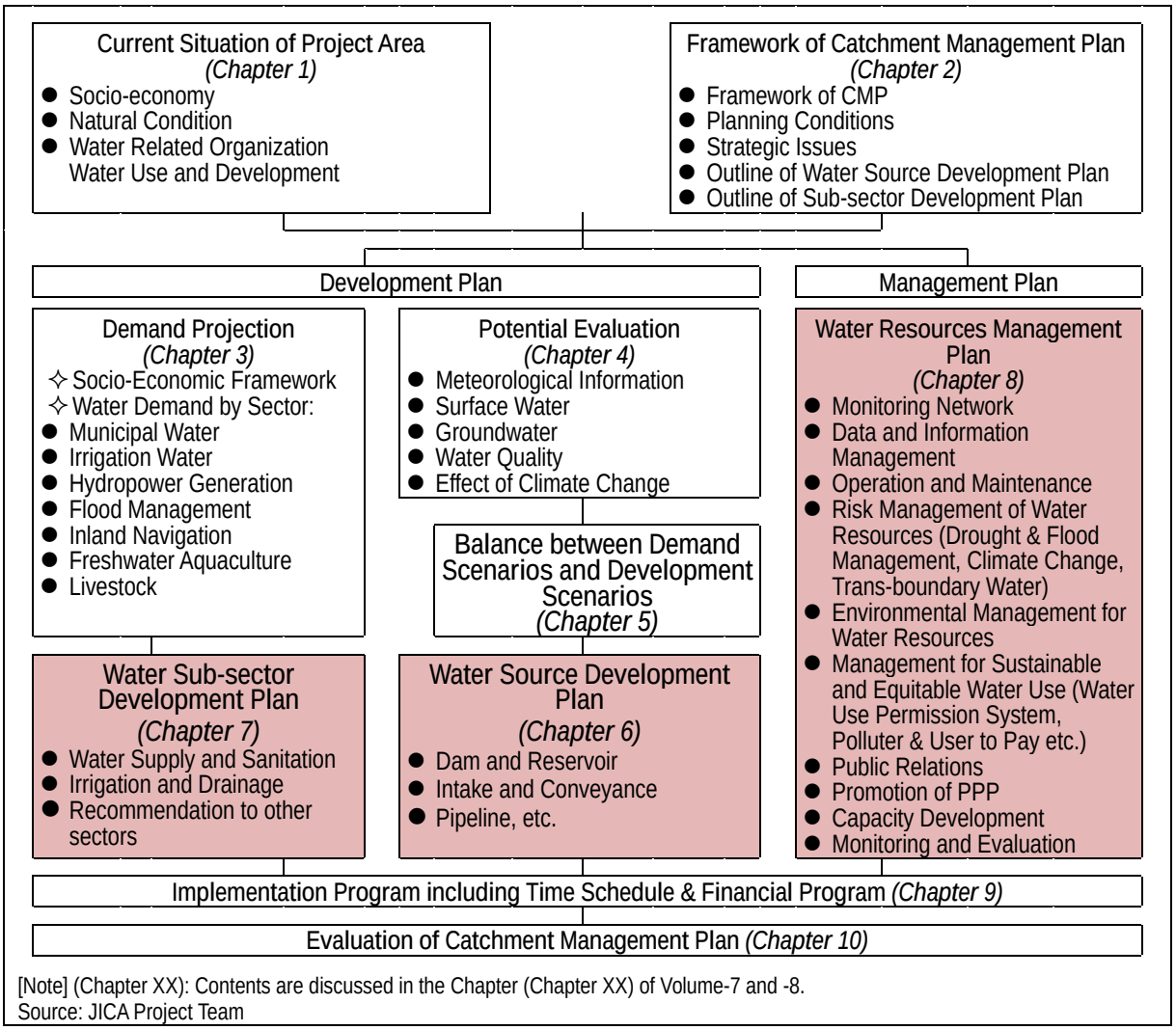
Objective of Catchment Management Plan (CMP) is to realize water resources management in the target area as a guideline and also a project implementation programme. Water resources management is the approach of proper delivery of water services meeting water user's needs on the basis of 3Ss and 2Es as shown below, by using the facilities and operation systems prepared by governments and private sector.

- 3S Sufficiency, Sustainability, and Safety
- 2E Efficiency and Equity

The target year of the CMP is year 2030 as well as National Water Resources Master Plan (M/P2013). The upper level plan of CMP is national level water policies and strategies for water resources development and management and the M/P2013 that is formulated based on the above policies and strategies. If any policies, master plans or equivalent at state level, they should be included here.

3.2.2 Contents of Catchment Management Plan

Contents of the CMP are shown in Figure 3-1.



[Note] (Chapter XX): Contents are discussed in the Chapter (Chapter XX) of Volume-7 and -8.
Source: JICA Project Team

Figure 3-1 Contents of Catchment Management Plan (CMP)

3.2.3 Strategic Issues of Water Resources Development and Management in the Project Area

Issues on water resources management and development in the target area are examined in view of the nine strategic issues taken up in the M/P2013 and are summarized in Table 3-1.

Table 3-1 Strategic Issues of Water Resources Management and Development

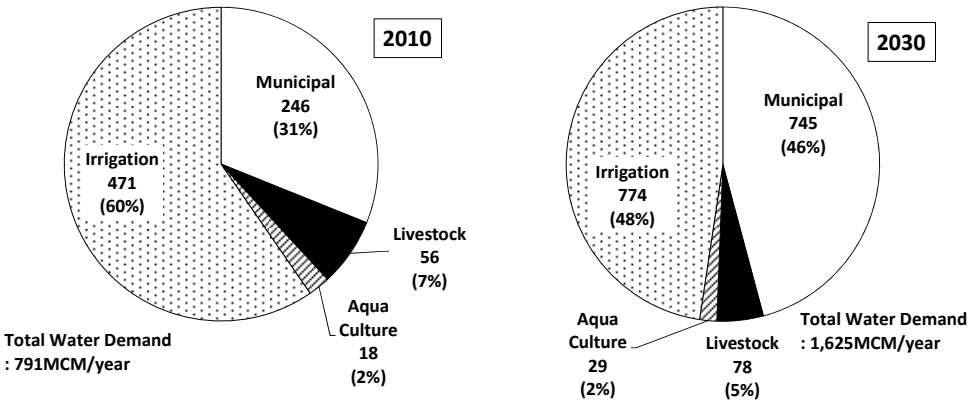
Strategic Issue		HA-1	Ogun-Oshun Basin
1	Water Resources Management and Development in Consideration of Unevenly Distributed Water Resources and Demand	Water resources potential is scarce in general. There are large differences in water resources place by place. Since Katsina State is located in the most upstream portion of the basin and the harshest condition in terms of water resources. Sokoto has to rely on the water resources generated in the upstream states.	Water resources potential per person is small due to large population in the basin. In Logos State, it is much smaller than that in other states in Ogun-Oshun Basin. Lagos can utilize the water that comes from upstream watershed, which means it has to rely on the resources generated in the upstream states.
2	Addressing Increasing Municipal Water Demand on the Premise of Current Low Operation Rate of Water Supply Facilities	The operation rate in the major four states in HA-1 is as low as 48.4%.	The operation rate in the major four states in Ogun-Oshun Basin is 40.3%. It is necessary to increase the operation rate of existing facilities.
3	Promotion of Sound and Self-reliant Irrigation Development	The irrigation infrastructure are dilapidated in most of the irrigation schemes with many pumps in need of repair/replacement and conveyance structures damaged or deteriorated, weed infested and silted up. In Bakalori Irrigation Project at present, the 15,000 ha earlier cultivated under sprinkler irrigation system has been abandoned because of the difficulty in maintaining the facilities.	Although there are irrigation schemes whose planned area is more than 1,000ha, these have not yet fully developed. Many schemes are small irrigation system currently. It is necessary to promote sound irrigation system, considering the expected increase in municipal water demand in the basin.
4	Effective Utilization of Existing Water Source Facilities in View of Contemporary Needs	It has been confirmed that there could be excess storage in Bakolori and Goronyo Dams. The excess storage volume can be utilized for several different purposes. It is necessary to discuss how to use the excess storage volume by stakeholders.	It has been confirmed that there could be excess storage in Oyan and Ikere-Gorge Dams. However, the excess storage volume may be utilized for fulfilling the municipal water demand by Lagos, if one considers the future water demand project by Lagos State. It is necessary to discuss how to use the excess storage volume by stakeholders.
5	Enhancement of Water-related Data/ Information and Its Uniform Management	Water-related data/information such as dams, water purification plants, irrigation schemes and production wells are not uniformly managed.	Water-related data/information such as dams, water purification plants, irrigation schemes and production wells are not uniformly managed.
6	Consideration of Increasing Risk on Water Resources	HA-1 is more vulnerable area against climate change in terms of water resources than other areas in the country, because the expected decrease in runoff due to the climate change is higher than the national average. There is a risk associated with trans-boundary water, since the contribution of inflow from upstream country against total runoff at Kainji Dam which is located at the downstream end of HA-1 is 80%.	The expected decrease in runoff due to the climate change is almost same as the national average. Since the trans-boundary water is minimal in Yewa River basin, the risk associated with it could not be significant.
7	Active Involvement of Water Resources Administrator in Management of Important Rivers and Flood Plains	There is Sokoto-Rima River across the central portion of HA-1, which is flowing in the vast floodplain. In the downstream area of Bakolori and Goronyo Dams, some villages along river channels were submerged during floods. Then it was said that flood release from the dams were the causes. The management of flood plain along Sokoto-Rima River should be enhanced in consideration of dam operation.	Since the water use in Ogun and Oshun Rievrs has been very active, the flood plain area in these rivers is expected to be used more intensively in future. The management of flood plain along Ogun and Oshun Rivers should be enhanced in consideration of dam operation in the upstream area.
8	Water Quality Monitoring to Secure Clean and Safe Water	The stakeholders pointed out that there are problems on pollution in water bodies and high turbidity of raw water for water supply, the actual conditions have not yet been investigated well.	The almost all of the pollution finally reaches to the lagoon along coastal area. It's recommended to implement a comprehensive research of water quality and quantity of the lagoon to decide its potentiality and proper alternatives of water source.
9	Institutional Development and Strengthening of Water Resources Management	Among strategies proposed in the M/P2013, the Project recognizes participatory management administration as a component to be strengthened for water resources management in HA level. The comprehensive organization governing the whole areas supposedly composed of CMCC and others.	Among strategies proposed in the M/P2013, the Project recognizes participatory management administration as a component to be strengthened for water resources management in HA level. The comprehensive organization governing the whole area is supposedly composed of CMCC and others.

