Chapter 5
Issues on Water Resources Development and Management

CHAPTER 5 ISSUES ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

5.1 IWRM and Water Resources Development Plan

Water resources in Uganda have been managed since 1999 based on the concept of IWRM which was adopted in "National Water Policy (1999)". However, there is a fundamental issue between water resources management under IWRM and water resources development: namely, spatial expanse of them. The former has mainly river basin concept which focus on natural aspect of water resources. [1] Meanwhile, water resources development has been planned and carried out in administrative units since before because water resources development plan or utilization plan has been formulated administrative-unit-wise. An advantage of this traditional way is to be able to use all kinds of statistic data stored administrative-unit-wise as basic information in order to formulate a water resources development plan. However, its deficit; it was the reason why IWRM was propounded, is unable to deal with the mutual influence that spans the border of administrative units as the small scale to international boundary as the large scale, because water resources settle quantitatively and qualifiedly in the river basin under natural conditions.

In Uganda, "Water Resource Management Zone"[2] called as the compromised idea in a manner is proposed. Four water management zones are set up considering eight major river basins and socio-economic conditions, and conforming to the district boundaries in Uganda; however, each zone consists several partial river basins has an issue: how to incorporate river basin management as a basic concept of IWRM. A comparison of both concepts for water resource development and management is shown in Figure 5-1.

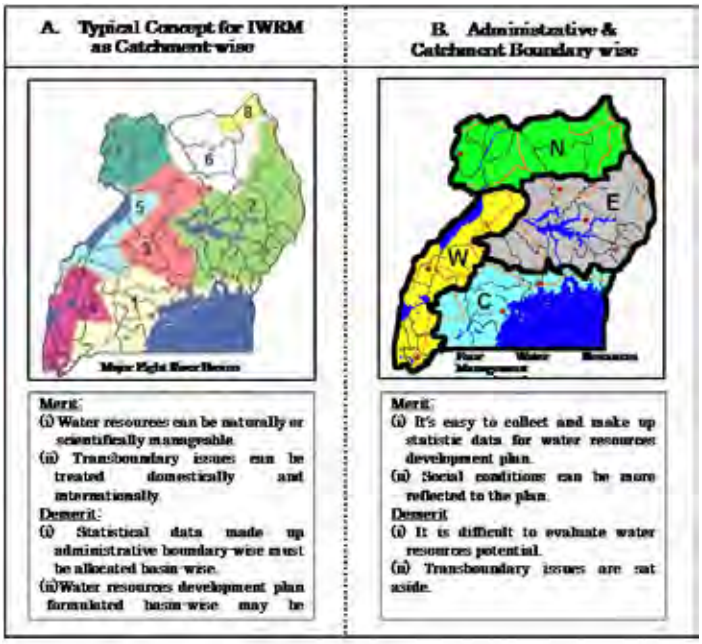


Figure 5-1 Two Concepts for Water Resources Development and Management

5.2 Surface Water Resources Development and Management

(1) Relation to Nile Treaty

Given Nile Treaty, it is necessary to make the Basic Plan under the water resources supplied by rainfall precipitated in the Lake Kyoga Basin itself.

(2) Imbalanced Distribution of Surface Water Resources in the Basin

[1] Another concept is groundwater basin, which differs from river basin through the viewpoint of groundwater management. However, it is usually regarded as same as river basin because both water resources are generally in the same hydrological circulation.
[2] Four Water Management Zone Offices will be established in Uganda. One of the offices plans to be established in Mbale in July 2011.

The available surface water resource through the year is different in each sub-basin. The distribution has a tendency that northern sub-basins has poor surface water resources, on the other hands, southern sub-basins has relatively more surface water resources.

(3) Appropriate Water Allocation

It is necessary to build adequate water allocation system among water sectors for keeping economic efficiency, effectiveness and social equity.

(4) Effect of Climate Change

IPCC Fourth Report said that Climate Change in the 21st will cause increase of annual rainfall in East Africa. However, it cannot give reliable rainfall quantity at any given future point in time so that it is reasonable not to put the rainfall increase effect into the basic plan.

(5) Monitoring and Potential Evaluation of Water Resources

It is necessary to build up revised monitoring system on rainfall and surface water discharge, and information sharing system among water sectors: these are fundamentals for more precise water resources estimation. These monitoring data will bring more accurate estimation of water resources in future.

(6) Management of Surface Water Usage

On the other hands, to grasp current water use is also essential for IWRM so that the strengthening of maintenance system of the database on water allocation and the information sharing among water sectors are necessary.

5.3 Groundwater Resources Development and Management

(1) Groundwater Development Plan

There is no development plan of National or local level, and, planning is required early. Therefore, capacity development for planning of development plan is required at each district. Since groundwater should be main water source for rural area, capacity development for groundwater in each district water office (DWO) is recognized as prime task.

(2) Groundwater Mapping

Since the groundwater mapping has been conducted on the basis of National Groundwater Database ,which has an issue on data accuracy, it has to be updated after revising NGWDB through checking existing data with WATSUP results and adding new data.

(3) Groundwater Potential

Many kinds and numbers of data are necessary to examine groundwater potential, since groundwater monitoring is generally more difficult than surface water, which can be measured directly. In the Study, groundwater recharge was analyzed by the water balance calculated by albedo and

topography analysis estimated by satellite image analysis, because the meteorological, hydrological and hydrogeological data are insufficient. In near future, it is necessary to improve their monitoring network system satisfactorily to consider the climate change too and this technique using satellite image data as provisional and practical method. Capacity development for DWRM's staff needs to conduct this kind of analysis by them.

(4) Borehole Completion Report

Although borehole completion reports are very important for groundwater resources management, technical issues on their accuracy negatively affect groundwater potential evaluation because of no guideline for drilling, borehole structure and pumping test.

(5) Groundwater Monitoring

Only three groundwater monitoring stations are functioning in Lake Kyoga Basin so far. To grasp the fluctuation of quantity and quality of groundwater resources, the role of groundwater monitoring is essentially important. The number of monitoring station is required at least each one station at the typified place in the 11 sub-basins.

(6) Permission for Groundwater Withdrawal

Water balance analysis is fundamental matter for water resources management. Therefore, to grasp groundwater withdrawal volume as sort of expenditure is so important that DWRM should monitor withdrawal volume of bulk water-users in particular through granting groundwater withdrawal permission.

(7) Water Management Zone Office

The main roles of the WMZ are listed below;

- Implementing Integrated Water Resource Management (IWRM),
- Bringing practical WRM much closer to the users,
- Models for the assessment of water balance, water quality and pollution loading, and
- Community participation.

Capacity development for WMZ office and DWRM is needed. The former is expected not only for groundwater management but water resources management and the latter DWRM manages WMZ office.

5.4 Conservation of Water Environment

5.4.1 Water Quality

(1) Surface water (Rivers and Lakes)

Issue on conservation of surface water quality is to maintain at least the current conditions. Slightly high organic compounds detects now in the urban areas of the Basin. BOD value was not significantly high in most cases; however, this situation is likely to change drastically in near future

and water resource would be deteriorated due to the rapid population growth and economical growth.

(2) Groundwater

Issue on groundwater in the Basin is contamination of Coliforms in many deep wells, shallow wells, and protected springs. Main cause seems to be pollutants deriving from livestock. T he polluted water infiltrates to the aquifer due to the inappropriate blockage of contaminated water on the ground surface and the faulty sealing of wells.

5.4.2 Necessity of Ambient Water Quality Standards and Water Quality Monitoring

In general, a precautionary measure is much cheaper than backward incidence. It takes enormous cost, time and effort to restore a deteriorated environment although some cost need to forestall and prevent pollution. Water quality would be deteriorated for real in Uganda due to rapid population growth and economic development. Therefore, an appropriate system for water quality monitoring should be formulated in order to take countermeasures against pollution before it becomes a serious situation.

Some of the countermeasures are to install septic tank, construct sewerage treatment system and increase public awareness. However, reliable data of water quality by periodical monitoring works and ambient water quality standard including classification of type of water use as an environmental conservation target for planning and implementation of countermeasure are essentially needed.

Therefore, the ambient water quality standard and the monitoring system should be well- formulated rapidly as a first step to conserve water environment in Uganda.

5.5 Water Balance of Supply and Demand

5.5.1 Future Water Demand

(1) Population Frame

The future population is forecasted in the "Strategic Investment Plan for the Water and Sanitation Sub Sector, July 2009" (SIP) applying the published population growth which estimated until 2017 by the Uganda Bureau of Statistics (UBoS) based on the population census data for 1992 and 2002. Total population of the basin is estimated to 9,321,959 and 22,766,831 for 2008 and 2035, respectively, and the estimated values of the population for each category are summarized in Table 5-1 and Figure 5-2 for some years indicative of milestones in the plan.

Table 5-1 Present and Future Population in Lake Kyoga Basin

Year	Whole Population in the Basin	Large Urban (NWSC)	Peri-urban/ Rural (NWSC Service Area)	Small Towns (Town Councils & Town Boards)	Rural (RGCs + Villages)
2008	9,321,959	392,351	481,972	604,295	7,843,341
2015	11,822,680	482,341	632,369	772,111	9,935,859
2020	13,979,550	587,059	748,386	925,437	11,718,668
2035	22,766,831	1,004,084	1,366,522	1,644,976	18,751,249

Source: Strategic Investment Plan for the Water and Sanitation Sub Sector, 2009

(2) Future Water Demand

The water demands of drinking, agricultural and industrial water in the whole Lake Kyoga Basin and each sub-basin in 2008 to 2035 are estimated based on SIP as presented in Table 5-2 and Table 5-3. The water demand of the Mpologoma sub-basin is the largest in the Basin sharing about 75 % of the demand of whole Kyoga basin, but its increase is not so sharp as the other sub-basins. The demand of the Mpologoma sub-basin increases to 365.9 MCM equivalent to about 12 % of increase, and remains only at about 43 % of the whole basin, though the demand of the whole basin gains from 435.6 MCM to 844.1 MCM equivalent to about 94 % of increase.

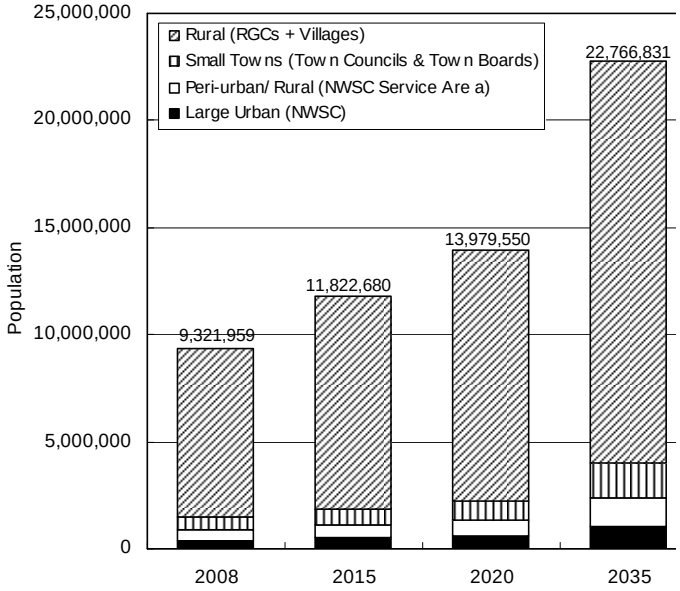


Figure 5-2 Present and Future Population in Lake Kyoga Basin

As for the water demand for each sector shown in Table 5-3, the demand of irrigation for crops is considered to be the largest throughout the project period. It shares about 55% only in 2035 though about 75% in 2008. Its increase from 2008 to 2035 is calculated to be 42% which is considered low comparing with the increase of the whole demand of the Basin of about 94%.

Table 5-2 Present and Future Water Demand for Sub-basins

(Unit:MCM)

Sub-basin	2008	2015	2020	2035
(1) Okok	7.7	12.4	16.1	26.7
(2) Okere	7.7	16.2	23.7	47.5
(3) Awoja	15.8	35.2	52.2	103.3
(4) Lwere	29.1	30.4	32.3	41.5
(5) Akweng	4.1	10.9	17.2	34.9
(6) Abalan	4.2	15.6	24.8	50.5
(7) Kyoga Lakeside Zone	12.3	24.7	35.4	65.4
(8) Mpologoma	327.6	322.4	325.5	365.9
(9) Lumbuye	6.2	8.7	11.3	20.5
(10) Victoria Nile	10.7	18.8	26.4	44.8
(11) Sezibwa	10.3	18.4	26.1	43.1
Total	435.6	513.6	590.8	844.1

Table 5-3 Present and Future Water Demand for Sectors

(Unit:MCM)

Year	Domestic NWSC	Domestic Small Towns	Domestic Rural	Livestock	Crops	Fisheries	Rural Industries	Total
2008	3.9	8.22	42.94	37.82	326.95	12.02	3.78	435.7
2015	5.12	12.09	71.91	48.56	339.55	24	12.36	513.7
2020	6.33	16.31	105.85	51.54	361.31	36.03	13.45	591
2035	11.42	31.53	208.7	63.92	463.22	48.03	17.24	844.1

Source: Strategic Investment Plan for the Water and Sanitation Sub Sector, 2009

5.5.2 Water Balance of Supply and Demand

The extension of water demand and the exploitable volume of water resources in the whole Lake Kyoga Basin are shown in Figure 5-3. Since it is unreasonable to formulate any development plan based on 1/10 probable drought year because much excessive investment is needed in a short period, 1/3 probable drought year was adopted in this study. In that case, the exploitable water volume: 650.5MCM/year can manage to cover water demand quantitatively until around 2025; however, since agricultural water, which occupies more than half of total water demand, depends almost on surface water, it is necessary to consider not only quantitative comparison but also water type of water sector.