Source: JICA Project Team

3.3 Projection of Future Water Demand

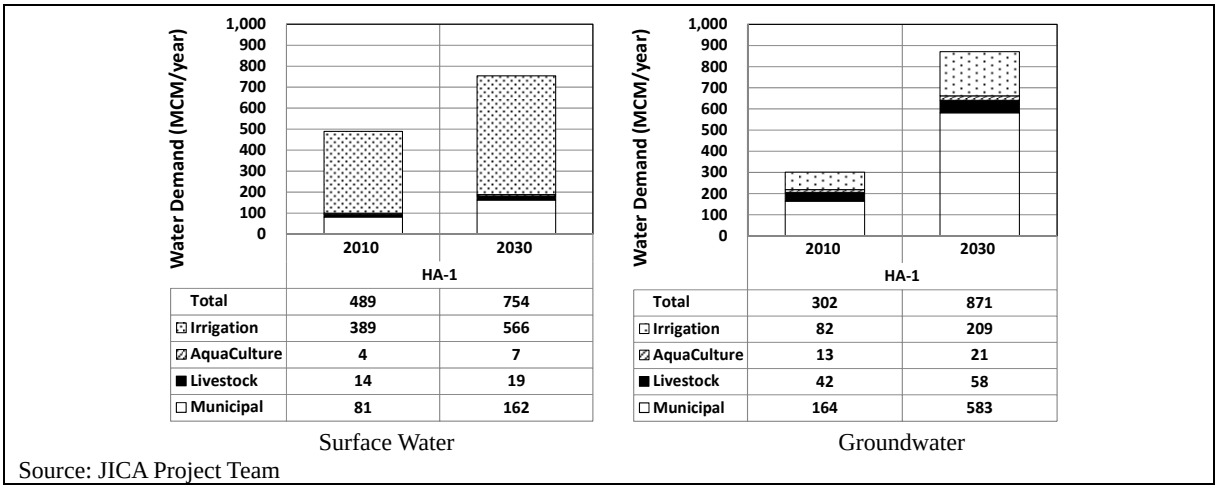
3.3.1 HA-1: Niger North

The existing total water demand in HA-1 is estimated at 791MCM/year in 2010. It is expected to increase to 1,625MCM/year in 2030. Figure 3-2 shows the share of water demand by each sector. The share of municipal water demand in 2010 is about 30%, and it will increase to about 50% in 2030. The share of irrigation water demand will decrease from about 60% in 2010 to about 50% in 2030. This is because of the increasing rate of municipal water demand is higher than that of irrigation water demand. The water demand for surface water source by each sector and that for groundwater are presented in Figure 3-3.



Source: JICA Project Team

Figure 3-2 Change in Share of Water Demand by Sector of HA-1



Source: JICA Project Team

Figure 3-3 Water Demand by Sector and by Water Source of HA-1

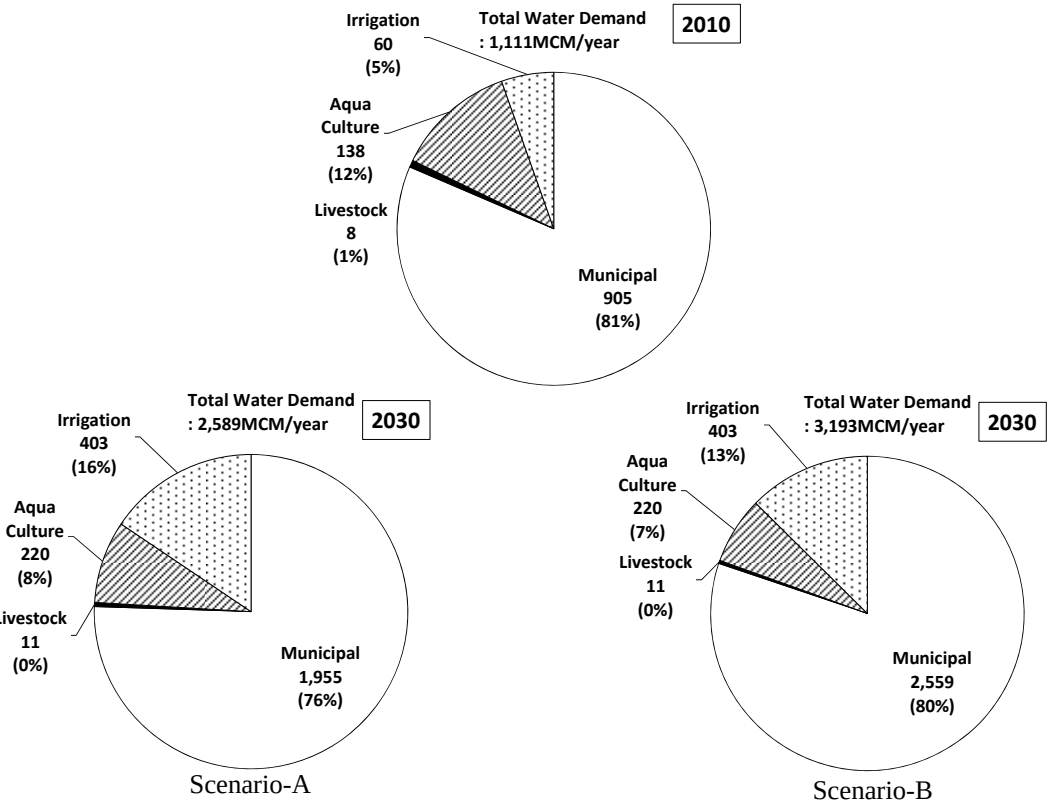
3.3.1 Ogun-Oshun Basin (Western part of HA-6: Western Littoral)

The water demand structure for the following two scenarios are presented below.

- Scenario-A: The socio-economic framework and methodology of water demand projection in the target area is same as that applied in M/P2013.
- Scenario-B: The socio-economic framework and water demand projection by States (if it exists)

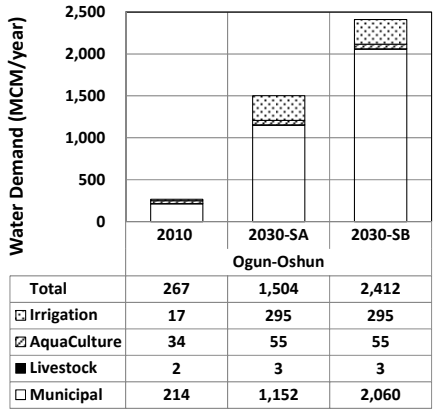
The existing total water demand in Ogun-Oshun Basin is estimated at 1,111MCM/year in 2010. It is expected to increase to 2,589MCM/year in 2030 for Scenario-A, and 3,193MCM/year in 2030 for Scenario-B. Figure 3-4 shows the share of water demand by each sector. The share of municipal water demand in 2010 is 81%, and it will slightly decrease to 76% in 2030 for Scenario-A, and 80% in 2030 for Scenario-B. The share of irrigation water demand will slightly increase from about 5% in 2010 to 16% in 2030 for Scenario-A, and 13% in 2030 for Scenario-B.

The water demand for surface water source by each sector and that for groundwater are presented in Figure 3-5.



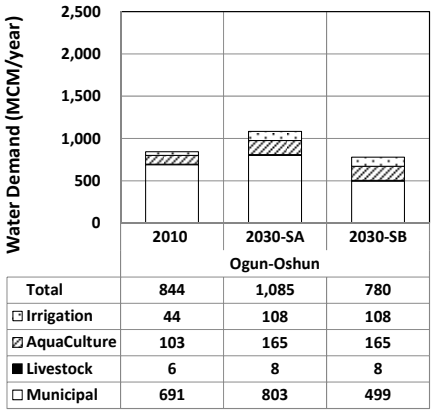
Source: JICA Project Team

Figure 3-4 Change in Share of Water Demand by Sectors of Ogun-Oshun Basin



	2010	2030-SA	2030-SB
Total	267	1,504	2,412
Irrigation	17	295	295
AquaCulture	34	55	55
Livestock	2	3	3
Municipal	214	1,152	2,060

Surface water



	2010	2030-SA	2030-SB
Total	844	1,085	780
Irrigation	44	108	108
AquaCulture	103	165	165
Livestock	6	8	8
Municipal	691	803	499

Groundwater

SA= Scenario A, SB= Scenario B
Source: JICA Project Team

Figure 3-5 Water Demand by Sectors and by Sources of Ogun-Oshun Basin

3.4 Evaluation of Water Resources Potential

For water resources potential, firstly, the updated catchment delineation, which will be a basis for discussing the water resources, is presented. Secondly, meteorological condition as an input condition for water resources is shown. Surface water resources potential in quasi-natural condition and groundwater potential are discussed on the basis of results of the rainfall-runoff model introduced in the M/P2013.

3.4.1 HA-1: Niger North

The average precipitation in HA-1 is about 767mm. Only 8% of the precipitation becomes runoff and the rest are lost as evapotranspiration and/or others. Total internal generation of the runoff is 8.3BCM/year, and the surface water resources potential is estimated at 35.1BCM/year (see Table 3-2 and Figure 3-6). The total water resources potential with inflow from neighbor countries is estimated

at 37.4BCM/year. Total groundwater resources potential is estimated at 5.0BCM/year as a renewable source on the basis of the estimated groundwater recharge.

3.4.1 Ogun-Oshun Basin (Western part of HA-6: Western Littoral)

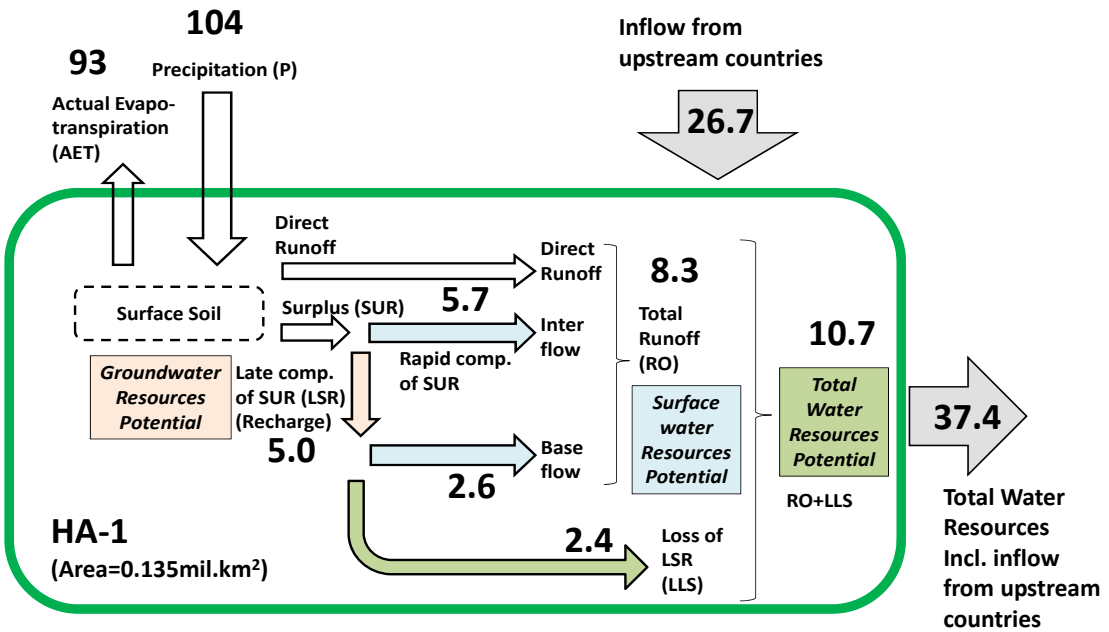
The average precipitation in Ogun-Oshun Basin is about 1,289mm. About 16% of the precipitation becomes runoff, and the rest are lost as evapotranspiration and/or others. Total internal generation of the runoff is 11.4BCM/year and the surface water resources potential is estimated at 11.5BCM/year (see Table 3-2 and Figure 3-6). The total water resources potential with inflow from neighbor countries is estimated at 13.1BCM/year. Total groundwater resources potential is estimated at 4.9BCM/year as a renewable source on the basis of the estimated groundwater recharge.

Table 3-2 Estimated Water Resources Potential in HA-1 and Ogun-Oshun Basin

		HA-1	Ogun-Oshun Basin	Entire Country
Water Resources Potential				
Total Water Resources Potential [1)]				
Including inflow from outside Nigeria	(BCM/year)	37.4	13.1	375.1
Only internal generation in Nigeria	(BCM/year)	10.7	13.0	286.6
Surface Water Resources Potential				
Including inflow from outside Nigeria	(BCM/year)	35.1	11.5	332.7
Only internal generation in Nigeria	(BCM/year)	8.3	11.4	244.2
Groundwater Resources Potential				
Groundwater Recharge	(BCM/year)	5.0	4.9	155.8
Runoff Condition（Only internal generation in Nigeria）				
Precipitation (P)	(mm/year)	767	1,289	1,148
Total Runoff (RO)	(mm/year)	62	199	268
Groundwater Recharge (GRE)	(mm/year)	37	85	171
Loss of Recharge (LOS)	(mm/year)	18	28	47
Runoff Rate (RO/P)	(%)	8.1	15.4	23.4
Recharge Rate (GRE/P)	(%)	4.8	6.6	14.9
Loss Rate (LOS/P)	(%)	2.3	2.1	4.1
Total Water Res. Rate ((RO+LOS)/P)	(%)	10.4	17.5	27.4

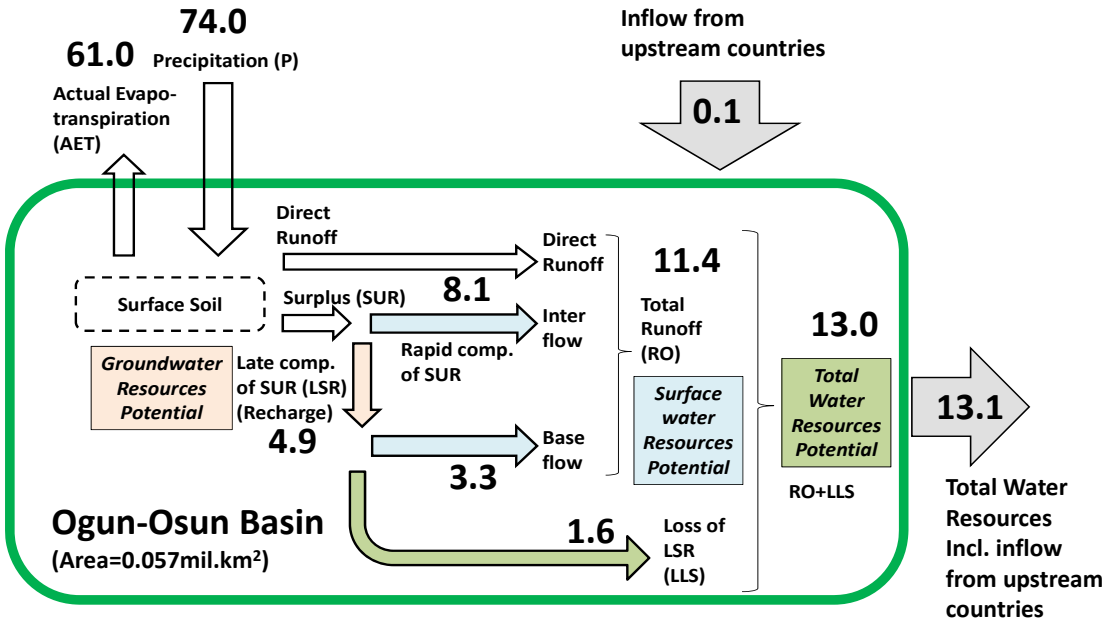
Note:
1) Total Water Resources Potential
= Surface Water Resource Potential + Groundwater Recharge – Base Flow Runoff
= Surface Water Resource Potential + Loss of Groundwater Recharge

Source: JICA Project Team



Unit: BCM/year (Billion m³/year)

(a) Water Resources Potential of HA-1



Unit: BCM/year (Billion m³/year)

(b) Water Resources Potential of Ogun-Oshun Basin

Source：JICA Project Team

Figure 3-6 Estimated Water Resources Potential in HA-1 and Ogun-Oshun Basin

3.5 Water Balance between Demand and Supply

The water balance between demand and supply capacity is discussed on the basis of the projected water demand and the water resources potential. Firstly, the overall water balance between total water demand and water resources potential in HA-1 and Ogun-Oshun Basin is presented. Secondly, the result of water balance analysis is presented for groundwater and surface water, respectively.

3.5.1 Methodology on Examining Water Balance between Demand and Supply Capacity

Water balance between demand and supply was examined by two methods below:

1) Overall water balance between total water demand and water resources potential in entire catchment area
2) Water balance between demand and supply capacity at local level in detail.

The water usage can be categorized into two types; groundwater and surface water uses. Water balance between demand and supply capacity above is analyzed at local level by the following steps:

- Step 1: The demarcation between usage of groundwater and surface water for municipal water supply is set, on the basis of the existing plans by state government.
- Step 2: The water balance for groundwater usage which include not only municipal water but also other purposes is checked, in order to secure sustainable usage of groundwater. If it is judged that the groundwater usage is sustainable, the next steps would be examined. If not, the demarcation between groundwater and surface water uses would be adjusted, and the groundwater balance would be checked again.
- Step 3A: The necessary development of groundwater is determined based on the results of Step2. The groundwater development plan is formulated.
- Step 3B: The surface water demand for municipal water supply is fixed based on the results of Step2. The water balance study for surface water is examined and the surface water development plan is formulated, considering the municipal water, irrigation water and other demands.
- Step 4A: The municipal water supply plan is formulated utilizing the results of step 3.
- Step 4B: The irrigation development plan is formulated utilizing the results of step 3B.

3.5.2 Results of Water Balance Study

(1) Overall Water Balance between Total Water Demand and Water Resources Potential in Entire Catchment Area

Table 3-3 shows the total water demand and water resources potential in entire catchment area/basin.

Table 3-3 Overall Water Balance between Total Water Demand and Water Resources Potential

Item	unit	HA-1	Ogun-Oshun Basin	
			Scenario-A	Scenario-B
Including inflow from outside Nigeria	(BCM/year)	37.4	13.1	
Only Internal Generation	(BCM/year)	10.7	13.0	
Groundwater Resources Potential	(BCM/year)	5.0	4.9	
Existing (2010)	(BCM/year)	0.79	1.1	
	(%)	2.1	8.4	
	(%)	7.4	8.5	
Future (2030)	(BCM/year)	1.63	2.6	3.2
	(%)	4.3	19.8	24.4
	(%)	15.2	20.0	24.6

Source: JICA Project Team

The existing total water demand in HA-1 is estimated at 0.80BCM/year. It is expected to increase to 1.65BCM/year. The water use rate in 2010 is just 2.1%. In 2030, the ratio will become 4.3%, however. The total water demand in 2030 is still much less than the total water resources potential.

On the other hand, the existing total water demand in Ogun-Oshun Basin is estimated at 1.11BCM/year. It is expected to increase to 2.59BCM/year for Scenario-A and 3.20BCM/year for Scenario-B, respectively. The water use rate in 2010 is 8.5%. In 2030, the ratio will become 20.0% for Scenario-A and 24.6% for Scenario-B, respectively.

(3) Water Balance Analysis between Demand and Supply Capacity at local level in Detail

Groundwater

Groundwater level lowering was forecasted in HA-1 and Ogun-Oshun Basin in case of groundwater development to meet groundwater demand in 2030. The lowering of the groundwater level was estimated with groundwater simulation model where groundwater development plan was installed into. As a result, groundwater level lowering will be less than 5m in the most of the area, so that it is concluded that proposed groundwater development can be implemented.

Surface Water

The total water demand in 2030 is still much less than the total water resources potential in both HA-1 and Ogun-Oshun Basin. However, because the water demand and water resources are unevenly distributed, the necessity of water resources development should be examined in detail by the water balance between supply and demand at local level. As the results of the water balance study for urban water supply, it is evaluated that some water sources could experience the deficit for supplying necessary water volume with 90% yearly dependability. It is evaluated that the irrigable area in terms of stable water supply with 80% yearly dependability is less than the planned area in some schemes. Water resources development plan and irrigation development plan will be formulated referring to analyzed result above.

Result of the analysis and recommendation are summarized below:

Table 3-4 Summary of Finding in Water Balance Study

Catchment Area / State	Result of analysis
HA-1: Niger North	
Katsina State	Water resources in Katsina state are very limited. There are not enough irrigation water sources for future full development of planned area when municipal water is prioritized. Planned irrigation water should be reduced or cropping pattern should be re-considered in the irrigation schemes which use water in the dams.
Zamfara State	The water balance study clarified that the existing Gusau dam cannot supply future municipal water for Gusau. It is proposed to construct new storage dam for municipal water supply for Gusau.
Sokoto and Kebbi States	It is evaluated that the existing Goronyo and Bakolori dams can supply enough water for the expected demand for 2030. There is excess volume of water in these dams. The optimum use of the excess water should be considered. One of ideas is that the excess storage will be used for "Controlled flood for enhancing the river environment as well as recharge to groundwater, with keeping flood control function".
Ogun-Oshun Basin (Western part of Western Littoral)	
Lagos	For Scenario-A, the water can be supplied by the existing dams except small local source. Scenario-B, additional water source should be developed. Construction of two new dams is proposed tentatively. Lagos State has a plan to utilize water in the lagoon with desalination. It is strongly recommended to conduct a comprehensive study on water quality and environment in the lagoon.
Ogun	It is judged that some local water sources in Ogun State cannot supply water stably. It is recommended to construct new dams for such sites.
Oyo	It is clarified that the construction of the proposed Odedele dam is necessary to meet the future water demand in Ibadan. For Scenario-B, it is recommended to construct a new dam in Oyo State in order to meet the future water demand in Lagos.
Osun	For Scenario-A, it is judged that main water sources for municipal water supply can meet the future water demand in 2030. For Scenario-B, it is recommended to construct a new dam in Osun State in order to meet the future water demand in Lagos.

Source: JICA Project Team

3.6 Water Sources Development Plan

3.6.1 Groundwater Development

Basic policy for groundwater development is as follows:

- Extraction of groundwater is sustainable
- Pumping should be efficient

Aquifer of HA-1 and Ogun-Oshun Basin was classified into 6 types as shown in Table-3-5 based on groundwater potential that was analyzed from groundwater recharge of each aquifer and borehole field theory. Representative parameter was decided for both weathered aquifer and multiple aquifer based on hydrogeological characteristics.

Table 3-5 Aquifer Classification

Model	Symbol	Aquifer Type	Thickness of Aquifer	Permeability Coefficient	Static Groundwater Level
Basement Rock	WH	Weathered Basement rock and weathered part of the other rock type	50m	0.69	GL-10m
	WM			0.39	
	WL			0.19	
Sedimentary Rock	MH	Sandstone or sandy formation within alternation of sandstone and shale	200m	1.56	GL-50m
	MM			0.78	
	ML			0.39	

Source: JICA Project Team

Available yield of borehole was estimated using formula in Table 3-6 with groundwater recharge, number of boreholes and distance between boreholes.

Table 3-6 Optimum Yield from Borehole Fields

Aquifer type T: Transmissibity (m^2/day) K: Conductance (m/day) L: Aquifer thickness (m)		Formula to estimate sustainable yield of borehole field (m^3/day) N: Number of boreholes in borehole field P: Groundwater recharge (mm/year) D: Distance between boreholes (m)		Yield per Borehole (m^3/day)	
Symbol	T=K×L	One borehole	More than 2 boreholes	Average	Range
WH	62	$Y=11.08\times T\times P^{0.06}$	$Y=T\times(0.74+0.43)\times N^{0.53}\times P^{0.25}\times D^{0.47}$	480	100-1,000
WM	31			380	300-500
WL	16			150	100-300
MH	104	$Y=13.58\times T\times P^{0.05}$	$Y=T\times(0.81+1.20\times N^{0.42}\times P^{0.20}\times D^{0.37})$	990	700-1,500
MM	58			560	500-900
ML	29			280	200-500

Source: JICA Project Team

Groundwater development plan for target area is shown in Table 3-7.