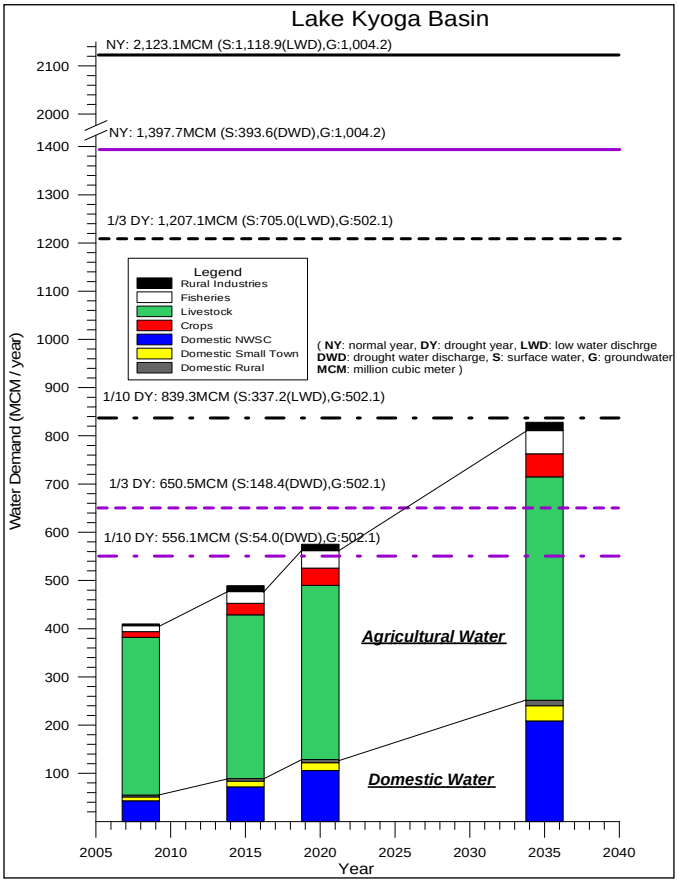


Figure 5-3 Water Balance of Supply and Demand in Lake Kyoga Basin

As for water demand for crops, which is majority of agricultural water, is not constant but seasonally changed by the pattern of planting crops that closely correspond to the pattern of rainfall. According to the typical cropping calendar of Pallisa and Bugili, the water demand period of crops is seven months per year. Therefore, 3-year low water discharge that means exploitable for 275 days a year (9 months) can be adopted to estimate exploitable surface water resources for agricultural water use. Table 5-5 shows the results of water balance in each sector by sub-basin. The table indicates that five sub-basins: Okok, Okere, Lwere, Kyoga Lakeside and Mpologoma are or will be challenged by deficit of agricultural water. Estimated water shortage volumes of each sub-basin are shown in Table 5-4. As for domestic water, if groundwater development goes well, the water demand growth in all sub-basins can be nearly covered.

Table 5-4 Estimated Water Shortage in Five Sub-basins

Unit: MCM/year

Sub-basin Name	2008		2015		2020		2035	
	GW for Domestic & Industrial Water	SW for Agricultural Water	GW for Domestic & Industrial Water	SW for Agricultural Water	GW for Domestic & Industrial Water	SW for Agricultural Water	GW for Domestic & Industrial Water	SW for Agricultural Water
(1) Okok				3.2		5.2	0.5	10.9
(2) Okere				0.7		5.7		19.9
(4) Lwere		0.3						1.7
(7) Kyoga Lakeside Zone		2.2		11.8		19.5		40.5
(8) Mpologoma		122.6		100.0		89.8		89.4

GW: groundwater, **SW**: surface water, **MCM**: million cubic met

Table 5-5 Evaluation of Water Balance in Each Sector

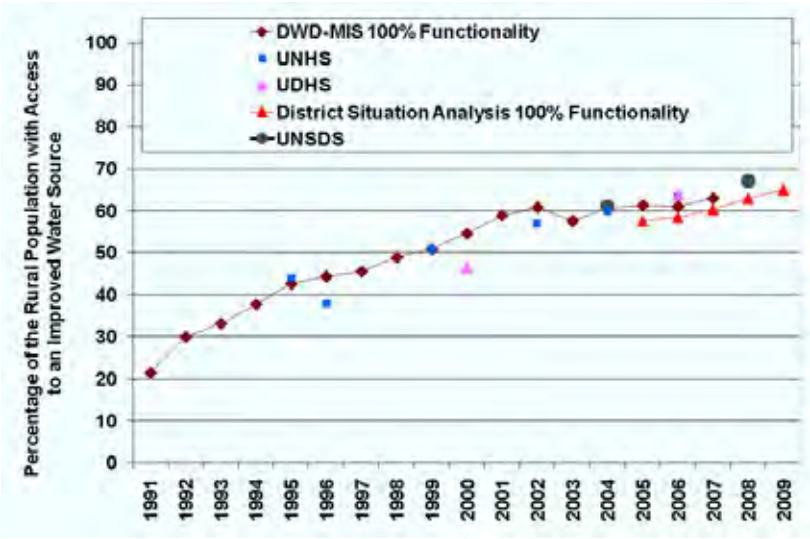
Sub-basin Name	Water Demand (MCM/year)																Exploitable Water Resource (MCM/year)									
	2008				2015				2020				2035				Normal Year					1/3 Drought Year				
	Domestic Water	Agricultural Water	Industrial Water	Total	Domestic Water	Agricultural Water	Industrial Water	Total	Domestic Water	Agricultural Water	Industrial Water	Total	Domestic Water	Agricultural Water	Industrial Water	Total	Surface Water		GW	Total		Surface Water		GW	Total	
																	DWD	LWD		DWD	LWD	DWD	LWD		DWD	LWD
(1) Okok	1.7	5.9	0.1	7.7	3.1	9.1	0.3	12.4	4.7	11.1	0.3	16.1	9.3	16.8	0.5	26.7	1.7	11.4	18.5	**20.2**	**29.9**	0.4	5.9	9.3	**9.7**	**15.1**
(2) Okere	2.6	5.1	0.1	7.7	4.5	11.4	0.3	16.2	6.8	16.4	0.5	23.7	16.0	30.6	0.9	47.5	4.1	23.3	76.4	**80.5**	**99.7**	1.2	10.7	38.2	**39.4**	**48.8**
(3) Awoja	6.8	8.3	0.1	15.2	11.5	22.4	0.7	34.5	16.9	33.6	1.0	51.5	35.2	65.1	2.0	102.2	59.7	165.8	257.4	**317.1**	**423.1**	24.3	105.4	128.7	**153.0**	**234.1**
(4) Lwere	2.4	26.4	0.3	29.1	4.1	25.5	0.8	30.4	6.1	25.5	0.8	32.3	12.9	27.8	0.8	41.5	14.0	50.5	43.9	**57.9**	**94.5**	4.0	26.1	22.0	**26.0**	**48.1**
(5) Akweng	2.0	2.0	0.0	4.1	3.5	7.1	0.2	10.9	5.4	11.4	0.3	17.2	11.8	22.4	0.7	34.9	27.1	90.4	53.7	**80.7**	**144.1**	9.3	61.8	26.8	**36.1**	**88.6**
(6)Abalan	2.2	2.0	0.0	4.2	3.6	11.6	0.3	15.6	5.3	18.9	0.6	24.8	10.6	38.8	1.2	50.5	38.3	112.9	83.7	**122.0**	**196.6**	13.5	73.7	41.9	**55.4**	**115.6**
(7) Kyoga Lakeside Zone	3.7	8.5	0.1	12.3	6.1	18.1	0.5	24.7	8.9	25.8	0.8	35.4	17.2	46.8	1.4	65.4	11.5	36.5	59.8	**71.3**	**96.3**	0.4	6.3	29.9	**30.3**	**36.3**
(8) Mpologoma	17.8	303.5	3.0	324.3	28.6	280.9	8.4	317.9	41.1	270.7	8.1	319.9	77.2	270.3	8.1	355.6	110.4	295.2	234.2	**344.6**	**529.4**	44.8	180.9	117.1	**161.9**	**298.0**
(9) Lumbuye	2.4	3.7	0.0	6.2	4.1	4.5	0.1	8.7	6.0	5.1	0.2	11.3	11.9	8.3	0.3	20.5	10.8	32.8	36.6	**47.5**	**69.4**	4.8	19.4	18.3	**23.1**	**37.7**
(10) Victoria Nile	4.9	5.7	0.1	10.7	7.9	10.6	0.3	18.8	11.3	14.7	0.4	26.4	20.9	23.2	0.7	44.8	48.1	140.5	75.9	**124.0**	**216.3**	18.0	112.2	37.9	**56.0**	**150.1**
(11) Sezibwa	4.6	5.6	0.1	10.3	7.0	11.0	0.3	18.4	9.8	15.8	0.5	26.1	17.4	25.0	0.7	43.1	67.9	159.7	64.1	**131.9**	**223.7**	27.7	102.6	32.0	**59.7**	**134.6**
Total	51.2	376.8	3.8	431.7	84.0	412.1	12.4	508.5	122.2	448.9	13.5	584.5	240.2	575.2	17.3	832.7	393.6	1,118.9	1,004.2	**1,397.7**	**2,123.1**	148.4	705.0	502.1	**650.5**	**1,207.1**

Shortage of Water Resource Marginal of Water Resource Coverage **DWD**: drought water discharge, **LWD**: low water dicharge, **GW**:groundwater

5.6 Plateaud Coverage Rate of Rural Water Supply

Drinking water supply, which is one of the keen needs for water resources development, is categorized into urban and rural water supply. Although urban water supply has been developed mostly on an economic basis by NWSC or Town Board respectively, rural water supply is apt to be left behind. A coverage rate of rural water supply had been improved rapidly until 2001 but it has been plateaud since 2002 as shown in Figure 5-4. It implies that additional facilities and maintenance of existing faculties cannot catch up growing water demand now.

Consequently, a practical and effective development plan should be formulated to meet the national target rate: 77% in 2015.



Source:MoWE (2009), "Water and Environment Sector Performance Report"

Figure 5-4 Coverage Rate of Rural Water Supply in Uganda

Chapter 6
Basic Plan on Water Resources Development and Management

CHAPTER 6 BASIC PLAN ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

6.1 Approaches to IWRM

The concept of IWRM was officially adopted in "National Water Policy (1999)" which provided the overall policy framework for the water sector as a means to ensuring sustainable management and utilization of Uganda's water resources. This Study was just the challenge to formulate the Basic Plan on water resources development and management (hereinafter referred as to the Basic Plan) as the first full-scale approach to IWRM in Lake Kyoga Basin.

6.2 Major Issues on Water Resources Development and Management in Lake Kyoga Basin

Major issues, which are come up through the Study and dealt with in the Basic Plan, are listed below.

- Shortage of reliable basic data for water resources development and management.
- Uncertain potential of water resources: surface water and groundwater
- Restriction of surface water due to "Nile Water Agreement"
- Climate change
- Fragile water balance between demand and supply
- Plateaud coverage rate of rural water supply
- Insufficient Stakeholders collaboration for water resources development and management
- Lack of "Ambient Water Quality Standards" for conservation of water environment
- Mitigation of flood and sediment disaster
- Necessity of capacity development for the related organizations and their staffs to water resources development and management
- Necessity of community participation

6.3 Basic Course for the Basic Plan

The Basic Plan is formulated to mitigate or resolve issues as listed above on water resources development and management in the Basin based on conceptual frameworks of IWRM, which plays to aspire for harmonized water resource management in the Basin. The basic course for the plan is formulated as follows base on the study results through the Study.

- Name of the Plan: "The Basic Plan on Water Resources Development and Management for Lake Kyoga Basin"
- Target Year: Short Term 2015, Middle Term 2020 and Long Term 2035.
- Target Area: Lake Kyoga Basin (1 57,080km^2)
- Related Districts: 38 Districts (August 2009)
- Target Population: Approximately 9.32 million estimated as at 2008.
- The Basin is subdivided into 11 sub-basins as basic unit for the Basic Plan. (Figure 6-1)
- Trans-boundary issue between Uganda and Kenya in the western side of the Basin is not included in the Basic Plan. The plan deals with Ugandan side of the Basin.

[1] except for Kenyan side from total area 58,230km^2

- In the case of demand-and-supply balance analysis for a water development plan in the Basic Plan, exploitable surface water resources will be estimated by 3-year drought water discharge; however, 3-year low water discharge will be used for agricultural water use considering its actual condition. (refer to 4.3.3)
- In general, self-contained water supply in each sub-basin is planned without interbasin diversion because of effectiveness and economic efficiency.
- Long-term prediction of rainfall in the east Africa based on the fourth evaluation report of IPCC (Intergovernmental Panel of Climate Change) indicate a tendency toward increase. However, the quantity of water resources in the Basic Plan is regarded as no change on the safe side.
- From the view point of cost-benefit performance and cost reduction, non-structural measures are adopted as much as possible instead of structural measures.

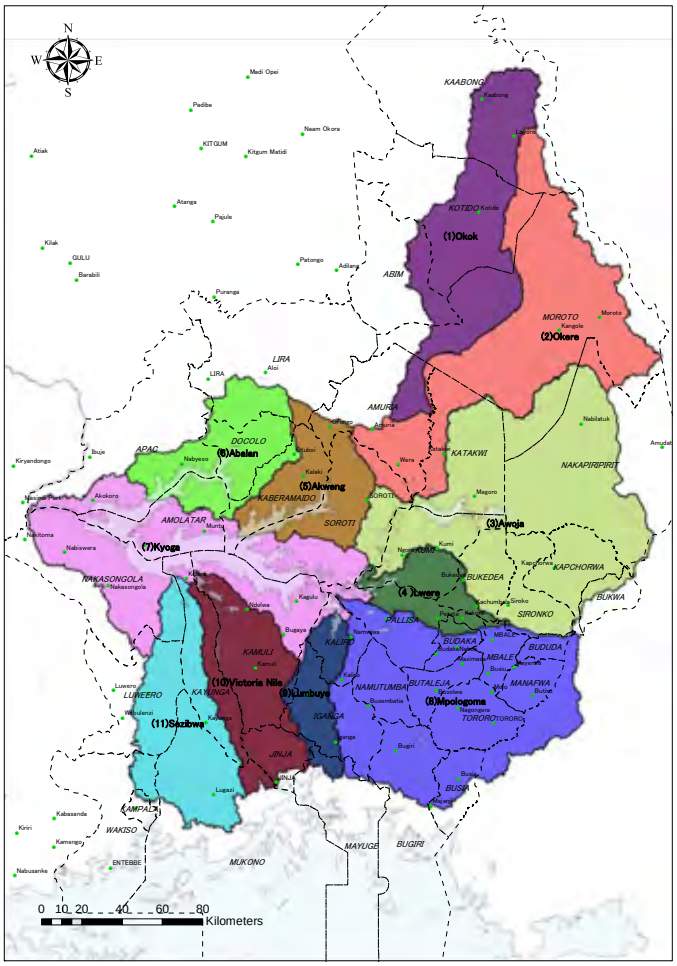


Figure 6-1 Distribution of Sub-basins and Related Districts

6.4 Basic Plan on Water Resources Development and Management

6.4.1 Comprehensive Water Resources Management

(1) Assessment of Water Resources

The water resources potential is basic and most important information in IWRM, and it is important to obtain more accurate water resources potential for implementation of more effective IWRM. Monitoring plans for surface water, groundwater and rainfall are proposed below to improve the current monitoring system.

1) Surface Water Monitoring Plan

- Number of gauging stations and the locations:

  Guideline numbers of river discharge and lake water level gauging stations are shown in Table 6-1.
- Data Processing:

Rapid data accumulation to DWRM should be realized through building up new data collection and processing system such as foundation of brunch offices and data processing in the offices.