Table 3-7 Number of Newly Drilled Borehole and Rehabilitated Boreholes to meet Water Demand of 2030

HA	State	Number of newly drilled borehole							Number of rehabilitated borehole		
		Urban/small urban/small town			Rural				Urban/small urban/small town	Rural	
		Motorized pump			Motorized pump			Hand pump	Motorized pump	Motorized pump	Hand pump
		200m	50m	Total	200m	50m	Total				
HA-1	Katsina	338	984	1,321	143	325	468	4,328	234	60	708
	Kebbi	229	279	508	161	109	270	2,317	239	55	750
	Sokoto	246	540	786	150	45	195	1,580	295	88	407
	Zamfara	43	368	410	64	194	258	2,408	36	5	280
Ogun-Oshun	Lagos	0	0	0	33	0	33	286	0	1	334
	Ogun	0	0	0	154	73	226	1,925	0	12	76
	Osun	0	235	235	0	140	140	1,200	67	19	208
	Oyo	6	424	430	6	251	258	2,386	160	27	510

Source: JICA Project Team

3.6.2 Surface Water Development

The strategy on surface water development of HA-1 and Ogun-Oshun Basin is set as shown in Table 3-8.

Table 3-8 Strategy on Surface Water Development

Objective	Strategy
Effective Utilization of Existing Dams	Many of the existing dams do not keep their original functions, because of lack of proper operation and maintenance including management of information on reservoir operation. It is necessary to revive these dams urgently, for preparing the expected increase in the water demand. The followings are considered. • Enhancement of dam management, including preparation of manual for dam management • Rehabilitation of dams • Enhancement of dam operation
Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country	The necessary water resources development would be proposed by utilizing the proposed dams in M/P1995 as the potential dams as well as the other potential sites. • By examining water balance for the potential dam sites, efficiency of each site is roughly evaluated. The priority for development should be given to the sites with higher efficiency. • In the area where water resources is very limited and the future demand is expected to be more than the supply capacity of water source, the demand control such as reduction of the planned irrigation area and/or changing the crop should be considered as one of options for managing the available water, in order to avoid the conflict among water users. • The integrated development with hydropower generation and irrigation components is proposed in order to promote self-reliant project.

Source: JICA Project Team

Surface water development plan in HA-1 is shown in Table 3-9.

Table 3-9 Proposed Surface Water Development Project in HA-1

Objective	No	Strategy	Project
Effective Utilization of Existing Dams	1-1	Capacity development of dam management	
	1-2	Rehabilitation of equipment for proper operation of major dams	
	1-3	Rehabilitation of deteriorated dams	
Preparation of Sufficient Surface Water Source	2-1	Surface water development for municipal water supply	Sakin Noma/Gusau dam project
	2-2	Surface water development for irrigation development	Kasanu dam project
	2-3	Integrated surface water development	This scheme is not proposed in HA-1 due to the limited water resources in HA-1

Source: JICA Project Team

Surface water development plan in Ogun-Oshun Basin is shown in Table 3-10.

Table 3-10 Proposed Surface Water Development Project in Ogun-Oshun Basin

Objective	Project		Scenario-A	Scenario-B
Effective Utilization of Existing Dams	1-1	Capacity development of dam management		
	1-2	Rehabilitation of equipment for proper operation of major dams		
	1-3	Rehabilitation of deteriorated dams		
Preparation of Sufficient Surface Water Source	2-1	Surface water development for municipal water supply	- Ibu dam project - Ota dam project - Araromi Ake/ Ijebu-Ode-Yemoji dam project - Odedele dam project	- Ibu dam project - Ota dam project - Araromi Ake/ Ijebu-Ode-Yemoji dam project - Odedele dam project - Aiyete dama project - Oba dam project
	2-2	Surface water development for irrigation development	There is no proposed project for the irrigation project with new dam development in Ogun-Oshun Basin.	
	2-3	Integrated surface water development	This scheme is not proposed in Ogun-Oshun Basin due to the expected increase in municipal water demand in future.	

Source: JICA Project Team

3.7 Water Resources Sub-sector Development Plan

3.7.1 Water Supply and Sanitation

In formulation of water supply and sanitation plan, the current operation rate of water supply schemes by use of surface water and groundwater sources was obtained. Then, the Project will make a water supply and sanitation development plan based on the following design criteria.

Water Supply: Per capita consumption, Designed capacity and yield of water sources, Rehabilitation scheme of existing facilities, New construction scheme of facilities, and Composition of water supply facilities in development plan

Sanitation: Standard of sanitation facilities by categorization of settlement, and Menu of development projects

Water Supply Development Plan

To meet the future water demand, the Project calculates water supply development for facility planning in the target year 2030, as shown in Table 3-11 and Table 3-12. Water supply development targets demand growth for 20 years from 2011 to 2030 because baseline year of water demand projection is 2010. But water supply development plan targets demand growth from 2015 to 2030, which is also ground for project cost estimation. It is assumed that development projects will be implemented at the development pace expected by the CMP.

Sanitation Development Plan

Based on current sanitation coverage as of baseline year 2010, the Project formulates sanitation development plan to meet demand in the target year 2030, which sanitation coverage should reach 100%. But sanitation development plan targets demand growth from 2015 to 2030, which is also ground for project cost estimation. Assuming development projects have been implemented at the development pace expected by the CMP conforming to the M/P2013 from 2011 to 2014, sanitation development by the projects proposed in the CMP are shown in Table 3-13 and Table 3-14.

Table 3-11 Water Supply Development Plan for Facility Planning in HA-1

Scheme	Category	Existing Capacity (2010)	Pre-CMP Period (2011-2014)	CMP Period (2015-2030)	**Total (2030)**
4 States					
Rehabilitation	Urban, SU/ST (SW)	217	-	153	**370**
	Urban, SU/ST (GW)	349	50	192	**591**
	Rural (GW)	102	19	63	**184**
	Sub-Total	**668**	**69**	**408**	**1,145**
Newly Construction	Urban, SU/ST (SW)		46	28	**74**
	Urban, SU/ST (GW)		186	677	**863**
	Rural (GW)		63	209	**272**
	Sub-Total		**295**	**913**	**1,208**
Total	**(MLD)**	**668**	**364**	**1,321**	**2,354**

Source: JICA Project Team

Table 3-12 Water Supply Development Plan for Facility Planning in Ogun-Oshun Basin

Scheme	Category	Existing Capacity (2010)	Pre-CMP Period (2011-2014)	CMP Period (2015-2030)	**Total (2030)**
4 States (Scenario A)					
Rehabilitation	Urban, SU/ST (SW)	546	-	421	**967**
	Urban, SU/ST (GW)	1,784	3	36	**1,823**
	Rural (GW)	102	15	55	**172**
	Sub-Total	**2,432**	**19**	**512**	**2,962**
Newly Construction	Urban, SU/ST (SW)		31	2,497	**2,528**
	Urban, SU/ST (GW)		4	45	**49**
	Rural (GW)		32	113	**145**
	Sub-Total		**67**	**2,655**	**2,722**
Total	**(MLD)**	**2,432**	**86**	**3,167**	**5,685**
4 States (Scenario B)					
Rehabilitation	Urban, SU/ST (SW)	546	-	421	**967**
	Urban, SU/ST (GW)	1,784	3	36	**1,009**
	Rural (GW)	102	14	51	**159**
	Sub-Total	**2,432**	**17**	**508**	**2,135**
Newly Construction	Urban, SU/ST (SW)		31	5,462	**5,493**
	Urban, SU/ST (GW)		4	45	**49**
	Rural (GW)		30	107	**138**
	Sub-Total		65	5,614	**5,680**
Total	**(MLD)**	**2,432**	**83**	**6,122**	**7,814**

Source: JICA Project Team

Table 3-13 Sanitation Development Plan in HA-1

Project	Category	Unit	Katsina	Kebbi	Sokoto	Zamfara	**4 states**
Public toilet	Urban	Nos	172	82	136	72	**462**
	S.U/S.T	Nos	481	256	290	267	**1,294**
Final septage disposal facility/site	Urban	Household	142,917	37,206	135,867	64,955	**380,944**
Sewerage system	Urban	m3	-	-	-	-	**-**
Hygiene promotion	S.U/S.T	Household	463,689	148,063	307,582	330,637	**1,249,971**
	Rural	Household	440,064	167,653	314,209	366,016	**1,287,942**

Source: JICA Project Team

Table 3-14 Sanitation Development Plan in Ogun-Oshun Basin

Project	Category	Unit	Lagos	Ogun	Osun	Oyo	**4 states**
Scenario-A							
Public toilet	Urban	Nos	1,688	311	197	374	**2,570**
	S.U/S.T	Nos	763	324	253	446	**1,786**
Final septage disposal facility/site	Urban	Household	2,092,658	484,781	244,859	462,706	**3,285,004**
Sewerage system	Urban	m3	239,273	-	11,042	34,109	**284,424**
Hygiene promotion	S.U/S.T	Household	1,437,537	766,513	488,501	870,682	**3,563,233**
	Rural	Household	102,557	515,919	525,804	824,239	**1,968,518**
Scenario-B							
Public toilet	Urban	Nos	3,985	311	197	374	**4,867**
	S.U/S.T	Nos	1,949	324	253	446	**2,972**
Final septage disposal facility/site	Urban	Household	3,320,268	484,781	244,859	462,706	**4,512,614**
Sewerage system	Urban	m3	564,908	-	11,042	34,109	**610,059**
Hygiene promotion	S.U/S.T	Household	3,952,549	766,513	488,501	870,682	**6,078,244**
	Rural	Household	-	515,919	525,804	824,239	**1,865,962**

Source: JICA Project Team

3.7.2 Irrigation and Drainage

The existing and proposed public irrigation schemes are categorized as shown in Table 3-15:

Table 3-15 Category of Public Irrigation Scheme

Name of Scheme			
1. Existing Irrigation Scheme		2. New Irrigation Scheme	
1.1	Completion with No Extension Scheme	2.1	Supplementary Irrigation Scheme
1.2	Ongoing Scheme	2.2	Dam Irrigation Scheme
1.3	Extension Scheme	2.3	Integration Scheme

Source: JICA Project Team

Irrigation project in HA-1and Ogun-Oshun Basin

Area of the existing public irrigation scheme above was evaluated and new public irrigation scheme was planned as shown in Table 3-16.

Table 3-16 Planned Irrigation Area as of 2030 (ha)

Category of Public Irrigation Scheme	HA-1	Ogun-Oshun Basin
Existing Irrigation Scheme	41,041	27,891
1.1 Completion with No Extension Scheme	24,441	474
1.2 Ongoing Scheme	9,750	24,617
1.3 Extension Scheme	6,850	2,800
New Irrigation Scheme	1,500	0
2.1 Supplementary Irrigation Scheme	0	0
2.2 Dam Irrigation Scheme	1,500	0
2.3 Integration Scheme	0	0
Total	42,541	27,891

Source: JICA Project Team

Regarding irrigation development schemes on Ogun-Oshun Basin, two scenarios (A and B) with different time schedule are set, considering the water demand of Lagos state. In Scenario A, the entire scheme will be completed by 2025 in accordance with the implementation schedule of M/P2013. In Scenario B, considering the water demand of Lagos state own, the entire scheme will be completed later than that of Scenario-A by 2030.

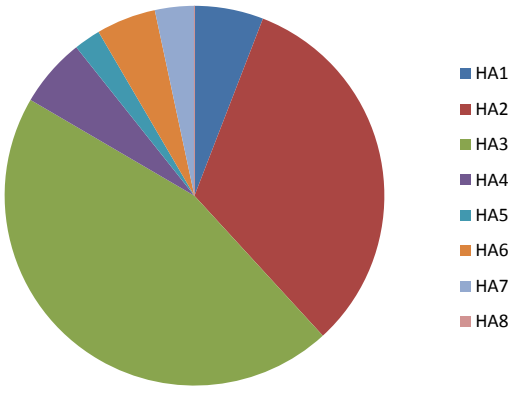
3.7.3 Hydropower Generation

Considering the large environmental and social impacts of constructing a large-scale hydroelectric station, as well as the lack of suitable dam sites with large enough capacities, a more practical choice for the proposed dam sites would be to install small hydropower stations that are driven by water used primarily for irrigation purposes.

(1) Evaluation of Hydroelectric Potential

We estimated the hydroelectric potential of each dam site based on the flow regime and dam height of each site, which were identified by our survey, to examine the possible introduction of hydroelectric stations, and sorted out the approximate results are shown in Figure 3-7.

HA	Annual Output (MWh)
HA-1	**69,722**
HA-2	383,971
HA-3	537,402
HA-4	69,929
HA-5	26,900
HA-6	**60,359**
HA-7	39,934
HA-8	0
Total	1,188,217



Source: JICA Project Team

Figure 3-7 Output (Potential) by HA

HA-1 cannot expect to maintain stable output throughout the year due to poor flow regime. However, it may be possible to operate a hydropower system in HA-1 by reallocating water among the dams proposed under the M/P2013, as some of them have surplus water in the reservoirs.

On the other hand, HA-6, which includes Ogun-Oshun Basin, cannot expect to maintain stable output throughout the year due to topographical constraints, which make it difficult to create enough hydraulic head, along with relatively poor stream flow. In addition, the hydropower station at Oyan Dam broke due to lack of maintenance and has stopped functioning all together despite the abundant stream flow.

3.7.4 Flood and Erosion Control

The Measures below are recommended against flood and soil erosion in HA-1 and Ogun-Oshun Basin.

Table 3-17 Measures against Flood and Soil Erosion

Catchment Area/Basin	Items
HA-1	In the Rima and Sokoto rivers, to manage the release from dams in upstream reaches and manage the floodplain downstream (forecast of water level and flooding extent)
	Heavy soil erosion of Rima River results in high turbidity of river water quality in dry season not less than 250NTU. The raw water from the Rima River for Sokoto water treatment plant (WTP) has high turbidity, affecting the operation of WTP. To study the causes of high turbidity of river water due to soil erosion and implement the mitigation measures by RBDA and State Government.
	To stabilize the channel around intakes in the Rima River and enhance the usage of river channels as fish pond in dry season, and enhance the usage of inland waterway transportation for local people.
Ogun-Oshun Basin	Management of Floodplain of Ogun River
	Ibadan Urban Drainage (Oyo State)
	Lagos Urban Drainage Improvement (Lagos State)
	Erosion Control in urban area (each State),
	Development of Inland Water Transportation in Ogun River

Source: JICA Project Team

3.8 Water Resources Management Plan

Content of water resources management plan is summarized in Table 3-18 for HA-1 and Ogun-Oshun Basin.

Table 3-18 Content of Water Resources Management Plan

Items		Content/proposal
8.1	General	(1) Objective and Strategy of Water Resources Management ● Organization and institution for water resources management ● Operation and maintenance for provision of water services ● Allocation and regulation of water resources quantity and quality ● Facilitation and improvement for water resources management
8.2	Institutional Framework of Water Resources Management	(1) Basic Approach for Strengthening of Institutional Framework It is important to focus on the Participatory Approach of Management in the basin for strengthening of institutional framework. It implies that of particular importance is to create a basin-wide comprehensive institutional arrangement involving all stakeholders in the basin for implementation of adequate catchment management plan. It will be composed of Catchment Management Coordinating Committee (CMCC), Technical Advisory Committee, and State IWRM Committee. NIWRMC including CMOs shall act as secretariat body for promotion and coordination within its management systems.
8.3	Operation and Maintenance of Water Resources Development Facilities	(1) Surface water Dams are important facilities for the development of surface water resources, so that dams need to be managed with respect to the following basic aspects. ● Dam structures and facilities ● Reservoirs ● Reservoir water level control (high water/low water-level operations) For HA-1, in particular, a number of dams including Bakorori, Goronyo, Zobe, Jibiya and Gusau Dams are in operation and construction of new dams is planned in Sokoto Rima River basin catchment area. The operation of these dams in an efficient and sophisticated manner is crucial for development of limited water resources. There are many earth dams but most of their bodies are seriously damaged: in particular, dams in HA-1 tend to be damaged seriously partly due to the dry weather in the northern part. For Ogun-Oshun Basin, in particular, new dams are in operation or to be constructed along

Items		Content/proposal
		Ogun or Oshun Rivers. The operation of these dams in an efficient and sophisticated manner is crucial for development of limited water resources. (2) Groundwater Regarding operation and management of the facilities for groundwater use, 12 items below were proposed. ● Operation and management of aquifer ● Operation and management of borehole facilities ● Pumping capacity of boreholes ● Construction system of boreholes ● Lowering of groundwater level by over pumping ● Sea water intrusion ● Land subsidence ● Groundwater contamination ● Increase in borehole successful rate ● Monitoring of groundwater lowering by drought ● Mining groundwater contamination in the northern part of Nigeria ● Promotion of groundwater recharge
8.4	Hydrological Monitoring	(1) Surface water In the M/P2013, problems and issues in surface water monitoring were analyzed, and the strategy on improvement of surface water monitoring is proposed as shown below: ● Improvement of surface water monitoring network ● Enhancement of data management capacity in NIHSA ● Establishment of hydrological modelling centre within NIHSA ● Enhancement of awareness on importance of hydrological monitoring According to interview to RBDA of Sokoto-Rima and Ogun-Oshun Basin and State Government as well as to information obtained in stakeholder meeting, there are no or few functional monitoring systems by RBDA and State government in HA-1 and Ogun-Oshun Basin. This could be mainly because of lack of budget for the hydrological monitoring activities. Considering the current situation, the strategies on surface water monitoring by RBDA and State Government were recommended. (2) Groundwater Issue of groundwater monitoring in the current situation was analyzed, and future direction for expected groundwater monitoring was recommended for items below: ● Evaluation of groundwater development potential ● Detection of groundwater environmental problems ● Clarification of demarcation of responsibility among the organizations in charge of groundwater monitoring. ● Proposal for institutional strengthening and capacity building of the organizations. ● Proposal on demarcation of responsibility among NIHSA, NIWRCM and State organizations
8.5	Data and Information Management	There are very few organizations in HA-1 and Ogun-Oshun Basin that could keep observing and archiving their data in consistent manner. Therefore, it is hard to find reliable data which covers whole area. Considering the current situation, the JICA Project Team explains implementation policy for observing data and collecting data, setting strategies below: ● Through sharing knowledge, allow people to make “INFORMED DECISION” ● NIHSA and CMO (Catchment Management Office or NIWRMC main body) should be focal Agencies of the database maintenance and operation Items below are proposed based on the current situation of target areas. ● Date to be managed ● Policy for data acquisition ● Management on data acquisition and archiving
8.6	Consideration of Risk Associated with Climate Change and Trans-boundary Water	(1) Climate Change Risks in water resources that will be caused by the Climate Change were presented. (2) Transboundary water ● Case in dam below was described as example of transboudary water issues. ● Kandajidam that is planned in upstream area of Niger River in HA-1 ● Risks that will be caused by transboudary water were assumed. ● Sokoto groundwater basin was examined as example of transboudary groundwater in HA-1. ● Transboudary groundwater around the border with Republic Benin was examined as example of transboudary groundwater in Ogun-Oshun Basin. (3) Coping Strategy on Risk associated with Climate Change and Transboundary Water ● Refinement of identification of the risk by enhancement of water-related data/information. ● Promotion of adaptive management. ● Enhancement of emergency management against flood and drought. ● Promotion of water demand management.
8.7	Water Environment	Three important problems/issues are identified on water environmental management and recommendations are presented in HA-1 and Ogun-Shun Basin.

Items		Content/proposal
	Management	● Drinking water quality monitoring ● Water pollution control ● Water environment conservation
8.8	Water Allocation and Regulation	In order to promote the framework on water allocation and regulation in HA-1 and Ogun-Shun Basin that is proposed in M/P2013, the followings are recommended. ● Formulation of the CMP is a first step for improving the water allocation and regulation in HA-1and Ogun-Shun Basin. The draft CMP should be finalized by continuing the stakeholder meetings. ● Stakeholder forum should be established based on the stakeholder meetings held on the process of formulating the draft CMP. The stakeholder forum should be the basis for CACK. In future, CACK should be officially established when the CMP will be finalized. Moreover, allocation and regulation on groundwater resources are proposed at hydrological area level.
8.9	Communication Strategies for Water Resources Management	The following action plans were suggested in the M/P2013. ● Strengthening of Public Relations (PR), through updating FMWR's quarterly magazine known as WATER ● Strengthening of web site of FMWR ● Strengthening and diversifying of the tools of PR to include all the media such as newspapers, TV, radio, magazines, etc. ● Strict and efficient management of document files within FMWR (digitalization, etc.) In line with the above-stated action plans, we suggest the proposals for improving the communication in terms of catchment management of water resource as follows. ● Dissemination of the national water policy, the water management legislation and the CMP in collaboration and consultation with the PR Unit ● Organization of programs, workshops and seminars on role of water in the economy and Society in the basin
8.10	Public Private Partnership (PPP)	It is recommendable to apply the same action plans which were suggested in the M/P2013 as follows. ● Strengthening of the PPP Unit of FMWR ● Capacity building for PPP projects preparation and implementation ● Budget allocation for PPP projects preparation ● Establishment of Projects Delivery Teams and Steering Committee ● Regular partners/stakeholders consultation on the PPP process ● Regular updating of policies and strategies to promote private sector participation We suggest the following proposals for each of the Basin State. ● Cost effective delivery of water services using private sector's support and initiative ● Creation of State PPP Unit within the Basin States
8.11	Manpower Development and Institutional Capacity Development	In view of the basic policies for Human Resources Development (HRD) in the M/P2013, we believe that it is extremely significant to emphasize the needs for HRD focusing on IWRM at basin and catchment status. We present items below for HRD Plan for the M/P 2013 below: ● Development and increase access to training opportunities ● Strengthening of training to respond to the needs at river basin level ● Strengthening and enlargement of training functions of NWRI within FMWR In addition to items above, we proposed project below in CMP. ● Project for human resources and institutional capacity development focused on IWRM at basin and catchment level
8.12	Monitoring and Evaluation	In order to implement steadily planned projects, a development of M&E system particularly for the preparatory stage of project is strongly recommended. The implementation of the projects proposed in the existing M/P1995 is far behind the proposed schedules. One of the causes is that the proper preparation for initial stage of the implementation has been neither planned nor managed appropriately. Process of project preparation stage will be as follows: To draft a Project Proposal based on the M/P2013➡ To carry out the F/S➡ To prepare the Project Explanatory Note➡ To propose the Budget Request➡To secure Budge Approval ➡ To implement the projects. Project will be promoted by M&E of the process above. For drafting and implementing these processes, the close cooperation is essential among FMWR, NIWRMC, RBDA, CMO and the concerned state governments.