- Strengthening of Financial Resource:
  The maintenance work is not enough due to lack of the fund. Therefore increase of revenue is necessary.
- Disclosure of Monitoring Data:
  The data will be open in the office of DWRM on request base during the early stage, and in a website of DWRM at the end. To provide processed monitoring data for a price will be one of the methods to make up for revenue shortage for maintenance of gauging stations.

Table 6-1 Surface Water Monitoring Plan

No.	Sub-basin	Land Area (km^2)	No. of River Gauging Stations						
			Present Conditions			Future Conditions			
			Operating	Not Operating	Total	New	Existing	Rehabilita-tion	Total
1	Okok	7,036	0	0	0	1	0	0	1
2	Okere	6,645	0	1	1	2	0	0	2
3	Awoja	11,037	6	6	12	1	3	1	5
4	Lwere	1,501	0	0	0	1	0	0	1
5	Akweng	2,443	0	3	3	0	0	1	1
6	Abalang	2,912	1	0	1	1	0	0	1
7	Kyoga Lakeside Zone	5,654	0	0	0	1	0	0	1
8	Mpologoma	8,969	4	3	7	2	4	0	6
9	Lumbuye	1,394	0	0	0	1	0	0	1
10	Victoria Nile	3,427	1	1	2	0	1	0	1
11	Sezibwa	4,227	1	0	1	1	1	0	2
Total		55,245	13	14	27	11	9	2	22

No.	Sub-basin	Lake	No. of Lake Gauging Stations						
			Existing Conditions			Future Conditions			
			Operating	Not Operating	Total	New	Existing	Rehabilita-tion	Total
3	Awoja	Bisina, Opeta	0	2	2	0	0	2	2
4	Lwere	Small lakes	0	1	1	0	0	0	0
5	Akweng	Kyoga	1	1	2	0	1	0	1
6	Abalang	Kyoga	0	1	1	0	0	1	1
7	Kyoga Lakeside Zone	Kyoga	0	2	2	1	0	1	2
Total		-	1	7	8	1	1	4	6

2) Groundwater Monitoring Plan

- Monitoring Stations:
  Monitoring stations in each sub-basin are planned in Table
- Data Processing:
  In near future, WMZ office should collect new data, process them, and accumulate data to DWRM.
- Strengthening of Financial Resource:
  The maintenance work is not enough due to lack of the fund. Therefore increase of revenue is necessary.
- Disclosure of Monitoring Data:
  Processed monitoring data should be open to public promptly.

Table 6-2 Groundwater Monitoring Plan

No.	Sub-basin	Land Area (km^2)	No. of Groundwater Monitoring Stations				
			Existing No.			Proposed	Total
			Planed or Rehabilitation Required	Operating	JICA Well		
1	**Okok**	7,036				2	2
2	**Okere**	6,645	1			1	2
3	**Awoja**	11,037				2	2
4	**Lwere**	1,501		1		1	2
5	**Akweng**	2,443				2	2
6	**Abalang**	2,912			2	1	3
7	**Kyoga Lakeside Zone**	5,654			3	2	5
8	**Mpologoma**	8,969	1	1	5		7
9	**Lumbuye**	1,394			3	1	4
10	**Victoria Nile**	3,427			2	2	4
11	**Sezibwa**	4,227		1		1	2
Total		55,245	2	3	15	15	35

3) Rainfall Monitoring Plan

- Number of gauging stations:
  Guideline numbers of rainfall monitoring stations are shown in Table 6-3 for each sub-basin.
- Data Processing:
  Observation and data processing system should be realized in each district water office, and data collection and database system among DWD, IWRM and Department of Meteorology also should be realized.

- Disclosure of Monitoring Data:
  Processed monitoring data should be open to public promptly. The data will be open in the office of DWRM on request base during the early stage, and in a website of DWRM at the end. The action causes more utilization of the data and advance of IWRM. To provide processed monitoring data for a price will be one of the methods to make up for revenue shortage for maintenance of gauging stations.

Table 6-3 Rainfall Monitoring Stations

No.	Sub Basin	Operating Number			Proposed Number			Counting		
		In the sub-basin	Near the sub-basin	Sub-total	In the sub-basin	Near the sub-basin	Sub-total	In the sub-basin	Near the sub-basin	Total
1	Okok	0	0	0	2	1	3	2	1	**3**
2	Okere	0	0	0	3	0	3	3	0	**3**
3	Awoja	1	0	1	3	1	4	4	1	**5**
4	Lwere	0	0	0	2	0	2	2	0	**2**
5	Akweng	1	0	1	2	0	2	3	0	**3**
6	Abalang	0	2	2	1	2	3	1	4	**5**
7	Kyoga Lakeside Zone	1	0	1	2	0	2	3	0	**3**
8	Mpologoma	3	0	3	11	0	11	14	0	**14**
9	Lumbuye	0	1	1	2	0	2	2	1	**3**
10	Victoria Nile	2	1	3	2	0	2	4	1	**5**
11	Sezibwa	8	4	12	2	2	4	10	6	**16**
Total		16	8	24	32	6	38	48	14	**62**

(2) Strengthening Organization for Unified Management of Water Resources

A collaborative interaction among the related organizations is necessary. Since it is almost impossible to cover regional and community level by DWRM, "Lake Kyoga Water Management Zone", which will function in the near future, is expected to be as one of the branch offices under DWRM. However, the Basic Plan proposes to establish "Sub-basin Liaison Council" consisting of the related districts (DWO etc.) under WMZ in order to coordinate issues on water resources among stakeholders within each sub-basin. On the other hand, a capacity development of DWRM as the responsible organization is necessary to play their roles.

(3) Guidelines of Borehole Drilling and Pumping Test

The guidelines of borehole drilling and pumping test are needed to standardize description and methodology of various types of borehole testing.

(4) Appropriate Water Allocation

Appropriate water allocation can be planned with estimation volume of exploitable water resources and water demand within each sub-basin. As for agricultural water covering major demand of surface water resources, a detailed water allocation plan should be formulated using the numerical simulation model constructed in the Study. A monitoring system on heavy water users should be formulated soon because it is one of the essential elements for water balance analysis. BaWMZ office should collect data with assistance from Sub-basin Liaison Council and send them to DWRM.（refer to 6.4.5）

(5) Selection of Method for Water Resources Development

The Basin has no potentiality literally to develop extensively new water resources by big dam. Furthermore, the Nile Treaties intercept water resources development of Victoria Nile River and Kyoga Lake, which are a part of the international river network: the Nile River Basin. Therefore, Uganda has to use their limited water resources sustainably with appropriate management.

(6) Community Participation

As for community participation to water resources management, WRM office and Sub-basin Liaison Council shall encourage community to engage water resources monitoring and water resources allocation procedure, attend seminars on water resources management put in awareness or public relations activities.

6.4.2 Effective, Stable and Equitable Water Supply

In these years, water quality degradation is running on along with economic activity decreasing the ratio of usable water resources. On the contrary, water demand increases constantly. In consideration of frequent drought by climate changes, it reveals that even Uganda needs to shift to water-saving society in order to ensure water quality and quantity.

(1) Water Demand Control

According to the water balance analysis, the present water demand of 435.7MCM in 2008 grows up to 844.1MCM in 2035 in the Basin, and the demand might exceed its potential water resource in some sub-basins. It is consequently required to establish balanced water utilization controlling the future water demand.

1) Effective Water Use

Pipeline systems for irrigation water are considered to be applied for conveyance and main canals to reduce losses such as percolation and evaporation diverted water for the effective transmission of water. The unaccounted-for water is high in some town water supply systems in the Basin. The loss of water is usually caused by leakage, and it is possible to improve unaccounted-for water with taking measures against leakage. The SIP sets improvement of the unaccounted for water from the present 25% to 10% in 2035, and it is consequently indispensable to take measures for providing against leakage for sure.

2) Application of Water Saving Technology

It is necessary to apply water saving methods for irrigation water application to reduce the demand in the future, since there are some sub-basins in which the irrigation demands and the potential water resources are not balanced even at present. In SIP it is planned to apply the water saving technology such as drip method and sprinkler method to improve the irrigation efficiency, and consequently it is necessary to introduce these method to save water in sure.

3) Improvement of Awareness of Water User

Improvement of the awareness of common users on water saving is important to effective and sustainable utilization of water in urban water supply through the medias such as television and radio. It is also considered to be ideal effective method to raise the tariff rates in order to improve the awareness of users on saving water.

(2) Increase of Water Supply Volume by Water Resources Development

The facility plan for the rural water supply is planned below based on the demand forecasting in the previous chapter.

Table 6-5 Rural Water Supply Coverage Plan of each Sub-basin

Sub-basin	2008	2015	2020	2035
(1) Okok	39	76	82	100
(2) Okere	62	77	82	100
(3) Awoja	63	76	82	100
(4) Lwere	55	75	82	100
(5) Akweng	82	82	85	100
(6) Abalan	71	79	83	100
(7) Kyoga	63	76	82	100
(8) Mpologoma	55	75	82	100
(9) Lumbuye	55	75	82	100
(10) Victoria Nile	60	75	82	100
(11) Sezibwa	70	75	82	100
Whole Basin	60	76	82	100

Unit: %

1) Drinking WaterbSupply

i) Urban Water Supply

a) Water Supply System for Large Towns and Peri-urban Areas

The present capacity and extension plan for large towns and peri-urban areas in the Basin can cover their future demand until 2035.

b) Urban Water Supply System for Small Towns

Table 6-4 Expansion Plan of Water Supply System for Small Towns

Description	2008	2015	2020	2035
Population	604,295	772,111	925,437	1,644,976
Population Served	255,889	529,604	704,250	1,644,973
Coverage (%)	42%	69%	76%	100%

The population increase of the small towns in the Basin is forecasted to increase from the present of about 600,000 to the future of about 1,600,000 in 2035 with an annual growth rate of about 3.6% as shown in Table 6-4. The coverage of the small towns is calculated as low as 42% for the whole basin, which is planned to be increased to 70% and 100% in 2015 and 2035, respectively.

ii) Rural Water Supply

The present coverage of 63% is increased to 77% and 100% in 2015 and 2035 respectively. Figure 6-2 shows the present and future population served by the type of technology. In particular, number of piped water system increases remarkably. It is because of the policy of the government puts emphasis on piped water system for the areas such as RGCs and trading centers where the population concentrates densely in order to realize effective water supply.

The coverage of rural water supply in each sub-basin is presented in Table 6-5. The

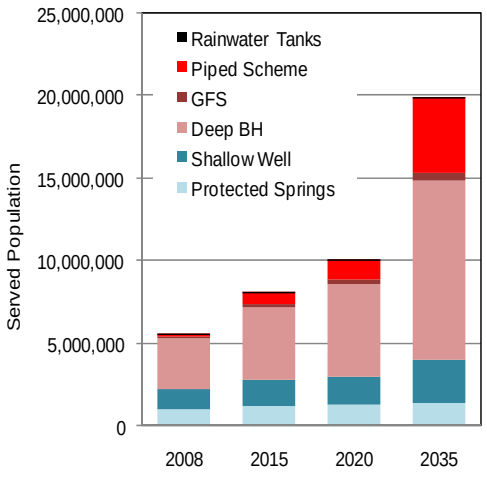


Figure 6-2 Present and Future Population Served for Rural Area

present coverage is different among the sub-basins, but it is planned to increase to 77% in 2015 and 100% in 2035. The member of facilities to be newly constructed to accomplish the target coverage rates is presented in Table 6-6.

Table 6-6 Number of Facilities to be Constructed in 2008 to 2035

Year	Sub-basin	Protected Springs	Deep BH	Shallow Well	GFS	Piped Scheme	Rainwater Tanks	Total Facility No.
2008 - 2015	1. Okok	3	415	18	1	77	12	**526**
	2. Okere	10	346	25	11	84	15	**491**
	3. Awoja	196	509	128	147	672	132	**1,784**
	4. Lwere	43	253	90	10	274	28	**698**
	5. Akweng	9	75	21	0	46	14	**165**
	6. Abalan	27	106	40	5	109	36	**323**
	7. Kyoga Lakeside	10	400	88	0	186	21	**705**
	8. Mpologoma	437	1,423	226	202	1,522	151	**3,961**
	9. Lumbuye	18	350	71	3	174	8	**624**
	10. Victoria Nile	24	546	181	1	305	2	**1,059**
	11. Sezibwa	86	215	187	2	490	13	**993**
	Total	**864**	**4,637**	**1,075**	**382**	**3,940**	**432**	**11,330**
2015 - 2020	1. Okok	1	242	7	1	45	8	**304**
	2. Okere	3	316	22	8	102	19	**470**
	3. Awoja	44	417	74	128	658	117	**1,438**
	4. Lwere	10	213	52	9	238	26	**548**
	5. Akweng	5	187	37	1	147	35	**412**
	6. Abalan	8	127	45	5	198	35	**418**
	7. Kyoga Lakeside	3	302	47	0	150	22	**524**
	8. Mpologoma	72	1,129	116	149	1,292	106	**2,864**
	9. Lumbuye	3	293	38	2	154	7	**497**
	10. Victoria Nile	7	410	104	0	293	2	**816**
	11. Sezibwa	26	202	110	5	511	16	**870**
	Total	**181**	**3,839**	**651**	**307**	**3,787**	**392**	**9,157**
2020 - 2035	1. Okok	3	1,056	29	4	270	34	**1,396**
	2. Okere	13	1,578	113	37	618	98	**2,457**
	3. Awoja	181	2,010	351	597	3,857	575	**7,571**
	4. Lwere	44	1,001	246	40	1,406	132	**2,869**
	5. Akweng	25	1,061	206	4	892	198	**2,386**
	6. Abalan	39	628	231	23	1,130	164	**2,215**
	7. Kyoga Lakeside	11	1,329	208	0	857	108	**2,513**
	8. Mpologoma	264	5,031	511	665	7,344	480	**14,295**
	9. Lumbuye	9	1,344	168	8	882	34	**2,445**
	10. Victoria Nile	28	1,760	443	2	1,576	8	**3,817**
	11. Sezibwa	109	875	480	25	2,832	75	**4,396**
	Total	**725**	**17,672**	**2,985**	**1,405**	**21,665**	**1,907**	**46,359**
Grand Total		**1,770**	**26,148**	**4,711**	**2,094**	**29,392**	**2,731**	**66,846**

2) Water for Production

According to the analysis result of water demand-supply balance in section 5.5.2, five sub-basins have already faced or would do in future to shortage of agricultural water or mainly crop water. It is necessary to store high water in rainy season to supplement the shortage. Although many surface water storage facilities have been constructed in the Basin, their functionality is supposedly very low. Thereafter, rehabilitation and the study for newly construction of them in five priority sub-basins should be carried out.