Source: JICA Project Team

3.9 Implementation Program

3.9.1 Outline of Projects

Classification of the proposed Project in the Catchment Management Plan (CMP) is shown in Table 3-19.

Table 3-19 Classification of Projects

A. Water Source Development	B. Sub-sector Development	C. Water Resources Management
A.1 Surface Water Development	B.1 Water Supply and Sanitation	C.1 Hydrological Monitoring
A.1.1 On-going Projects	B.1.1 Water Supply Rehabilitation Scheme	C.2 Water Allocation and Regulation
A.1.2 Effective Utilization Existing Dams	B.1.2 Water Supply New Construction Scheme	C.3 Water Environment Management
A.1.3 New Water Source Development	B.1.3 Sanitation Scheme	
A.2 Groundwater development	B.2 Irrigation/Drainage	
A.2.1 Borehole rehabilitation	B.2.1 Rehabilitation of Existing Scheme	
A.2.2 New boreholes drillings	B.2.2 New Irrigation scheme	

Source: JICA Project Team

3.9.2 Implementation Program in HA-1

(1) Implementation Schedule

Implementation schedule of the proposed projects (water sources development, water supply and sanitation, irrigation and drainage, water resources management) is formulated by the 1st to 3rd stage (1st: 2014-2020, 2nd: 2021-2025, 3rd: 2026-2030). The schedule is decided based on strategies of each sector.

(2) Cost Estimate

Cost of high priority projects is shown in Table 3-20 to Table 3-22 with its detail. Total amount of the Project cost is 8.7 billion Naira for surface water development, 15.1 billion Naira for groundwater development, and 23.8 billion Naira in total. On the other hand, it is 256.3 billion Naira for water supply and sanitation and 51.6 billion Naira for irrigation and drainage. Also it is 3.5 billion Naira for water resources management. Of the total project cost, 8% for water supply development and water resources management, 77% for water supply and sanitation and 15% for irrigation and drainage. water supply and sanitation cost occupies large part of the total cost.

Table 3-20 Project Cost for Water Sources Development Schemes

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Surface Water Development	6,854	0	685	343	788	8,670
2. Groundwater Development	11,990		1,189	600	1,378	15,157
Total	18,844	0	1,874	943	2,166	23,827

Source: JICA Project Team

Table 3-21 Cost of Sub-sector Development Schemes

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Water Supply and Sanitation		202,615	20,261	10,130	23,300	256,308
2. Irrigation and Drainage	40,696	80	4,077	2,039	4,689	51,581
Total		243,391	24,338	12,169	27,989	307,889

Source: JICA Project Team

Table 3-22 Cost of Water Resources Management Schemes

Project	Content (Million Naira)		Content (Million Naira)
	Equipment	Administration	
1. Hydrological Monitoring	1,310	1,452	2,762
2. Water Environment Management	463	251	714
Total	1,773	1,703	3,476

Source: JICA Project Team

(3) Financial Program for Project Implementation

Financial program of water sources development, water supply and sanitation, irrigation and drainage schemes are shown in Table 3-23.

Table 3-23 Financial Program for Project Implementation

Project	Investment for each Stage (Billion Naira)			Total (Billion Naira)
	1st Stage 2014-2020	2nd Stage 2021-2025	3rd Stage 2026-2030	
A. Water Source Development	7.5	10.3	6.0	23.8
B. Water Supply and Sanitation	121.6	79.8	55.0	256.2
C. Irrigation and Drainage	21.4	16.2	14.0	51.6
Total	150.5	106.3	75.0	331.6

Source: JICA Project Team

3.9.3 Implementation Program in Ogun-Oshun Basin (Western part of HA-6: Western Littoral)

(1) Implementation schedule

Implementation schedule of the proposed projects (water sources development, water supply and sanitation, irrigation and drainage, water resources management) is formulated by the 1st to 3rd stage (1st: 2014-2020, 2nd: 2021-2025, 3rd: 2026-2030). The schedule is decided based on strategies of each sector.

(2) Cost Estimate

(2-1) Scenario-A

Cost of high projects is shown in Table 3-24 to Table 3-26 with its detail. Total amount of the Project cost is 24.6 billion Naira for surface water development, 5.3 billion Naira for groundwater development, and 29.9 billion Naira in total. On the other hand, it is 1,299.5 billion Naira for water supply and sanitation and 106.9 billion Naira for irrigation and drainage. Also it is 3.2 billion Naira for water resources management. Of the total project cost, 2% for water supply development and water resources management, 90% for water supply and sanitation and 7% for irrigation and drainage. Water supply and sanitation cost occupies large part of the total cost.

Table 3-24 Project Cost for Water Sources Development Schemes (Scenario-A)

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Surface Water Development	19,412	0	1,941	971	2,232	24,556
2. Groundwater Development	4,213	0	422	210	484	5,329
Total	23,625	0	2,363	1,181	2,716	29,885

Source: JICA Project Team

Table 3-25 Cost of Sub-sector Development Schemes (Scenario-A)

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Water Supply and Sanitation	1,027,291		102,729	51,365	118,139	1,299,524
2. Irrigation and Drainage	82,134	2,400	8,454	4,226	9,721	106,935
Total	1,111,825		111,183	55,591	127,860	1,406,459

Source: JICA Project Team

Table 3-26 Cost of Water Resources Management Schemes (Scenario-A)

Project	Content (Million Naira)		Content (Million Naira)
	Equipment	Administration	
1. Hydrological Monitoring	1,307	1,165	2,473
2. Water Environment Management	463	251	714
Total	1,770	1,416	3,187

Source: JICA Project Team

(2-2) Scenario-B

Cost of high priority projects is shown in Table 3-27 to Table 3-29 with its detail. Total amount of the project cost is 67.9 billion Naira for surface water development, 5 billion Naira for groundwater development, and 72.9 billion Naira in total. On the other hand, it is 2,669.3 billion Naira for water supply and sanitation and 106.9 billion Naira for irrigation and drainage. Also it is 3.2 billion Naira for water resources management. Of the total project cost, 3% for water supply development and water resources management, 94% for water supply and sanitation and 4% for irrigation and drainage. Water supply and sanitation cost occupies large part of the total cost.

Table 3-27 Project Cost for Water Sources Development Schemes (Scenario-B)

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Surface Water Development	53,712	0	5,371	2,686	6,177	67,946
2. Groundwater Development	3,944	0	396	196	454	4,990
Total	57,656	0	5,767	2,882	6,631	72,936

Source: JICA Project Team

Table 3-28 Cost of Sub-sector Development Schemes (Scenario-B)

Project	Content (Million Naira)					Total (Million Naira)
	Construction	Equipment	Engineer -ing	Admini-stration	Physical Contingency	
1. Water Supply and Sanitation		2,110,097	211,010	105,505	242,662	2,669,274
2. Irrigation and Drainage	82,134	2,400	8,454	4,226	9,721	106,935
Total		2,194,631	219,464	109,731	252,383	2,776,209

Source: JICA Project Team

Table 3-29 Cost of Water Resources Management Schemes (Scenario-B)

Project	Content (Million Naira)		Content (Million Naira)
	Equipment	Administration	
1. Hydrological Monitoring	1,307	1,165	2,473
2. Water Environment Management	463	251	714
Total	1,770	1,416	3,187

Source: JICA Project Team

(3) Financial Program for Project Implementation

(3-1) Scenario-A

Financial program is shown in Table 3-30, which was estimated for water sources development, water supply and sanitation and irrigation and drainage. In water sources development sector (surface water and groundwater), investment for the 2nd Stage is the largest of all the stage. In water supply and sanitation sector, investment for the 1st Stage is the largest of all the stage. Then investment will gradually reduce afterward. In irrigation and drainage sector, investment for the 1st Stage is the largest of all the stage. Then investment will gradually reduce afterward.

Table 3-30 Financial Program for Project Implementation (Scenario-A)

Project	Investment for each Stage (Billion Naira)			Total (Million Naira)
	1st Stage 2014-2020	2nd Stage 2021-2025	3rd Stage 2026-2030	
A. Water Sources Development	5.4	22.1	2.5	30.0
B. Water Supply and Sanitation	676.6	397.9	225.1	1,299.6
C. Irrigation and Drainage	62.7	41.9	2.3	106.9
Total	744.7	461.9	229.9	1,436.5

Source: JICA Project Team

(3-2) Financial Program

Financial program is shown in Table 3-31, which was estimated for water sources development, water supply and sanitation and irrigation and drainage. In water sources development sector (surface water and groundwater), investment for the 2nd Stage is the largest of all the stage. In water supply and sanitation sector, investment for the 2nd Stage is the largest of all the stage. In irrigation and drainage sector, investment for the 3rd Stage is the largest of all the stage.

Table 3-31 Financial Program of Investment for Water Sources Development Schemes (Scenario-B)

Project	Investment for each Stage (Billion Naira)			Total (Million Naira)
	1st Stage 2014-2020	2nd Stage 2021-2025	3rd Stage 2026-2030	
A. Water Sources Development	5.2	40.3	27.3	72.8
B. Water Supply and Sanitation	727.2	1,183.8	758.3	2,669.3
C. Irrigation and Drainage	18.9	10.6	77.4	106.9
Total	751.3	1,234.7	863.0	2,849.0

Source: JICA Project Team

3.10 Evaluation of Catchment Management Plan

3.10.1 Economic Evaluation

An economic evaluation on projects such as "Water Supply" and "Irrigation and Drainage" proposed as the sub-sector development project is carried out.

(1) HA-1: Niger North

(1-1) Water Supply Projects

Result of economic analysis is shown in Table 3-32.

Table 3-32 Results of Economic Analysis of Water Supply Projects

	Rehabilitation Schemes						New Construction Schemes					
	Urban & Semi-urban			Rural			Urban & Semi-urban			Rural		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	50.0%	3.6	314.7	27.6%	2.2	11.1	10.1%	1.01	13.5	9.2%	0.94	-4.9
Total of 4 States	41%	3.1	30.6	24%	2.0	1.5	8.0%	0.9	-13.9	8.7%	0.9	-1.1
1 Katsina	36%	3.1	5.6	19%	1.7	0.2	7.4%	0.8	-9.6	8.0%	0.9	-0.6
2 Kebbi	48%	3.6	7.3	24%	2.0	0.4	9.1%	1.0	-1.1	9.1%	0.9	-0.2
3 Sokoto	42%	1.0	11.1	26%	2.1	0.5	7.8%	0.9	-1.8	7.9%	0.8	-0.3
4 Zamfara	36%	2.3	3.8	26%	2.1	0.2	9.9%	0.9	-0.1	10.0%	1.0	0.0

Note) NPV: Naira in billion
Source: JICA Project Team

Rehabilitation Schemes

The EIRR of HA-1 as a whole shows quite high rate of 41% in Water Supply of Urban and Semi-urban/Small-town in HA-1. On the other hand, The EIRR of the nation as a whole shows also quite high; 24% in Rural Water Supply in HA-1; because all rehabilitation work in rural area converges on groundwater supply improvement.

New Construction Schemes

The EIRR of water supply in Urban and Semi-urban/Small-town of HA-1 presents 8%, below 10% of OCC. The EIRR of Rural Water Supply as a whole presents 9.2%, slightly below 10% of OCC because of burdening new wells and equipment costs. However, it could be judged rather economically feasible if taking into account the low level of ability-to pay of rural areas.

(1-2) Irrigation and Drainage Projects

Results of economic analysis of Irrigation and Drainage Projects of HA-1 are shown in Table 3-33 and Table 3-34.

Table 3-33 Results of Economic Analysis of Existing Schemes (NPV: Naira in billion)

	Rehabilitation Schemes			Irrigation Extension of ongoing Schemes			Irrigation Extension of coming Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	41.8%	4.1	47.9	13.2%	1.3	33.4	10.8%	1.1	5.2
HA-1	30.5%	2.9	1.7	9.7%	1.1	-0.2	9.0%	0.9	-0.5

Note) NPV: Naira in billion
Source: JICA Project Team

Table 3-34 Results of Economic Analysis of New Schemes (NPV: Naira in billion)

	Supplementary Irrigation Schemes			Dam Irrigation Schemes			Integration Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	20.3%	2.0	66.5	9.6%	0.96	-3.9	10.4%	1.0	4.3
HA-1	-	-	-	4.6%	0.5	-0.9	-	-	-

Note) NPV: Naira in billion
Source: JICA Project Team

In Rehabilitation Schemes, the EIRR presents quite high rate of 30.5%. In Irrigation Extension Projects of ongoing scheme, the EIRR is 9.7%, due to limited rice farming area even in rainy season. In Irrigation Extension Projects of coming scheme, and Dam Irrigation Schemes, both schemes present the EIRRs lower than 10%.

(2) Ogun-Oshun Basin (Western part of HA-6: Western Littoral)

(1-1) Water Supply Projects

Result of economic analysis is shown in Table 3-35.

Table 3-35 Results of Economic Analysis of Water Supply Projects (NPV: Naira in billion)

	Rehabilitation Schemes						New Construction Schemes					
	Urban & Semi-urban			Rural			Urban & Semi-urban			Rural		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	50%	3.6	314.7	28%	2.2	11.1	10.1%	1.01	13.5	9.2%	0.94	-4.9
Scenario-A	59%	6.1	96.3	37%	2.8	2.1	13.3%	1.3	145.4	13.9%	1.3	1.5
1 Lagos	74%	8.2	49.6	27%	2.2	0.1	14.7%	1.4	140.1	11.7%	1.1	0.0
2 Ogun	40%	4.0	7.8	41%	2.9	0.3	8.6%	1.0	-5.2	17.4%	1.4	0.6
3 Osun	51%	5.0	16.7	41%	3.0	0.7	10.5%	1.0	1.0	12.9%	1.2	0.2
4 Oyo	47%	4.8	13.4	37%	2.7	0.8	9.3%	0.9	-3.6	13.0%	1.2	0.5
Scenario-B												
1 Lagos	74%	8.2	49.1	-	-	-	15.3%	1.5	324.4	-	-	-

Note） NPV: Naira in billion
Source: JICA Project Team

Rehabilitation Schemes

In water supply in Urban and Semi-urban/Small-town, the EIRR of both Scenario-A and Scenario-B shows quite high rate of EIRR. In Rural water supply, the EIRR shows also quite high of 37%.

New Construction Schemes

In water supply in Urban and Semi-urban/Small-town, the EIRR of both Scenario-A of whole Ogun-Oshun river basin and Scenario-B exceeds 10% of OCC. In Rural Water supply, the EIRR presents 13.9% that exceeds 10% of OCC.

(2-2) Irrigation and Drainage Projects

Results of economic evaluation of Ogun-Oshun Basin are shown in Table 3-36 and Table 3-37.

Table 3-36 Results of Economic Analysis of Existing Schemes (NPV: Naira in billion)

	Rehabilitation Schemes			Irrigation Extension of ongoing Schemes			Irrigation Extension of coming Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	41.8%	4.1	47.9	13.2%	1.3	33.4	10.8%	1.1	5.2
Scenario-A	45.5%	4.3	2.9	14.6%	1.4	16.9	14.3%	1.3	0.7
Scenario-B	-	-	-	10.5%	1.0	1.3	-	-	-

Note) NPB: Billion Naira
Source: JICA Project Team

Table 3-37 Results of Economic Analysis of New Schemes (NPV: Naira in billion)

	Supplementary Irrigation Schemes			Dam Irrigation Schemes			Integration Schemes		
	EIRR	B/C	NPV	EIRR	B/C	NPV	EIRR	B/C	NPV
Nigeria	20.3%	2.0	66.5	9.6%	0.96	-3.9	10.4%	1.0	4.3
Scenario-A	-	-	-	8.0%	0.8	-0.4	-	-	-
Scenario-B	-	-	-	-	-	-	-	--	--

NPV: Naira in billion
Source: JICA Project Team

In Rehabilitation Schemes, the EIRR presents quite high rate of 45.5%. In Irrigation Extension Projects of ongoing Scheme, the EIRR of both Scenario A and Scenario B shows exceed 10% of OCC. In Irrigation Extension Projects of coming Scheme, and Dam Irrigation Schemes, the EIRR of the irrigation extension projects presents economically feasible, 14.3%. On the other hand, the EIRR of the dam irrigation schemes shows lower than 10% of OCC.

3.10.2 Financial Program for Project Implementation

(1) Financial Schedule

Table 3-38 shows the project costs of water supply scheme of target states by state and by stage up to the target year of 2030

Table 3-38 Water Supply Project Costs by Stage (Naira in billion)

Stage / State	1st 2014-2020	2nd 2021-2025	3rd 2026-2030	Total 2014-2030	Stage / State	1st 2014-2020	2nd 2021-2025	3rd 2026-2030	Total 2014-2030
HA-1	121.2	89.2	56.3	266.7	Ogun-Oshun Scenario-A	605.5	202.8	53.8	862.1
Katsina	65.2	43.8	24.4	133.4	Lagos	490.3	32.1	0.0	522.4
Kebbi	23.5	17.7	10.9	52.1	Ogun	6.7	116.8	2.3	125.8
Sokoto	19.2	12.3	10.4	41.9	Osun	39.9	3.0	12.6	55.5
Zamfara	13.3	15.4	10.6	39.3	Oyo	68.6	50.9	38.9	158.4
					Ogun-Oshun Scenario-B	634.7	760.3	414.2	1,809.2
					Lagos	519.5	589.6	360.4	1,469.4
					The other 3 states	115.2	170.7	53.8	339.8

Source: JICA Project Team

Table 3-39 presents the project costs of irrigation and drainage schemes of the target states by scheme and by stage up to the target year of 2030.

Table 3-39 Irrigation & Drainage Project Costs by Stage (Naira in billion)

Stage / State	1st 2014-2020	2nd 2021-2025	3rd 2026-2030	Total 2014-2030	Stage / State	1st 2014-2020	2nd 2021-2025	3rd 2026-2030	Total 2014-2030
HA-1	21.5	16.2	18.2	55.9	Ogun-Oshun Scenario-A	65.4	41.6	11.0	118.0
Rehabilitation	1.4	0.8	0.6	2.8	Rehabilitation	2.2		-	2.2
On-going	16.9	6.4	-	23.3	On-going	60.2	39.6	-	99.7
Extension	3.2	9.0	7.2	19.4	Extension	3.0	2.0	0.0	5.1
Supplementary Irrigation	-	-	-	-	Supplementary Irrigation	-	-	-	-
Dam Irrigation	-	-	10.4	10.4	Dam Irrigation	-	-	11.0	11.0
Integration	-	-	-	-	Integration	-	-	-	-
					Ogun-Oshun Scenario-A	18.9	10.7	88.4	118.0
					On-going	13.7	8.6	77.4	99.7
					Other Schemes	5.2	2.1	11.0	18.3

Source: JICA Project Team

(2) Promotion of Financing Arrangement

(2-1) Water Supply Project

In Nigeria, the water supply development is generally assumed by FGN and the state governments. Particularly, the state governments play the crucial role for it, currently bearing more than 80% of the entire development costs of Nigeria. However, the financial conditions of the states are not enough sufficient to implement the development projects. So, the state governments have to collaborate closely with FGN for the financial support for the implementation. Also, it is strongly required to the state governments to make continuous efforts to diversify the financial mobilization for the sector development by elaborating and proposing the business models accompanied with the state's guarantee that may attract the both national and international private firms and NGOs as well as by appealing to the international donor agencies.

(2-2) Irrigation and Drainage Projects

Average annual cost for the project is 3.5 billion Naira in HA-1 and 6.9 billion Naira in Ogun-Oshun Basin until the target year. Above amount of 3.5 billion Naira and 6.9 billion Naira are equivalent to 10% and 20% respectively of 350 billion which a 3-years'averaged figure from 2009 to 2011 budgeted by the FGN for the development of the irrigation and drainage sector. Obviously the FGN budget is to be allocated to all 8 HAs in nation-wide consideration of such factors as location, soil, social needs, economic efficiency and environmental conservation. With regard to HA-1 and Ogun-Oshun river basin, as recommended in the M/P2013, the budget should be allocated firstly to the projects that could achieve the highest economical effectiveness, namely the rehabilitation projects. Secondary, the budget should be spent to the new projects.

3.10.3 Evaluation from Social and Environmental Aspects

The principal objective of this evaluation is to examine how the proposed projects in the Draft CMP may potentially influence on the current condition of the natural and social environment. If negative impacts are forecasted by the project's implementation, then, necessary mitigation measures will be examined. The projects proposed in the Draft CMP shall be evaluated through the execution of the Initial Environmental Examination (IEE). Projects of Draft CMP cover four (4) sectors except Water Resources Management Projects. Number of the Projects that constitute CMP is shown in Table 3-40.

Table 3-40 Number of Projects of CMP

Sector	HA-1			Ogun-Oshun					
				Scenario-A			Scenario-B		
	Ongoing Projects	Proposed Projects*	Ongoing Projects	Ongoing Projects	Proposed Projects*	Ongoing Projects	Ongoing Projects	Proposed Projects*	Ongoing Projects
Dam	2	2	4	4	4	8	4	6	10
Municipal Water Supply	0	43	43	0	120	120	0	120	120
Irrigation and Drainage	6	8	14	4	10	14	4	10	14
Sanitation	0	28	28	0	31	31	0	31	31
Total	8	81	89	8	165	173	8	167	175

Source: JICA Project Team

EIA Category and required level of survey is as follows:

Categoly-1: Full EIA is required
Categoly-2: Partial EIA may be required
Categoly-3: Not require EIA

From the above criteria, projects of Draft CMP in Category -1 and Category-2 are subject to scoping at IEE study level (see Table 3-41). This is in compliance with the Guidelines for EIA and JICA guidelines for environmental and social considerations (ver.2004).

Table 3-41 Categorization of Projects in Draft CMP subjected to IEE/EIA Study

Sector	EIA Category 1			EIA Category 2		
	HA-1	Ogun-Oshun		HA-1	Ogun-Oshun	
		Scenario-A	Scenario-B		Scenario-A	Scenario-B
Dam	4	4	6	0	4	4
Municipal Water Supply	16	33	37	23	83	80
Irrigation and Drainage	5	4	3	9	10	10
Sanitation	4	7	7	8	8	8
Total	29	47	53	40	105	102

Source: JICA Project Team

In general, the projects proposed in the CMP of HA-1 and Ogun-Oshun Basin will benefit three main sectors namely municipal water supply, irrigation/drainage and sanitation. As for municipal water supply high positive impacts are expected through the project implementation on the current health level of the beneficiary population by consuming potable water which in turn will allow the exercise of better hygiene practices in the households. As for irrigation/drainage, the socio-economic status of the population will be highly upgraded through the increase of agricultural production and employment opportunities. In addition food security for the population will be improved. As for sanitation, a high positive impact is expected on the public health of the population through the safe disposal of sewage and excreta.