3) Industrial Water

There is no industry consuming much water in the basin, and rural cottage industries processing products relating to local fishery and agriculture are expected to use water in the basin, of which demand will be increased but shares a few percent of the whole demand.

6.4.3 Prevention of Flood and Sediments Disaster to Protect Lives and Properties

One of the main pillars in the Basic Plan is prevention of flood and sediments disaster to protect lives and properties. The northern part of the Basin including Lira district was suffered serious flood damage for three month from July 2007 and Bududa was hit by the sediment disaster in March 2010, which conduced to approximately 350 deaths and missed people. It is presumed that the main cause of these disasters are not only extraordinary heavy rain but also increased runoff ratio caused by deterioration of upstream coming from overgrazing, deforestation, slash-and-burn farming and so on. Therefore, three prevention plans for deforestation, flood and sediment disaster are mutually and closely related.

(1) Deforestation Prevention Plan

- Deforestation Monitoring
- Clarifying Boundary of Protected Area of Forest
- Enhancement of Public Awareness of Various Problems to be Caused by Deforestation
- Enhancement of Public Awareness of Forest Protection
- Expansion of Landuse Regulation and Development Prohibition Area and Thoroughness of the Regulations
- Tree-Planting Program
- Study and Research on Sustainable and Effective Utilization of Forest Resources such as Agro Forestry, Implementation of Pilot Project, and Preparation of Guideline/Manual
- Communication, Education and Public Awareness of Sustainable and Effective Utilization of Forest Resources

(2) Flood Prevention Plan

- Construction and Rehabilitation of Earth Dam and Valley Tank
- Advice to Road Development Aiming at Securing Transportation of Emergency Materials and Evacuation Route with a Function of Evacuation Site
- Publicity and Thoroughness of Regulated Items in National Environment Regulations (Clarifying River Bank Protection Area, Thoroughness of Development Regulation etc.)

(3) Prevention Plan for Sediments Disaster

- Specifying Disaster Risk Area by Disaster Type
- Designation of Regulated Area of Landuse and/or Development
- Relocation Planning
- Education of Disaster Management to Community about Forerunning Phenomena of Sediment Disasters
- Development of Evacuation Site and Route

(4) Plan for Common Measures for Flood and Sediment Disaster Prevention

- Publicity and Thoroughness of Regulated Items in National Environment Regulations
- Establishment of System for Collection, Accumulation and Sharing of Disaster Information
- Preparation of Hazard Map and Risk Map
- Establishment of Early Warning System for Disasters
  Outline of the early warning system is shown in Table 6-7.
- Community Based Disaster Management Activities
  The following activities are conducted targeting at communities with high potential of disaster.
  a) Workshops for lecture on disaster mechanism, relationship between rainfall and disaster, forerunning phenomena of disaster, etc.
  b) Town watching and preparation of community hazard map
  c) Rainfall observation using a simple rain gauge by inhabitants themselves
  d) Training of observation and judgment of forerunning phenomena of disasters especially for sediment disasters
  e) Training of warning dissemination and evacuation
  f) Formulation of disaster management committee at community level

Table 6-7 Outline of Early Warning System for Flood and Sediments Disaster

Items		Flood	Sediments Disaster	
			Wide Area	Narrow Area
Purpose		Calling for attention to wide area.	Calling for attention to wide area.	Announcement of warning to surrounding inhabitants.
General of Monitoring	Item	Rainfall and water level	Rainfall	Rainfall and forerunning phenomenon.
	Site	Present and past monitoring sites (observation stations) of rainfall and/or water level. Additionally, sites to be considered to matter particularly from hydraulic viewpoint.	Existing rainfall observation stations.	One site per a village or a parish.
	Person in charge	Person in charge of monitoring in relevant ministry/agency or inhabitant near monitoring site.	observation in relevant ministry/agency	Inhabitant
	Method	Direct monitoring by monitoring person.	Direct monitoring	Direct monitoring, (simple measurement)
	Frequency	Once a day at the minimum in rainy season. When rainfall is heavy or water level is rapidly rising, every 8 hours. (however, which should be investigated based on accumulated data and be revised in future)	Once a day at the minimum in rainy season. When rainfall is heavy, every 8 hours (which should be investigated based on accumulated data and be revised in future).	Rainfall: Once a day at the minimum in rainy season. When rainfall is heavy, every 8 hours.Forerunning phenomenon: As needed depending on situation.
Monitoring Results	Communication Method	Telephone, SMS, Radio transmission.	Telephone, SMS, Radio transmission	Telephone, SMS, Orality (voice)
	Reporting Frequency	Same as monitoring frequency.	Same as monitoring frequency	Same as monitoring frequency
	Reporting Target	DWRM	DWRM, Responsible person of district	Leader of community
	Data Analyser	DWRM	DWRM, Responsible person of district	Leader of community
	Analysis Method	Judging risk allowances of disaster occurrence by comparing past data	Judging risk allowances of disaster occurrence by comparing past data	Judging risk allowances of disaster occurrence by comparing past data.
Early Warning	Criterion	Judging risk allowances of disaster occurrence by comparing past data.	Judging risk allowances of disaster occurrence by comparing past data.	Judging risk allowances of disaster occurrence by comparing past data.
	Releaser	DWRM	DWRM	Leader of community
	Target	Responsible persons of relevant ministries/agencies, Responsible person of district, Leader of community located in flood risk area, Inhabitants.	Responsible persons of relevant ministries/agencies, Responsible person of district, Leader of community, Inhabitants.	Inhabitants
	Communication Method	Telephone, SMS, Radio transmission, Television, Radio	Telephone, SMS, Radio transmission, Television, Radio	Telephone, SMS, Orality (voice)
	Expected Reaction to Target	Activities for disaster preparedness, which are preparation of emergency materials like food and equipments for disaster response at national and local government level, and are early harvesting of crops, remove of household goods, and preparation of water, food, cloths, etc. at community level.	Recognition of increased possibility of occurrence of disaster. Preparation of emergency response.	Preparation of evacuation. Evacuation

6.4.4 Conservation Plan of Water Environment

Conservation of water environment is very important not only for natural ecosystem and people living environment but also reservation of good water resources for future water demand.

(1) Ambient Water Quality Standard

An ambient water quality standard for Lake Kyoga Basin is proposed as shown in Table 6-8 and its classification is defined as follows.

- AA Class: better quality than A Class
- A Class: for drinking
- B Class: for fishery and bathing
- C Class: for irrigation

Table 6-8 Ambient Water Quality Standards for River, Lake and Swamp

Ambient standards (River)

Type	pH	DO (mg/l)	BOD (mg/l)	SS (mg/l)	Total Coliform (MPN/100ml)
AA	6.5～8.5	≧7.5	≦1.0	≦25	≦50
A	6.5～8.5	≧7.5	≦3.0	≦25	≦50
B	6.5～8.5	≧5.0	≦5.0	≦50	≦1000
C	6.0～9.0	≧5.0	≦10.0	≦100	≦5000

Ambient standards (Lake・Swamp)

Type	pH	DO (mg/l)	BOD (mg/l)	SS (mg/l)	Total Coliform (MPN/100ml)	T-N (mg/l)	T-P (mg/l)
AA	6.5～8.5	≧7.5	≦1.0	≦1	≦50	0.1	0.005
A	6.5～8.5	≧7.5	≦3.0	≦5	≦50	0.2	0.01
B	6.5～8.5	≧5.0	≦5.0	≦15	≦1000	0.5	0.05
C	6.5～8.5	≧2.0	≦8.0	Floating matter not be observed	-	1	0.1

(2) Water Quality Monitoring Plan

Water quality monitoring plan is set up as shown below.

- Monitoring Points: As shown in Table 6-9, 30 points set up by DWRM are taken over as water quality monitoring point and 73 stations are newly added.
- Frequency: Living environment items and human health items are monitored every month and every year respectively.
- Measuring Item and Method: pH, SS, and DO are measured by portable device on site. BOD, Total Coliform, T-N and T-P are measured at laboratory with water samples taken on site. As for groundwater, measuring items are pH, EC, Fe, F and Coliform.

Table 6-9 List of Water Quality Monitoring Point

NO.	Sub-basin	Existing Monitoring Points						Planned Monitoring Points					
		River	Lake	Borehole	Municipal	Potable water	Sub-total	River	Lake	Borehole	Municipal	Potable water	Total
1	Okok			1			1	1		2			**3**
2	Okere	2		2			4	2		2			**4**
3	Awoja	3		1			4	5	2	2			**9**
4	Lwere						0	1		2			**3**
5	Akweng					2	2	1	1	2		2	**6**
6	Abalang		1				1	1	1	3			**5**
7	Kyoga Lakeside Zone	1	1				2	1	2	5			**8**
8	Mpologoma	3		1	5		9	6		7	5		**18**
9	Lumbuye	1					1	1		4			**5**
10	Victoria Nile	1			3		4	1		4	3		**8**
11	Sezibwa	1		1			2	2		2			**4**
	Total	12	2	6	8	2	30	22	6	35	8	2	**73**

- Implementation system: DWRM have been monitored basically ambient water quality by them. Since DWRM have no subordinate organization corresponding to TSU in the Basin, WMZ office and laboratory should monitor and submit data to DWRM.
- Operation and Maintenance : Although DWRM have to prepare personnel, necessary equipment and materials for a while, whole O/M of monitoring works will transfer to WMZ office.

(3) Wastewater Regulation

DWRM shall enforce managing local factories based on wastewater regulation together with water quality monitoring.

(4) Facilities for Conservation of Water Environment

In accordance with rapid population growth, water pollution load will increase dramatically. Therefore, sewage facilities are necessary for conservation of water environment. The facility plan is formulated

in the Basic Plan based on the current water quality to meet the ambient standards defined above, considering the class of each Sub-basin.

1) Definition of Ambient Standard Class for each Sub-basin

Average values of water quality standard items and defined ambient standard class of each Sub-basin are shown in Table 6-10. The standard class of each Sub-basin is defined not to deteriorate the current conditions.

Table 6-10 Ambient Standard Class of each Sub-basin

Source Type	Sub-basin	Ambient Standard Class
Lake	(3) Awoja	AA
	(5) Akweng	A
	(7) Kyoga Lakeside Zone	B
	(8) Maplogoma	A
River	(2) Okere	A
	(3) Awoja	B
	(4) Lwere	B
	(5) Akweng	A
	(7) Kyoga Lakeside Zone	B
	(8) Maplogoma	B
	(9) Lumbuye	A
	(10) Victoria Nile	AA
	(11) Sezibwa	A

2) Sewerage Treatment System Plan

Since the stabilization process by the oxidation pond method is applied in Uganda as well as in the large towns in the Lake Kyoga Basin, this method is adopted in this plan. The flow of the stabilization process is shown in Figure 6-3.

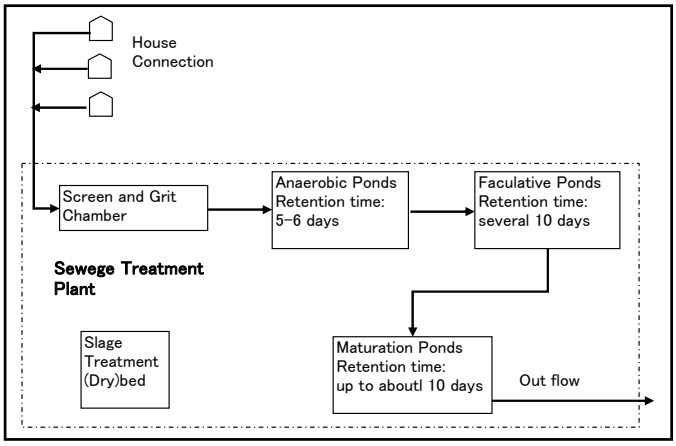


Figure 6-3 Flow Chart of Stabilization Process

Necessary number and overall construction schedule of the sewerage system in each sub-basin base on the standard specification of it in Uganda as listed below to meet the ambient water quality standards are estimated in Table 6-11.

- Type of system: oxidation pond (no aeration)
- Capacity: 550m3/day
- Elimination efficiency: 50%
- Hydraulic retention time: 20-25 days
- Influent quality: BOD 150mg/l
- Drainage water quality: BOD 75mg/l
- Service Coverage: 10% of urban population

Table 6-11 Construction Schedule of Sewerage System

Year / Sub-basin	Short Term 08→15	Mid. Term →20	Long Term →35	Total
1. Okok	1	1	6	8
2. Okere	1	0	3	4
3. Awoja	2	1	6	9
4. Lwere	1	0	1	2
5. Akweng	1	0	1	2
6. Abalan	0	0	2	2
7. Kyaga	1	0	1	2
8. Mpologoma	0	2	18	20
9. Lumbuye	1	1	2	4
10. Victoria Nile	6	2	5	13
11. Sezbwa	19	6	32	57
Total	**33**	**13**	**77**	**123**

The table indicates that three sub-basins: 8.Mpolagoma, 10.Victoria Nile and 11.Sezbwa need to adopt more large-scale type of stabilization pond or higher grade sewerage system because their rapid urbanization require too many standard facilities.

6.4.5 Information System for Water Resources Development and Management

Integrated information system for data collection, arrangement, storage and sharing information related to water resources development and management shall be constructed. Outline of the system is illustrated in Figure 6-4.

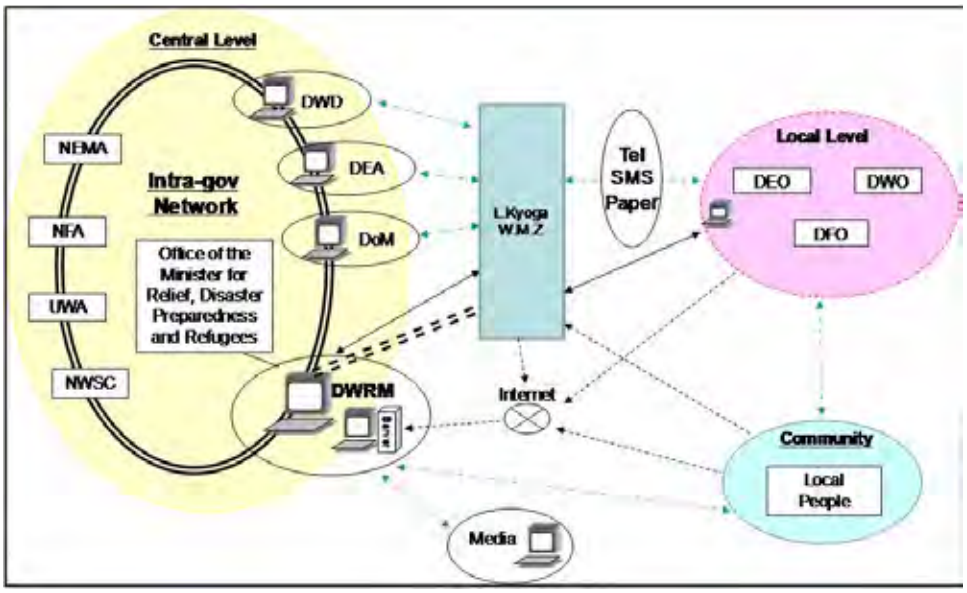


Figure 6-4 Outline of Information Sharing System

6.4.6 Total Schedule of the Basic Plan

Total schedule of the Basic Plan is shown in Table 6-13.