Some adverse impacts on the environment are also expected from the project implementation in HA-1 and Ogun-Oshun Basin which shall be diminished through the proposed mitigation measures. In this sense, especial attention must be given to the dam sectors since it involve huge physical intervention and may need the resettlement of people living around the candidate site.

3.11 Recommendations

3.11.1 Development of Catchment Management System and Establishment of CMP

With the technical cooperation of JICA, Federal Ministry of Water Resources (FMWR) has formulated National Water Resources Master Plan 2013 (M/P2013) through the work of 30 months starting from August 2011.

On the basis of the M/P2013, the first version of Catchment Management Plan (CMP) was prepared by the collaboration of JICA Project Team and NIWRMC - an agency of FMWR. Although the CMP is based on the M/P2013, this first version of CMP should be elaborated with further efforts due to the following reasons. 1) A consensus of the stakeholders is not concluded yet sufficiently as the preparation of the CMP was done in short period of a half year. 2) The CMP is not finalized as the organization and institution to authorize it are not established year. It is important to solve these issues and to achieve the water resources development and management to suffice people's water demands such as water use, flood disaster mitigation and water quality conservation.

(1) Development of Catchment Management System

The CMP proposes three (3) new organizations as an important catchment management system. Namely 1) Catchment Management Coordination Committee (CMCC), 2) Technical Advisory Committee (TAC) and 3) State Integrated Water Resources Management Committee (State IWRM Committee). Such system is not developed yet. Representatives of stakeholder related to water resources should be selected as members of the committees.

As for the member state of the CMP of HA-1, the main states were four (4) states: Katsina, Kebbi, Sokoto and Zamfara at the preparation time of the first version. As Niger State occupies some area and population in HA-1, Niger State should be member state of CMCC and TAC in the future stage. Participation of Niger State and the other states (Jigawa and Kano: small occupation in the territory) in HA-1 to CMCC and TAC will be a matter of discussion in future.

As for the member state of the CMP of Ogun-Oshun Basin, the main states were four (4) states: Lagos, Ogun, Osun and Oyo at the preparation time of the first version. Participation of other states (Ekiti、Kwara and Ondo: small occupation in the territory) in Ogun-Oshun Basin to CMCC and TAC will be a matter of discussion in future.

FMWR and NIWRMC should take action immediately to start the development of catchment management system.

(2) Establishment of Catchment Management Plan

The stakeholders' consensus in the first version of the CMP is insufficient as the preparation period is short. In particular, among water subsectors (hydropower generation, livestock, inland fishery, flood management, water quality conservation etc.) other than water supply & sanitation and irrigation & drainage, the consensus of stakeholders will be necessary. In addition, as well as government agencies, consensus building including water user stakeholders, NGO, academic institutions will be also needed.

Further, CMP shows a option of water source development to meet the water demand in Lagos State forecasted by Lagos State. Permission of this option will be committed by CMCC to be established in future.

FMWR and NIWRMC should take action immediately to establish the CMP through enough and repeated stakeholder meetings.

3.11.2 Practical Use and Periodic Review of CMP

(1) Practical Use of CMP

The CMP has been prepared in the collaboration with the consultant team dispatched by JICA Technical Cooperation Program (JICA Project Team) and "Steering Committee", "Technical Advisory Committee" and "Counterpart Team" formulated by the members from FMWR. In other words, this plan is a work produced by enthusiasm for the water vision of Nigeria and technology of Japan on water resources development and management.

In the future, FMWR and State Governments are recommended to elaborate and maintain the CMP for better utilization of it.

(2) Periodic Review of CMP

The CMP has been formulated on the basis of the evidence of 1) water resource potential based on a scientific approach and 2) water demand forecast based on economic growth and population projections up to 2030. In future, it will be necessary to check the demand forecast by looking at the track record of economic growth and population growth.

In addition, it is necessary also to check water resource potential on a regular basis. The reason is a matter of trans-boundary water. About 26.7BCM/year of water resources are flowing in HA-1 from outside the country through the Niger River. Reduction of inflow will take place by water resources development in the upper river basins. The other reason is the problem of global climate change. Increase in drought frequency and occurrence of large floods have been foreseen. Some situations, water resource potential also may change.

In view of the above, FMWR, NIWRMC and State Governments are recommended to carry out periodic reviews (for example, every five years) of the CMP.

3.11.3 Implementation of Water Resources Development

As water resources development plan, the CMP shows two (2) development plans for water sub-sectors, namely "Water Supply Development Plan" and "Irrigation and Drainage Development Plan", including the water source development (groundwater development and surface water development).

(1) Water Supply Development Plan

Water Supply Development Plan is a development plan that corresponds to the improvement of water supply rate and new water demand of future population growth to increase to up to 2030 (around 10 million people in HA-1, around 16 million people in Scenario-A and 31 million people in Scenario-B in Ogun-Oshun Basin). The current water supply rates are: 71% (Urban), 51% (Semi-urban), 40% (Rural) and 56% in the national average. In accordance with the road map of FMWR (2011), the water supply rate in 2025 is planned to achieve 100% of each.

As to the water demand projection of Lagos State, there are two (2) scenarios. Namely, Scenario-A: water supply demand projection based on the national population census (adopted at the M/P2013) and Scenario-B: water supply demand projection based on the state own population census. The CMP proposes four new dams for Scenario-A and six new dams for Scenario-B with the addition of two added to Scenario-A.

Water supply system is a critical infrastructure underlying the country. As the investment to water source development facilities (dams and wells), water purification facilities and water distribution networks will be large-scale, investment in government level become essential. Both governments of Federal and State are recommended to implement steadily the projects proposed in the plan.

(2) Irrigation and Drainage Development Plan

Irrigation and Drainage Plan is a development plan with the aim of 100% self-sufficiency rate of rice in conjunction with the promotion of rain-fed rice cultivation by 2030. The projects with high investment efficiency have been selected in the development plan. Areas with a gravity irrigation system and areas with good development efficiency for water source development have been selected. The large scale irrigation projects are on-going currently in the areas of Jibiya, Zobe, Middle Rima Valley, Sabke in HA-1 and in the areas of Lower Ogun and Middle Ogun in Ogun-Oshun Basin. These irrigation projects will enable rice production in rainy season and contribute the increase of self-sufficiency rate of rice.

In the case of pump irrigation system, the promotion of sound and self-reliant irrigation with hydroelectric power generation using the dam for water resources development is recommendable. For the potential of hydroelectric power plant installation at existing dams in HA-1 and Ogun-Oshun Basin, future research is needed.

For food security of the country, the promotion of irrigated agriculture with high yield and toughness to drought is of particular importance. Urbanization progresses, there is a tendency for demand for rice will increase. In Nigeria urbanizing, future demand for rice will increase. In addition, large-scale projects such as irrigated agriculture, will contribute significantly to the creation of employment opportunities in rural areas. From these points of view, planned investment of the federal government to irrigation scheme will be necessary. FMWR is recommended to steadily implement the irrigation scheme proposed in the M/P2013.

(3) Involvement in Other Sub-sectors

Also in water resource-related schemes under the jurisdiction different, involvement of FMWR

becomes more and more important in future. For example, flood management and hydroelectric power generation are important areas.

Regarding hydropower generation using dam, future cooperation with the Federal Ministry of Power and related state ministry having jurisdiction over the power becomes necessary. Also, regarding flood management, future cooperation with the Federal Ministry of Environment and related state ministry having jurisdiction over the flood management becomes necessary. As inland aquaculture and livestock farming may conflict with the irrigation sector, coordination among stakeholders is necessary for promotion of efficient use of water resources. Against this background, for the water related projects under the jurisdiction of other ministries, FMWR and the related state governments are recommended to strengthen cooperation with other ministries in order to participate actively.

3.11.4 Implementation of Water Resource Management

Water Resources Management Plan shows the methodology how to provide the water services based on the Sufficiency, Efficiency, Fairness, Safety and Sustainability, to the water users who expect [Effective Use of Water], [Mitigation of Flood Damage] and [Conservation of Water Quality], by using the facilities and operational systems installed on the basis of Water Resources Development Plan.

FMWR is recommended to implement steadily the projects and action plans which are indicated by Water Resources Management Plan proposed in M/P2013. Water Resources Management Plan is aiming at the state shown below.

The best state of water resources management:

- There is a good plan. There is an appropriate action.
- There are organizations and systems for desirable Water Services.
- Water Services to suffice safety and security are provided for water users.
- Water Services are never delayed. If there is trouble in delivery system for Water Service, someone restores it immediately.
- Water users pay the price gladly for the right price of Water Services.
- Information relating to Water Services is collected and analyzed. This information is managed and utilized to improve Water Services
- People engaging Water Service study every day with the spirit of self-advancement.
- Water Services are always monitored by water users, and the results of services are evaluated.

The CMP shows exhaustively various action plans and projects for each management item in Water Resources Management Plan. The specific management item for HA-1 is “Efficient Operation of Dam”. In Sokoto-Rima River Basin, there exist Bakorori Dam, Goronyo dam, Zobe dam and Jibiya dam, and new Gusau dam is proposed for water supply. FMWR and RBDA are recommended to examine the efficient dam operation including dam safety, and to apply the results to actual dam management.

3.11.5 Steady and Sound Investment

(1) Direct Capital Investment of Federal Government of Nigeria (FGN)

In the M/P2013 which is the basis of the CMP shows the investment plan to realize 100% water supply rate and 100% of rice self-sufficiency at the target year 2030 in Nigeria. For water supply projects, investment of about 200 billion Naira per year (almost 2 times of current 3 years average) is necessary. In particular, the estimated investment in the first phase (2014-2020) is about 280 billion Naira per year.

On the other hand, for irrigation projects, investment of about 105 billion Naira (almost 4 times of current 3 years average) is required. In particular, the estimated investment in the first phase (2014-2020) is about 49 billion Naira per year.

Government financial support is indispensable. Nigerian Government is recommended to allocate the budget on priority basis for these two sectors to realize the national goals although the national financial situation is severe.

(2) Other Sources of Financing

The CMP envisages that the governments will make an intensive capital investment more exceeding

the current capital expenditures of annual average to the water supply projects and to the irrigation & drainage projects. For the smooth financing and implementation of the projects, the efforts to find other source of funds like below are indispensable, apart from relying heavily on the increase of the government direct capital investment.

- **Utilization of Private-sector Funds:** FMWR shall promote the introduction of the Public-Private Partnership (PPP) and the privatization of the water supply projects and the irrigation projects currently undertaken by the governments in order to decrease the government direct capital investment.
- **Utilization of International Development Partners' (IDPs) Funds:** The intensive efforts to get the awards such as the "Grant Technical Aid and Grant Financial Aid" or "Soft Loan" from IDPs are to be made for decreasing the government direct capital investment. Besides, for realizing actually the investment programs efficiently and concretely, it is also requested to share the related information among all IDPs through the actions such as the stakeholders' meetings and the use of the donor's coordination platforms.
- **Promotion of Users' Pay Principle:** Every user of treated water and irrigation water must pay the charge according to the volume they use. However, most of the users actually don't pay the charge. This causes the quite low level of revenues of these projects. So, it is a crucial matter to improve the revenues through the efforts in making users aware of the importance of payment through such as public awareness campaign. As a result, the incomes from the projects are expected to grow, which could generate the incremental cash flow for the coming new projects and simultaneously decrease the government direct capital investment.

Aiming to realize steadily the CMP, Federal Government and State Governments are recommended to actualize the above three (3) actions which contribute toward decreasing the government direct capital investment.

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