6.5 Priority of the Basic Plan on Water Resources Development and Management

Priority of each item in the Basic Plan was evaluated by point rating of relative contribution degree to the eight goals of Millennium Development Goals for reducing global poverty in consideration of PEAP. As a result, drinking water supply plan, particularly rural water supply features high on the evaluation list of priority.

6.6 Outline Schedule and Approximate Cost of Water Supply Plan

In the Basic Plan, the construction and expansion of the water supply system are proposed to be implemented simultaneously in each sub-basin without any emphasis put on any sub-basin. The costs for construction and expansion of them are estimated as shown in Table 6-12

Table 6-12 Summary of Estimated Project Costs

(Unit: mUGX)

Water Supply Facilities	2008 - 2015	2015 - 2020	2020 - 2035
1. Urban Water Supply			
1.1 Large Town + Peri-urban areas			
Construction Costs	54.254	77,088	330,725
O & M costs	6,963	2,557	11,714
Total	61,217	79,646	342,429
1.2 Small Towns			
Construction Costs	71,311	51,054	327,108
O & M costs	7,712	5,380	34,208
Total	79,023	56,434	361,316
2. Rural Water Supply			
Construction Costs	71,311	51,054	327,108
O & M costs	7,629	5,464	34,566
Total	78,940	56,519	361,675

Table 6-13 Schedule of the Basic Plan on Water Resources Development and Management for Lake Kyoga Basin

Item	year	Sub-basin No. 1 Ok	2 Or	3 Aw	4 Lw	5 Ak	6 Ab	7 Ky	8 Mp	9 Lu	10 Vi	11 Se	Planning Phase: Short Term (2010-2015) 2008	2009	2010	2011	2012	2013	2014	2015	Middle Term (2016-2020) 2016	2017	2018	2019	2020	Long Term (2020-2035) 2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Responsible Organization
1. Comprehensive Water Resources Management																																								
1-1	Water Resources Assessment																																							
	(1) River Gauging Station Network	X	X	X	X	X	X	X	X	X	X	X																												DWRM
	(2) Lake Water Gauging Station Network			X		X	X	X																																DWRM
	(3) Groundwater Monitoring Network	X	X	X	X	X	X	X	X	X	X	X																												DWRM
	(4) Meteorological Monitoring Network	X	X	X	X	X	X	X	X	X	X	X																												DWRM
	(5) Guidelines of Well Drilling and Pumping Test	DWRM																																						DWRM
	(6) Water Resources Database System	DWRM, L.Kyoga WMZ																																						DWRM
1-2	Organization Strengthening for WRDM																																							
	(1) Setting up Sub-basin Liaison Council	X	X	X	X	X	X	X	X	X	X	X																												DWRM
	(2) Capacity Development of DWRM	DWRM, L.Kyoga WMZ																																						MoWE, DWRM
2. Effective, Stable and Equitable Water Supply																																								
2-1	Controlling Water Demands																																							
	(1) Effective Water Use	X	X	X	X	X	X	X	X	X	X	X																												DWD
	(2) Introduction of Water-saving Technology	X	X	X	X	X	X	X	X	X	X	X																												DWD, MAAIF
	(3) Awareness of Water User	X	X	X	X	X	X	X	X	X	X	X																												MAAIF, DWD, DWO
2-2	Increasing Water Supply through WRDM																																							
	(1) Urban Water Supply (Small Town Dominant)	X	X	X	X	X	X	X	X		X	X	Coverage Rate 42% to 69%								Coverage Rate 69% to 76%					Coverage Rate 76% to 100%															DWD, NWSC
	(2) Rural Water Supply	X	X	X	X	X	X	X	X	X	X	X	Coverage Rate 60% to 77%								Coverage Rate 77% to 83%					Coverage Rate 83% to 100%															DWD
	(3) Agricultural Water Supply	X	X		X			X	X							Basic Study			M/P, F/S		Implementation																			MAAIF, DWD
3. Prevention of Flood and Sediment Disaster for Life and Property																																								
3-1	Deforestation Prevention Plan																																							
	(1) Clarifying Boundary of Protected Area of Forest	X	X	X	X			X																																NFA, DFO
	(2) Expansion of Landuse Regulation and Development Prohibited Area and Thoroughness of the Regulations	X	X	X	X			X																																MoLG
	(3) Tree-Planting Program	X	X	X	X			X																																NFA
	(4) Study and Research on Agro Forestry	X	X	X	X			X																																DEA
	(5) Enhancement of Public Awareness of Forest Protection	X	X	X	X			X																																DFO
3-2	Flood Prevention Plan																																							
	(1) Construction and Rehabilitation of Surface Water Storage Facility	X	X	X	X	X	X	X	X	X																														MAAIF
	(2) Road Development for Transportation of Emergency Materials and Evacuation Route	X	X	X	X	X	X	X	X	X																														MoWT
3-3	Erosion and Sediment Management Plan																																							
	(1) Specifying Disaster Risk Area by Disaster Type	X	X	X	X			X																																MoDPR, DWRM
	(2) Designation of Regulated Area of Landuse and/or Development	X	X	X	X			X																																MoLHU
	(3) Relocation	X	X	X	X			X																																MoDPR
	(4) Education of Disaster Management to Community	X	X	X	X			X																																MoDPR
	(5) Development of Evacuation Site and Route	X	X	X	X			X																																MoDPR, MoWT
3-4	Common Measures for Flood and Sediment Disaster																																							
	(1) Publicity and Thoroughness of Regulated Items in National Environment Regulations	X	X	X	X	X	X	X	X	X																														DOE,NEMA
	(2) Establishment of System for Collection, Accumulation and Sharing of Disaster Information	X	X	X	X	X	X	X	X	X	X	X																												MoDPR, DWRM
	(3) Preparation of Hazard Map and Risk Map	X	X	X	X	X	X	X	X	X																														DWRM
	(4) Establishment of Early Warning System for Disasters	X	X	X	X	X	X	X	X	X																														MoDPR, DWRM
	(5) Community Based Disaster Management Activities	X	X	X	X	X	X	X	X	X																														District
4. Conservation Plan of Water Environment																																								
4-1	(1) Establishment of Ambient Water Quality Standards	X	X	X	X	X	X	X	X	X	X	X																												DEA
	(2) Strengthening Water Quality Monitoring System	DWRM, L.Kyoga WMZ																																						DEA
	(3) Sewerage Treatment System	X	X	X	X	X	X	X	X	X	X	X																												NWSC
5. Setting up System for Collection, Sharing and Transmission of Relevant Data on WRDM		DWRM, L.Kyoga WMZ																																						DWRM

Note: **Ok**: Okoke,**Or**: Okere, **Aw**: Awaja, **Lw**: Lwere, **Ak**: Akuweng, **Ab**: Abalan, **Ky**: Kyoga Lake-side, **Mp**: Mpologoma, **Lu**: Lumbuye, **Vi**: Victoria Nile, **Se**: Sezibwa, **WRDM**: Water Resources Development and Mangement, **WMZ**: Water Management Zone
DWD:Directorate of Water Development, **DWRM**: Directorate of Water Resources Management, **MoWE**: Ministry of Water and Environment, **MAAIF**: Ministry of Agriculture, Animal Industry and Fisheries, **DWO**: District Water Office
NWSC: National Water and Sewerage Corporation, **NFA**: National Forestry Authority, **DEA**: Directorate of Environment Affaires, **DFO**: District Forestry Office, **MoWT**: Ministry of Works and Transportation, **MoDPR**: Ministry of Diaster Preparadness and Refugees

6.7 Evaluation of the Basic Plan on Water Resources Development Management

6.7.1 Technical Evaluation

Since construction of drinking water supply facilities for safe and stable water supply and sewerage treatment facilities for conservation of surface water quality incorporated in the Basic Plan have been implemented beforehand in Uganda, there is no technical problem to deal with them using stored experiences and technology for years in Uganda. Other items in the plan are planned without any technical difficulty.

6.7.2 Economical and Financial Evaluation of Rural Water Supply Plan

(5) Economical Evaluation

Economic evaluation was conducted on the rural water supply plan having high priority in the Basic Plan. Economical benefit from the planned rural water supply are assumed using average monthly water related expenditure and opportunity loss calculated with time required to fetch water. These values were captured by the household survey in the Study.

Average monthly water related expenditure was 9,452UGX/house which is equivalent to 7% of total monthly expenditure. This water related expenditure can be regarded as amount of willingness to pay for water service. Time required to fetch water is 94 min/day/house on average and it is equivalent to 113 UGX/day/house which is calculated from average annual income. Economical evaluation result is that NPV and EIRR are 279billionUGX and 12.7% respectively as shown in Table 6-14. Since the EIRR value is larger than Discount rate, the implantation of this rural water supply plan is reasonable.

Table 6-14 Economic Evaluation of Rural Water Supply Plan

	NPV (Billion UGX)	EIRR	B/C
Rural Water Supply	+279	12.7%	1.08

Note: Discount Rate = 10%

(6) Financial Evaluation

Average of monthly water related expenditure was 9,452UGX/house, which is 7% of average monthly expenditure in the Basin. It is almost impossible to care for new water supply system and set up operation and maintenance system by only this expenditure or appropriate water tariff. Since these projects are highly public and essentially needed for PEAP, an initial cost for construction and renovation should be covered by the government budget and donor's support, and the operation and maintenance cost should be borne by water users.

6.7.3 Evaluation on Social Environmental Consideration

(7) Water Supply Facilities

- Living Environment (pollution)

Air and water pollution, noise, and vibration are expected from operation of the construction machinery. However, the impact of these will be limited due to the short construction period and the

small size of the facilities to be built. Water pumps will generate some noise but the effect will be kept minimum as they will be installed inside a building.

- Natural Environment

Some impacts are expected on the local ecosystem and water levels in the vicinity of the facilities, but the effect will be very small because of the small size of the facilities.

- Social Environment

Safe and stable water supply will reduce the workload of the women and children who carry domestic water every day. It will also contribute to reduce diseases in communities. However, the new water supply can also create new differentials between those who benefits from it and those who do not. Therefore, careful consideration and planning are needed before construction of facilities.

(8) Water Storage Facilities: Valley Tank, Pond

- Living Environment (pollution)

Air and water pollution, noise, and vibration are expected from operation of the construction machinery. However, the impact of these will be limited due to the short construction period and the small size of the facilities to be built.

- Natural Environment

Impacts on the local ecosystem in the vicinity as well as the downstream of the water storage facility need to be considered.

- Social Environment

Cultural and historical sites inside or near the target areas need to be considered.

(9) Waste Water Treatment Facilities: Oxidation Pond

- Living Environment (pollution)

Air and water pollution, noise, and vibration are expected from operation of the construction machinery. Though a water treatment facility improves the environment in the downstream areas, they also produce undesirable waste as a result of the water purification process. Proper disposal of such waste is important to prevent new pollution near the facility. Therefore, careful planning is necessary prior to the construction of a water treatment facility.

- Natural Environment

Improvements on the ecosystem in the downstream areas are expected.

- Social Environment

Water treatment facilities are necessary for sustainable development of the downstream communities as they can provide convenient and healthier living to the people in the communities. Preservation of cultural and historical sites and resettlement of the local people need to be considered for selection of a target site.

(10) Forestation

- Living Environment (pollution)

Since heavy machinery is not normally used for forestation in Uganda, noise and air pollution are

not of a concern. A target area of forestation will be initially prone to land erosion due to lack of the strong foundation of the trees. Therefore, forestation of a large area at the same time can result in a major land erosion and displacement of a large amount of soil. However, as trees grow, they start acting as a water storage preventing erosion and flood and stabilizing water supply.

- Natural Environment

Preservation and enrichment of the vegetation in the target areas by proper forestation are expected. Reduction of CO_2 is also expected.

- Social Environment

New jobs will be created around the target areas. They can also serve as a fuel source for poor people.

Chapter 7
Master Plan of Rural Water Supply in Priority Districts

CHAPTER 7 MASTER PLAN OF RURAL WATER SUPPLY IN PRIORITY DISTRICTS

7.1 Selection of Priority Districts

Among various programs proposed in the study on the water resources and management of Lake Kyoga basin, the rural water supply is given the highest priority to increase the water supply through water resources development and management, and some priority districts are selected among 38 districts in the basin to prepare the rural water supply master plan. The priority districts are determined through the discussion with the counterpart agencies such as DWD and DWRM.

7.1.1 Districts to be Considered for the Selection

The 38 districts of the basin are first narrowed down to the 17 districts in the aspects of the groundwater resources management, security, and groundwater potential as shown in Table 7-1, and then the priority districts are selected among them considering the social and the natural conditions.

Table 7-1 Candidate Districts for Selection of Priority Districts

District	Over Boundary	Off-limits by JICA	Near Mt. Elgon	Selected as Candidate	District	Over Boundary	Off-limits by JICA	Near Mt. Elgon	Selected as Candidate
Kayunga				x	Katakwi				x
Luwero	x				Kumi				x
Mukono	x				Manafwa			x	
Nakasongola	x				Mayuge	x			
Wakiso	x				Mbale				x
Amuria	x				Namutumba				x
Budaka				x	Pallisa				x
Bududa			x		Sironko				x
Bugiri	x				Soroti				x
Bukedea				x	Tororo				x
Bukwa	x				Abim	x			
Busia	x				Amolatar		x		
Butaleja				x	Apac	x			
Iganga				x	Dokolo		x		
Jinja	x				Kaabong	x			
Kaberamaido				x	Kotido	x			
Kaliro				x	Lira	x			
Kamuli				x	Moroto	x			
Kapchorwa				x	Nakapiripirit	x			
					Total Nos.	17	2	2	17

Note: The shaded columns indicate the candidate districts for selection.

7.1.2 Prioritization Criteria

For the fair evaluation, the parameters of two (2) aspects; social and natural conditions are considered in prioritizing each district as follows:

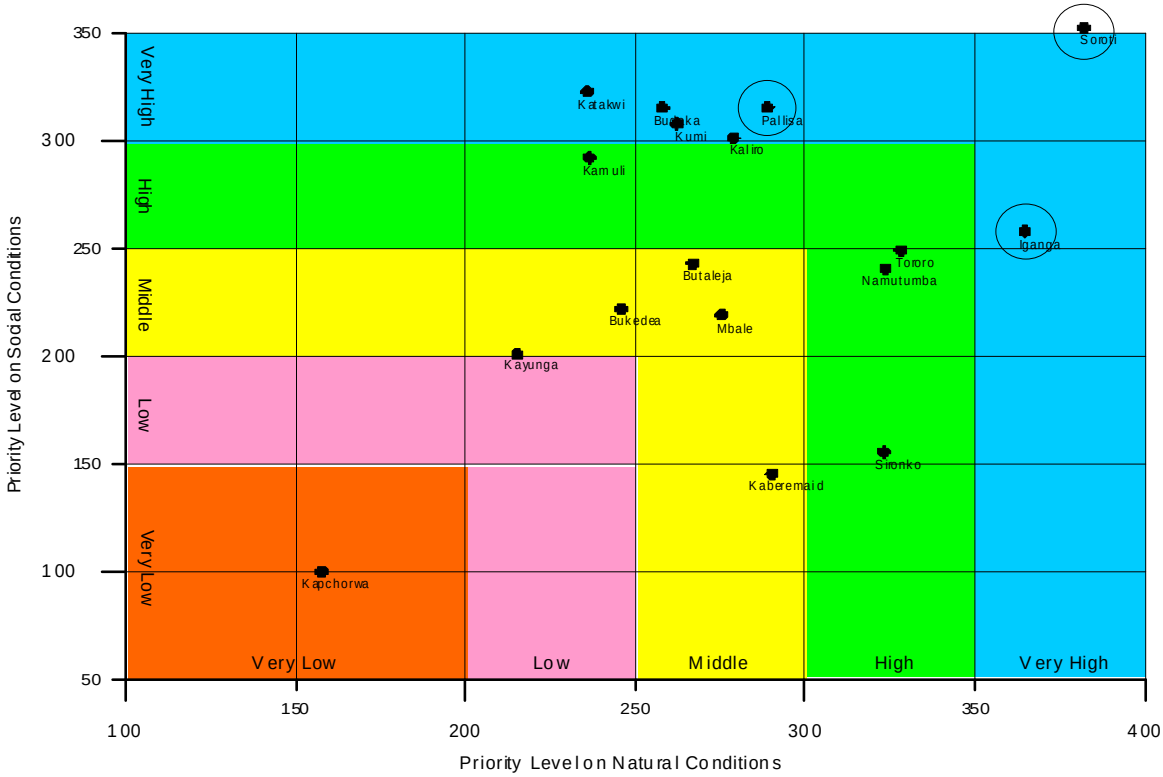
Social Conditions
- Poverty Ratio
- Waiting Time at Water Source in Dry seasons
- Rural Water Supply Coverage
- Rural Water Supply Equity
- Functionality

Natural Conditions
- Drilling Depth
- Static Groundwater Level
- Water Yield
- Groundwater Recharge Potential
- Water Quality (Total Dissolved Solids (TDS))

Each parameter of the social and the natural conditions is linearly scaled to the range from 0 to 100 corresponding the lowest to the highest values. High values represent high priority for the selection. The scores of each district are plotted in Figure 7-1.

7.1.3 Selection of Priority Districts

The Soroti district is the highest both in social and natural conditions. The Iganga district is the second highest in groundwater potential and gets rather high score in social condition. The social scores of Pallisa, Katakwi, Budaka, Kumi and Kaliro districts are high, and Pallisa district marks the highest score of natural condition among them. Therefore, the three (3) districts of Soroti, Iganga and Pallisa are selected for the priority districts.



Social and natural conditions are classified as follows:

- Social condition: very high (300<), high (250-300), medium (200-250), low (150-200), very low (<150)
- Natural condition: very high (350<), high (300-350), medium (250-300), low (200-250), very low (<200).

Figure 7-1 Selection of Priority District for Master Plan of Rural Water Supply

7.2 Inventory Survey for Water Supply Situations of Sub-counties and RGCs in Priority Districts

7.2.1 WATSUP Survey

To grasp the present situation of rural water supply in the sub-counties of the priority districts, the results of the inventory survey for Water Atlas Up-date Project (WATSUP Survey) conducted by DWD in 2010 are applied. The purposes of the WATSUP（Water Atlas Up-date Project) survey carried out by DWD in 2010 are as follows:

- Strengthening the capacity of Districts in the field of data management
- Up-date of the water sources baseline survey carried out between 1998-2002

- Production and dissemination of an up-dated Water Atlas and improvement of accuracy, effectiveness and easiness in access

The survey includes the following items and especially the data on location and type of water source and functionality of water source are utilized for master planning.

Table 7-2 Survey Contents of WATSUP Survey

Item	Point Water Source	Piped Water System
1	Location of water source including GPS readings and information on whether the water source is located in an urban area, an RGC or a IDP camp.	Location of water source including GPS readings (readings to taken at the source for the piped scheme, i.e. whether the water is drawn from)
2	General information including year of construction, source number, source of funding and current ownership and estimated number of households served.	Service levels and service areas - overview of total number of connections, specification on connected institutions, service areas in rural and urban settings. General information including year of construction, source number and source of funding.
3	Type of point water source (protected spring, shallow well, borehole, rainwater harvesting tank, public stand post etc.)	Type of piped system - GFS, pumped piped system (groundwater based)
4	Operation and maintenance - type of management, information on existence and functionality of the WSC including no. of women in key positions.	Operation anad maintenance - type of management, information on existence and functionality of the WB/WSC including no. of women in key positions.
5	Operational status (functionality) including time for non-functionality, reasons for non-functionality and details of recent major repairs.	Operational status (functionality) including time for non-functionality, reasons for non-functionality /non-use, reasons for reduced functionality and details of recent major repairs/replacements.

Source: WATSUP Data Collection Guideline (2009)

7.2.2 Rural Growth Center Survey

The Rural Growth Centers (RGCs) are considered neither as administrative units justified legally nor as the ones based on any town and rural development plans, but are considered as those villages having trading center and/or public facilities such as school, health center administrative office etc., of which population is rapidly growing. The inventory survey for the RGCs in the priority districts (Rural Growth Center (RGC) Survey) was conducted by the Study Team to grasp the present water supply and the socio-economic situations in the RGCs of the priority districts. The RGC survey includes population, boundary, existing water source, administrative and business facility, etc. As shown in Table 7-3, the total of 59 RGCs consisting of 11, 19 and 29 in the Soroti, the Pallisa and the Iganga districts, respectively were surveyed.

Table 7-3 List RGCs for RGC Survey

1. Iganga Distgrict				2. Pallisa District		3. Soroti District	
No.	RGC	No.	RGC	No.	RGC	No.	RGC
1	Namungalwe	20	Ikonia	1	Kasasira	1	Acuna
2	Nambale	21	Busiiro	2	Kameke	2	Kidetok
3	Nabitende B.	22	Nabitende K.	3	Kibale	3	Pingire Etem
4	Nawandala	23	Busalamu	4	Kagumu	4	Kadungulu
5	Bugono	24	Kabira	5	Kapala	5	Kagwara Port
6	Nakalama	25	Nakigo	6	Kamuge	6	Mugarema
7	Bumanya	26	Wailama	7	Buseta	7	Kasilo Corner
8	Kiwanyi	27	Ibulanku TC	8	Tirinyi	8	Pingire Corner
9	Nakivumbi	28	Buwologoma	9	Kabole	9	Gweri
10	Busesa	29	Waibuga	10	Petete	10	Mulondo
11	Nondwe			11	Butebo	11	Iningo
12	Ikumbya			12	Gogonyo		
13	Naigobya			13	Kadama		
14	Bukoova			14	Nabiswa		
15	Namusisi			15	Bulangira		
16	Nakabugu			16	Kibuku		
17	Kyanvuma			17	Agule		
18	Lambala			18	Kabweri		
19	Nawampiti			19	Boliso I TC		

7.3 Rural Water Supply Master Plan

7.3.1 Present Situation of Rural Water Supply

(1) **Administrative Units and Study Area**

The Iganga, the Pallisa and the Soroti districts were split up at the beginning of July 2010 as shown in Figure 7-2. The rural water supply master plan is to be prepared for the rural areas of sub-counties situated in the former district areas of the selected priority districts, but the new administrative boundaries and units are not considered.

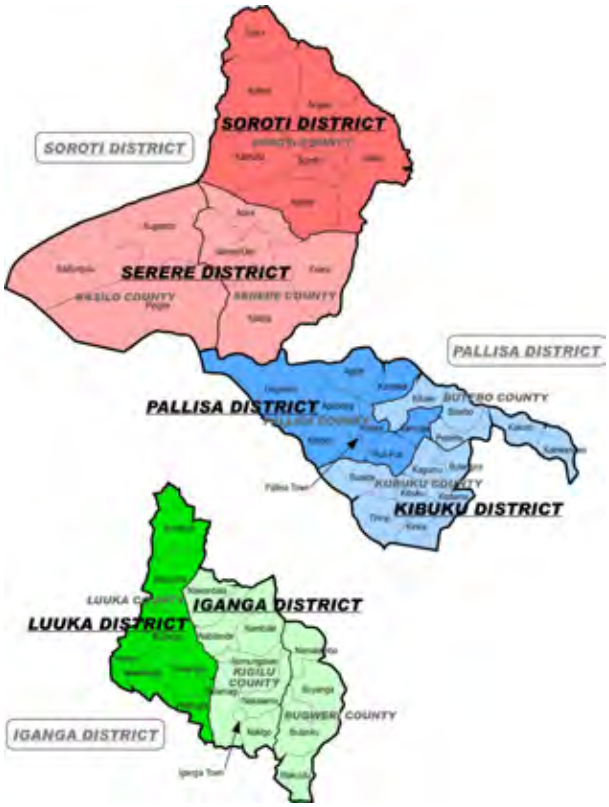


Figure 7-2 Former and Present Administrative Units

(2) **Rural Water Supply**

The source of rural water supply in the priority districts is mainly groundwater, and deep and shallow wells with hand pump unit are applied in the most of the village areas as shown in Table 7-4. In some areas water supply systems are connected to the transmissions of NWSC, and such systems are managed and maintained by NWSC though those areas are categorized in the rural areas. Such areas are excluded from those for the master plan study.

Table 7-4 Ratio of Water Sources in Priority Districts

(Unit: %)

District	Deep Groundwater	Spring Water	Shallow Groundwater	Rain Water
Iganga	62.0	11.2	26.7	0.1
Pallisa	70.6	18.6	10.7	0.1
Soroti	67.8	6.4	25.6	0.1

The present population to be covered by rural water supply and the annual water demand of the whole districts are as follows:

	Iganga District	Pallisa District	Soroti District
- Population	597,855	450,719	485,116
- Annual water demand (MCM) (Present water consumption: 15 liter/day/capita)	3.27	2.47	2.66

As shown in Table 7-5, there are 61 RGCs identified in the priority districts; 29, 17 and 15 numbers in the Iganga, the Pallisa and the Soroti districts, respectively, excluding those of which water supply facilities are provided and managed by NWSC. Out of these RGCs, four (4) RGCs in the

Soroti district will have existing piped water supply systems, and then the remaining 57 RGCs are requiring water supply facilities.

Table 7-5 List of RGCs for Master Planning

1. Iganga Distgrict				2. Pallisa District		3. Soroti District	
No.	RGC	No.	RGC	No.	RGC	No.	RGC
1	Namungalwe	18	Lambala	1	Kasasira	1	Acuna
2	Nambale	19	Nawampiti	2	Kameke	2	Kidetok
3	Nabitende B.	20	Ikonia	3	Kagumu	3	Pingire Etem
4	Nawandala	21	Busiiro	4	Kapala	4	Kadungulu*
5	Bugono	22	Nabitende K.	5	Kamuge	5	Kagwara Port
6	Nakalama	23	Busalamu	6	Buseta	6	Mugarema
7	Bumanya	24	Kabira	7	Kabole	7	Kasilo Corner
8	Kiwanyi	25	Nakigo	8	Petete	8	Pingire Corner
9	Nakivumbi	26	Wailama	9	Butebo	9	Gweri
10	Busesa	27	Ibulanku TC	10	Gogonyo	10	Mulondo
11	Nondwe	28	Buwologoma	11	Kadama	11	Iningo
12	Ikumbya	29	Waibuga	12	Nabiswa	12	Ocapa*
13	Naigobya			13	Bulangira	13	Kyere*
14	Bukoova			14	Kibuku	14	Kamod*
15	Namusisi			15	Agule	15	Tubur
16	Nakabugu			16	Kabweri		
17	Kyanvuma			17	Boliso I TC		

Note: The RGCs with "*" are those having the existing schemes, and then only the future extension of the schemes is considered in the master plan.

The coverage of RGCs in the priority districts calculated based on the data collected through the WATSUP survey and RGC survey are presented in Figure 7-3, and the coverage of the whole RGCs in the priority districts are 27.1 %, 36.5 % and 60.1 % for the Iganga, the Pallisa and the Soroti districts, respectively. On the other hand, the coverage of the rural areas other than the RGC areas are 69.1 %, 58.7 % and 71.2 % for the Iganga, the Pallisa and the Soroti districts, and the coverage of RGCs are found to be quite lower comparing with these values.

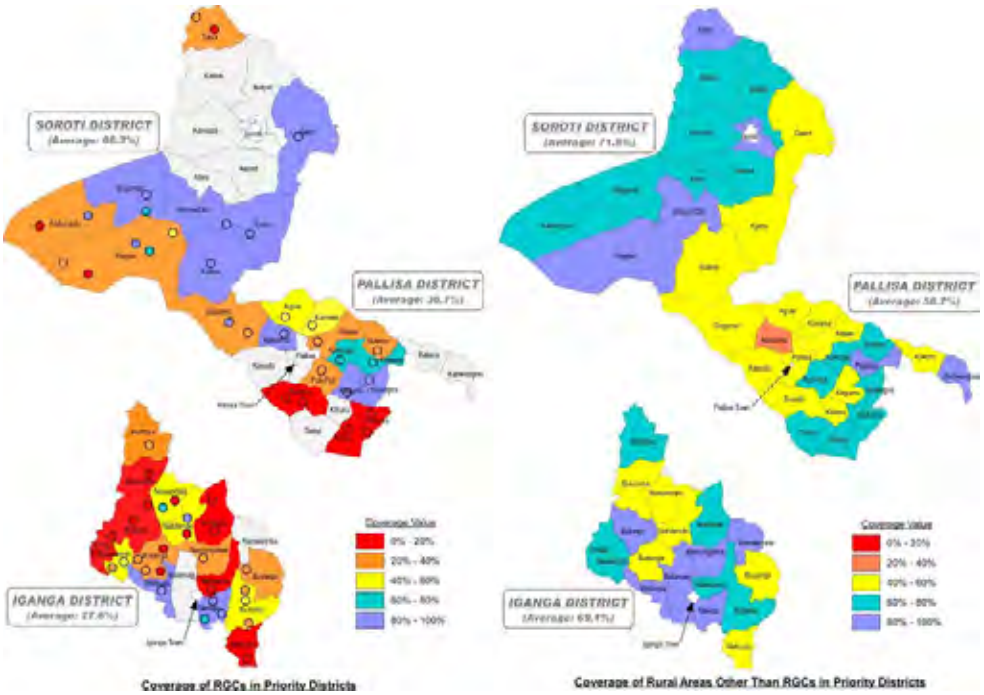


Figure 7-3 Coverage of RGCs and Other Rural Areas in Priority Districts

(3) **Hydrogeological Condition**

Main geology of target districts is called the Basement Complex composed by granite or gneiss formed in Precambrian era. After the Precambrian era, this area didn't get large tectonic movement. Therefore, peneplain has formed by weathering and erosion. Characteristically, granite is easy to be weathered and has many fractures from near surface to several dozen meters in depth. Weathered granite forms sandy state near surface. Clay mineral called "Kaoline" derives from weathered granite. Since the topography is flat in this area, thick clay layer which has 20 to 30m thickness is formed occasionally. Since clay has very low hydraulic permeability, the recharge of groundwater from surface is very limited. Lowness of groundwater yield of wells in this area is caused by this thick clay layer. In the existing well data analysis, average well yield is very low, i.e. 2.5 m^3/h in Iganga and Soroti districts, and 1.9 m^3/h in Pallisa district.

Two types of aquifer are considered, which are the weathered granite before argillization and the fracture zone in the rock. Fractures occur not only vertical but also horizontal in granitic rocks. Many small hills of granite called "Inselberg" with more resistant rock masses, which formed through weathering process, are observed in this area. This inserberg is considered as good groundwater recharge area. Therefore, the important thing is to understand the distribution of exposed bedrock place and continuity of decomposed granite layer or fracture.

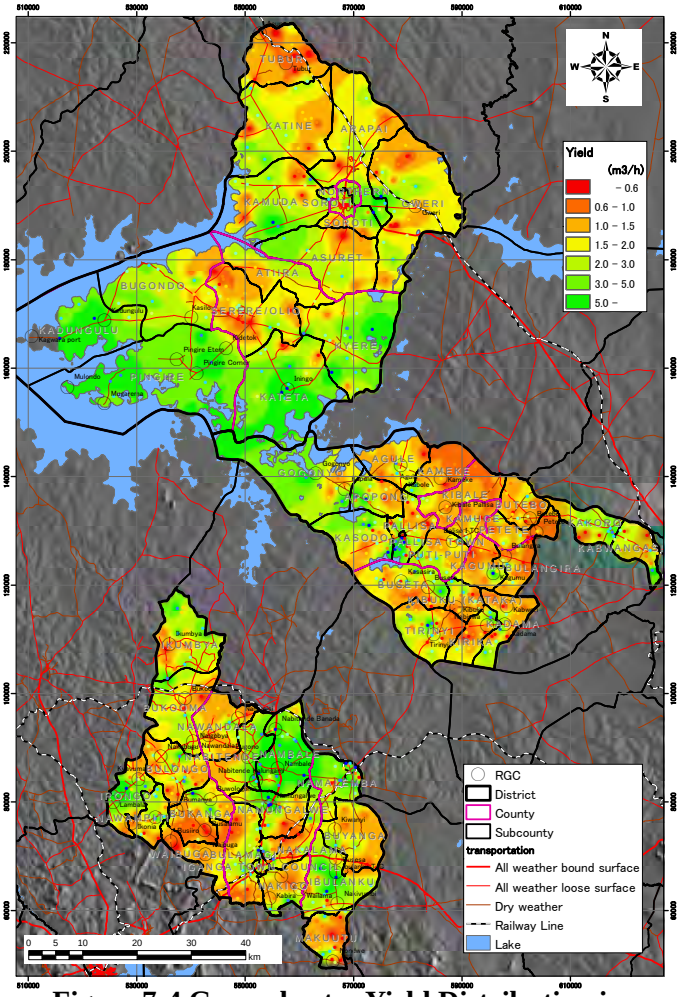


Figure 7-4 Groundwater Yield Distribution in the Priority Districts

Figure 7-4 shows the well yield distribution of each district. In Iganga district, very low yield areas are in Waibuga subcounty, Bukanga subcounty, and the border area between Namungalwe and Nakalama sub-county. The oldest geologies in this area, i.e. Nyanzian formation and Granitoid, are distributed in Makuutu sobcounty. This sub-county has also very low yield. Nambale sub-county and Ibulanku sub-county are relatively high yield.

Pallisa district has low yield in whole area, i.e. most of sub-counties have below 2m^3/h yield. Especially, Bulangira, Agula, and Butebo sub-county have very low yield. But Kakoro sub-county, Trinyi sub-county, and the area along Lake Kyoga or Mpologoma river are relatively high yield.

Southern part of Soroti district, Kadungulu, Pingire, Kateta and Kyere sub-counties, are high yield area. But the northern part of Soroti district has low yield.

Figure 7-5 shows the success rate of wells calculated based on the probability density function against yield of each sub-county. Water balance was considered between groundwater resource amaount and groundwater demand planned in this master plan in 2035. Used groundwater amount is only 1% out of groundwater amount. Then, even in 2035, the groundwater amount is enough, but there is one sub-county which is exceeded 10% of usable groundwater amount.

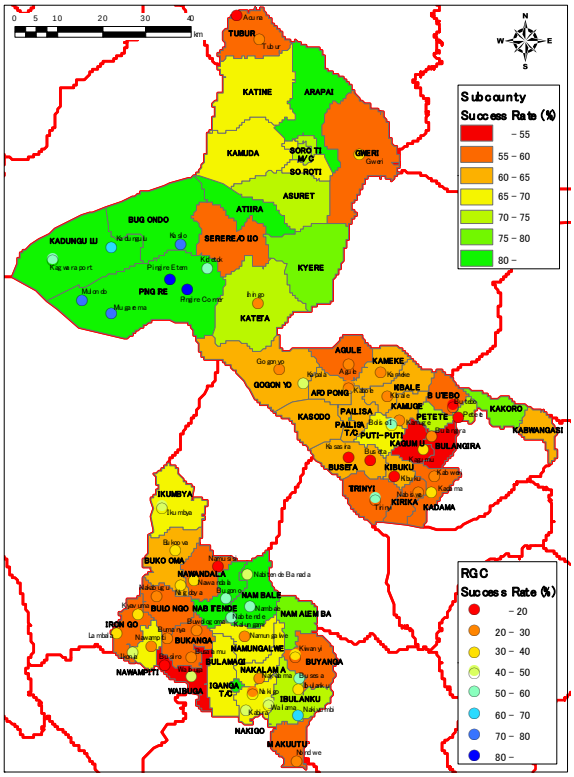


Figure 7-5 Success Rate of Wells by Sub-county in Case of 1.0 m^3/h Yield and Success Rate of Wells by RGC in Case of Planned Yield

7.3.2 Basic Conditions of Master Plan

The basic year of the master plan is set for 2010 and the final target year is set for 2035 with the reference milestone years of 2015 and 2020. The master plan is to be achieved with three (3) steps; the short, medium and long term plans for the target years of 2015, 2020 and 2035, respectively. The target values of access to safe water in each target year are as follows:

Table 7-6 Target Value of Master Plan

Target Years	2015	2020	2035
Target Value of Coverage for each District	77 %	83 %	100 %

The water supply facilities are planned for the RGC areas and the rural areas other than RGCs in this master plan as shown bellow.

- Piped water supply systems are provided to RGC areas, and their extension plans are also considered according to the population growth of the respective RGCs.
- The deep boreholes with hand pump are applied for the rural areas other than RGCs. The repair of non-functional water supply facilities, and the replacement of the existing borehole facilities are also considered in the master plan in order to keep the proper safe water access in rural areas.

The groundwater is basically applied for the rural water supply because the surface water source is not used predominantly in the priority districts. However, it is considered to adopt connection to the NWSC transmissions as an alternative source in case that the groundwater potential is judged to be limited and there is no other groundwater sources even if it is considered to transmit water from nearby areas in the same district. As for the groundwater, only the deep groundwater is considered because the shallow aquifer and spring water is not considered as the stable safe water even if protected.

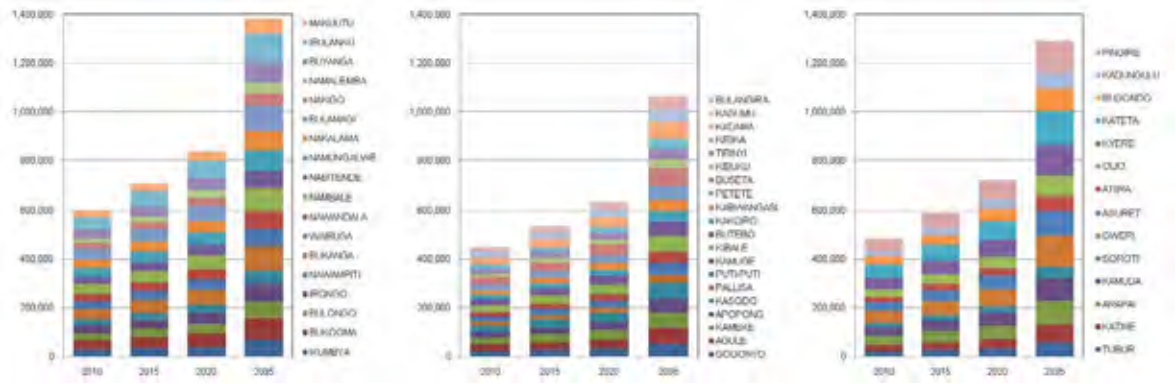
7.3.3 Water Demand

The future population is worked out in SIP until 2035 based on the census data of UBOS (2002). Based on the SIP population and the population worked out by the RGC survey, the future population of the whole district and RGCs in the district are estimated as summarized in Figure 7-6, and the future water demands are also estimated apply in the water consumption per capita as tabulated below.

Table 7-7 Future Rural Water Demands of Priority Districts

(m^3/day)

Priority District (Consumption)	2010 (15 lit./d./capita)	2015 (20 lit./d./capita)	2020 (25 lit./d./capita)	2035 (30 lit./d./capita)
Iganga District	8,968	14,139	20,899	41,467
Pallisa District	6,761	10,723	15,877	31,865
Soroti District	7,277	11,804	17,952	38,797



Iganga District | Pallisa District | Soroti District

District	2010	2015	2020	2035
Iganga (RGC Pop.)	597,855 (88,867)	706,957 (105,084)	835,968 (124,251)	1,382,230 (205,458)
Pallisa (RGC Pop.)	450,719 (45,744)	536,127 (54,407)	635,069 (64,454)	1,062,167 (107,801)
Soroti (RGC Pop.)	485,116 (32,012)	590,218 (38,947)	718,090 (47,386)	1,293,240 (85,339)

Figure 7-6 Present and Future Rural Population of Priority Districts

7.3.4 Water Supply Plan

The water supply facilities required for each term are planned for each sub-county considering the followings.

- Since the coverage of RGCs is found to be low comparing with the village areas other than RGCs, the water supply facilities are provided for RGCs with higher priority than the other areas and complete substantially in the short and the middle term plans. However, the RGCs having existing piped water supply facilities are put lower priority and their implementations are planned for the middle and the long term plans.

- Second priority is given to the village areas of which coverage values are lower, and much gains of coverage is considered. The population covered by one (1) borehole is set at 300 as applied in SIP in the calculation of coverage by boreholes with hand pump.
- The provision of water supply facilities are so determined that the coverage of the whole district achieves the target coverage set for each term.
- The repair of the non-functional facilities is planned to be conducted in the short and the middle terms.
- The replacement of the existing water supply facilities is planned considering the life period of 25 years in accordance with the setting in SIP; actually four (4) % of the existing boreholes have to be replaced every year.

The numbers of water supply facilities and the coverage values of each term are summarized in Table 7-8, and the improvement of coverage in each sub-county is illustrated in Figure 7-7.

Table 7-8 Summary of Water Supply Facilities Proposed for Master Plan

District	Descriptions		2010 (Present)	2015 (Short Term Plan)	2020 (Middle Term Plan)	2035 (Long Term Plan)	Total
Igandga			**Coverage**				
	RGC		27.1%	95.6%	100.0%	100.0%	-
	Out of RGC		69.1%	73.8%	79.6%	100.0%	-
	Whole District		63.0%	77.1%	82.6%	100.0%	-
			Required Water Supply Facilities				
	RGCs Areas	Construction	-	21 RGCs	5 RGCs	3 RGCs	**29 RGCs**
		Extension	-	-	21 RGCs	26 RGCs	-
	Other Rural Areas	Boreholes	-	306 nos.	406 nos.	2,035 nos.	**2,747 nos.**
		Repair	-	70 nos.	69 nos	-	**139 nos.**
		Replace	-	180 nos.	252 nos.	1,491 nos.	**1,923 nos.**
Pallisa			**Coverage**				
	RGC		36.5%	91.8%	100.0%	100.0%	-
	Out of RGC		58.7%	75.2%	81.1%	100.0%	-
	Whole District		56.5%	76.9%	83.1%	100.0%	-
			Required Water Supply Facilities				
	RGCs Areas	Construction	-	11 RGCs	6 RGCs	-	**17 RGCs**
		Extension	-	-	11 RGCs	17 RGCs	-
	Other Rural Areas	Boreholes	-	390 nos.	361 nos	1,638 nos.	**2,389 nos.**
		Repair	-	47 nos.	47 nos.	-	**94 nos.**
		Replace	-	160 nos.	233 nos.	1,297 nos.	**1,690 nos.**
Soroti			**Coverage**				
	RGC		60.1%	97.2%	100.0%	100.0%	-
	Out of RGC		71.2%	75.6%	81.7%	100.0%	-
	Whole District		70.4%	77.0%	82.9%	100.0%	-
			Required Water Supply Facilities				
	RGCs Areas	Construction	-	7 RGCs	3 RGCs	1 RGC	**11 RGCs**
		Extension	-	4 RGCs	11 RGCs	14 RGCs	-
	Other Rural Areas	Boreholes	-	303 nos.	437 nos.	2,202 nos.	**2,947 nos.**
		Repair	-	84 nos.	84 nos.	-	**168 nos.**
		Replace	-	169 nos.	244 nos.	1,532 nos.	**1,945 nos.**

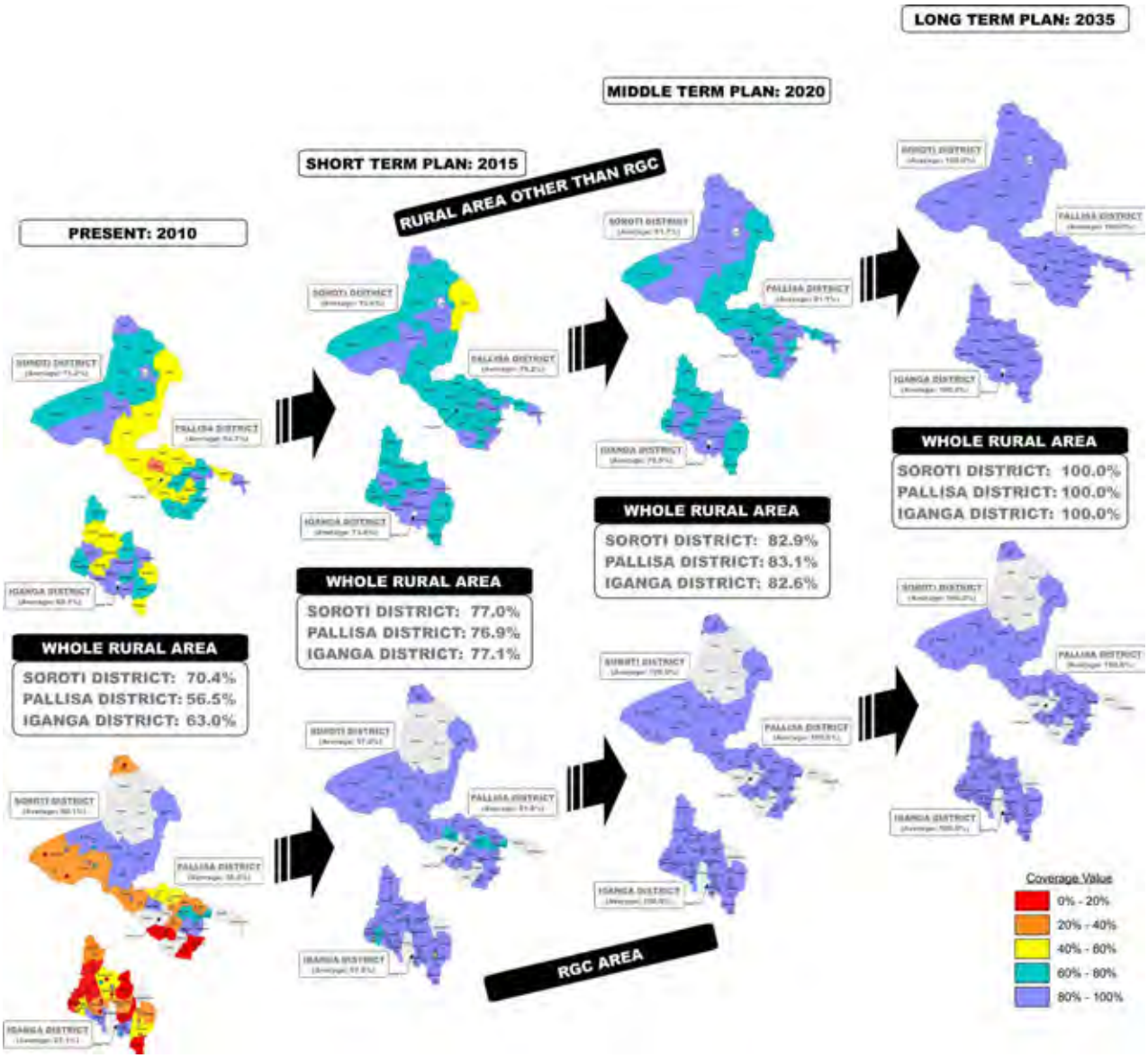


Figure 7-7 Improvement of Sub-county-wise Coverage in Priority Districts

7.3.5 Water Supply Facilities

(1) **Water Supply Facilities for Rural Areas Other than RGC**

The deep boreholes with hand pump are predominantly applied in the rural areas in the priority districts, since the groundwater resources are considered the most promising source for safe water supply in the districts. In the master plan, the deep boreholes with hand pump as shown in Figure 7-8 are proposed to be applied for the rural areas other than RGCs.

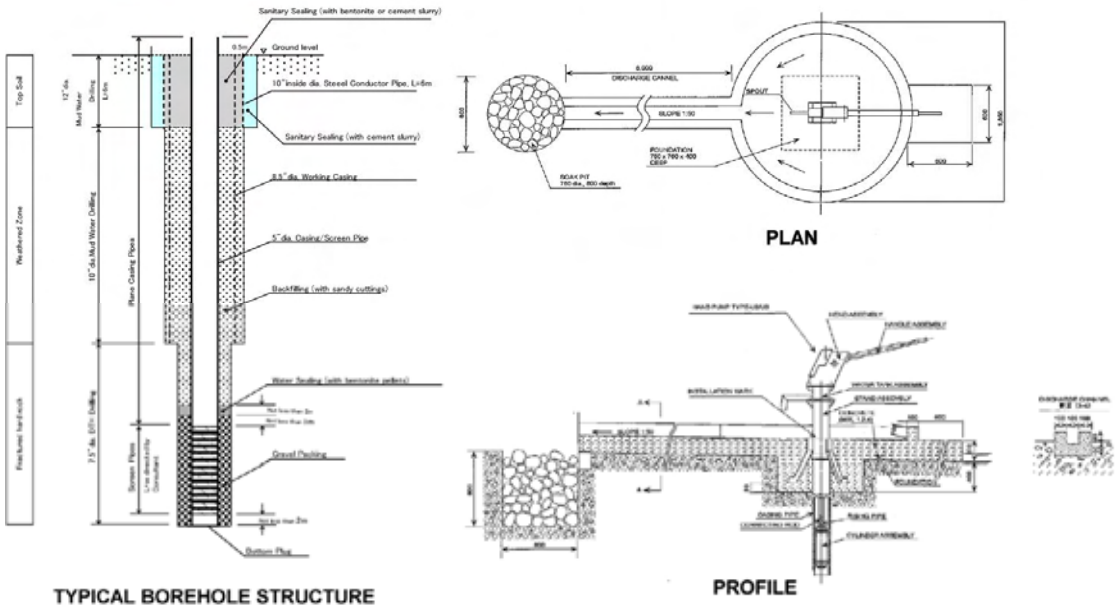


Figure 7-8 Typical Borehole Structure with Hand Pump for Rural Water Supply

(2) **Water Supply Facilities for RGC Areas**

1) Types and Service Levels of Water Supply Facilities to be Applied

The RGCs are divided into four (4) categories in terms of population scale as follows:

Category	Population
- Category I:	<1,000
- Category II:	1,000 - 3,000
- Category III:	3,000 - 5,000
- Category IV:	5,000<

As shown in Table 7-9, the point water source with borehole is provided for the RGCs of Category I. The solar power generation system is applied for the power system of the water supply facilities for RGCs of Category I taking into account of advantages in operation and maintenance. As for the RGCs of the other categories, the piped water supply system is proposed be provided. The deep boreholes with submersible motor pump are applied at the water source, and the water is conveyed by the raw water transmission to the elevated water tank (reservoir). The water is distributed by the distribution pipelines to the water kiosks constructed in the service areas, and sold to the peoples in the area.

Table 7-9 Categories of RGCs and Water Supply Facilities to be Applied

	Category I	Category II	Category III	Category IV
1. Population	500 - 1,000	1,000 - 3,000	3,000 - 5,000	5,000 -
2. Consumption (liter/day/capita)	20 (2015), 25 (2020), 30 (2035)			
3. Type of Facilities	Point Water Source Power Source: Solar power	Piped Water Supply Facilities Electricity or diesel-generated power if commercial supply is not available. In case that NWSC transmission is available near the RGC and its groundwater potential is judged to be poor comparing with the estimated demand, the system may be proposed to be connected such transmission.		
4. Operation Hours	6 hr. (Operation hours of solar-powered pump: 6 hr)	12 hr.	12 hr.	18 hr.
5. Distribution	On site taps or water kiosk	Water Kiosks 1 water kiosk covers 450 persons. No house connection is considered.		Water kiosks and house connections (yard taps) 1 water kiosk covers 450 persons House connections are considered for 10 % of RGC population with 6 persons/connection

2) Alternative Water Sources

As shown in Figure 7-9, the connection to NWSC transmission and the inter-district transmission from neighboring areas are considered in case that the groundwater potential is judged to be so limited in and around the RGC areas that it seems to be difficult to explore the required yields of boreholes to meet the water demand.

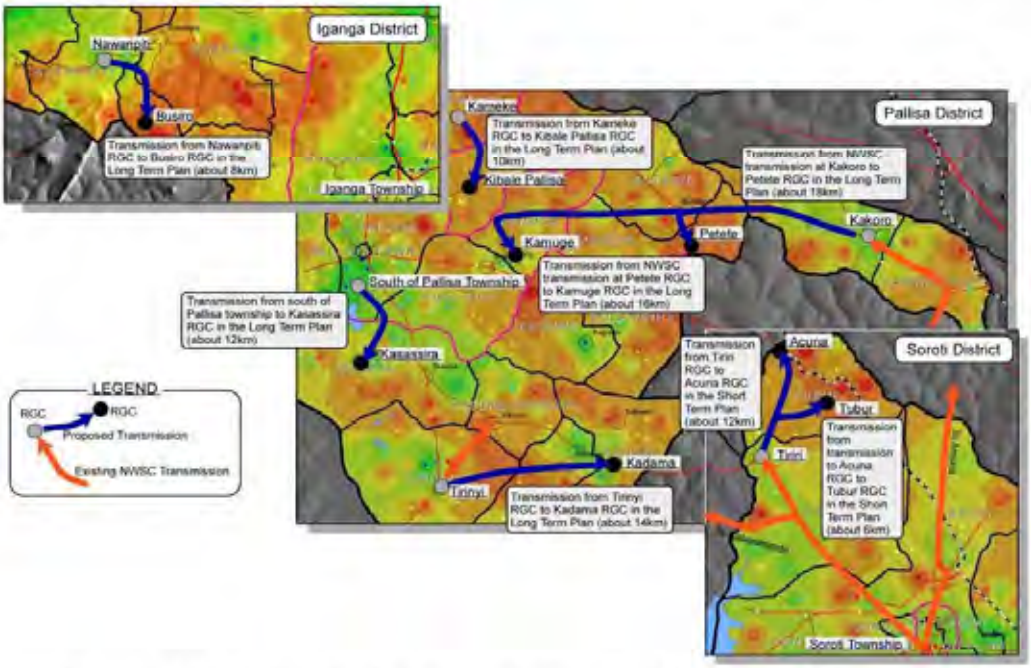


Figure 7-9 Proposed Plan of Transmission from NWSC and Other RGCs

(3) **Alternatives for Power Source of Submersible Motor Pump of Boreholes**

As for the power source of the submersible motor pumps of boreholes, there are three (3) alternatives such as commercial electricity supply, diesel generation and solar generation are considered. Where the commercial electricity supply is available, it is proposed to use it as much as possible from view of economic efficiency. However, where such electricity supply is not available, either diesel generation is proposed to be applied as a result of comparison on the aspect of economy, total cost, easiness in operation and maintenance.

(4) **Term-wise Development**

In the master plan, there are three (3) target years are set; the short term plan for 2015, the middle term plan for 2020 and the long term plan for 2035. The scales and capacities of the water supply facilities are planned considering the period and the demand of each term as follows:

- The izes and capacities of the elevated tanks and the main distribution pipelines are planned to meet the demand of 2020, even when they are constructed in the short term plan of 2015, because they are considered difficult to expand to meet the demand of the middle term plan (2020) after the construction in the short term plan (2015). The facilities are planned to additionally constructed to meet the demand for the long term plan (2035).
- The other parts of facilities such as water source facilities (deep boreholes), transmission pipelines to elevated tanks, water kiosks and yard taps are planned to be provided to meet to the demands of each target year.

7.3.6 Management Plan of Water Supply Systems

(1) **Present Situation of Operation and Maintenance of Rural Water Supply Systems**

The water supply facilities in rural areas of Uganda are individual and are operated and maintained mainly WSCs which are formed by election of WUC and/or WUG. for each facility as shown in Table 7-10. Piped water supply systems of RGCs are managed by the water supply board to be

Table 7-10Water Supply System and O&M Organization

Area		Population	Type of Water Supply System	O&M Organization of the Facilities
Rural	Village	Less than 500	Point Water Source ・Borehole with hand pump ・Shallow well ・Protected spring ・Gravity flow scheme Tap ・Rain water tank	Water User Community or Water User Group (WUC[*1] or WUG[*2]): The whale community served by the individual point water facility
				Water and Sanitation Committee (WSC[*3]): WSC of about 6 people elected by the WUC
				Water User Association (WUA[*4]): In case of many WUC/WCG being served by one water source (like a GFS), the WSCs come together to form a WUA, who in turn can select/elect the Central Committee (like a WSC) to O&M the whole scheme.
	Rural Growth Center (RGC)	500 ～5,000	Point Water Source	Same the above
			Small scale of Water Supply System with pipeline and pumps.	Water Supply Board under Water Authority
Urban	Small Town	5,000～15,000	Water Supply System with pipeline and pumps	Town Board Water Supply Offce
				Private Operator under the Town Water Authority
	Large Town	More than 15,000	Large Scale Water Supply System	National Water and Sanitation Corporation (NWSC)

Note: *1 Water User Community *2 WUG: Water User Group
*3 WSC: Water and Sanitation Committee *4 WUA: Water User Association

established for each system under the sub-county office. The following items are considered in the management of the water supply facilities.

(2) **Point Water Source**

- The water charge collection is not enough to reserve the fund necessary for purchasing spare parts, etc. causing abandoning of non-functional facilities.
- To reinforce the WSC organizations, it is necessary for the officer of the district water office in charge of community support to open up their activities to such communities, but their capacity is not sufficient in quantity and quality.
- The TSU plays a role to support the district water offices, and it is possible to improve the capacity of water offices by reinforcing the support of TSU.
- The present numbers of Hand Pump Mechanics (HPMs) of 19, 20 and 35 have to be increased to 25, 28 and 41for the Iganga, the Pallisa and the Soroti districts, respectively in accordance with the increase of borehole facilities in future.

(3) **Piped Water Supply Scheme**

- The fuel and electricity costs are considered to affect its income and expense balance to the extent that the operation of the system may be interrupted due to shortage of operation fund especially in the systems of rather small RGCs of which operation is conducted by a private operator.
- On the other hand, there are some systems operated directly by the water board under the sub-county without any deficit, and they take their efforts to reserve the operation fund for the expenses for fuel and electricity by saving salary of manpowers for operation and maintenance.
- In the small scheme of which revenue from the water charge collection is not much, the operation costs are large comparing with the revenue by water charge collection, and the fund amount necessary for operation may not be reserved resulting in the interruption of the operation especially in the initial stage of the operation.

(4) **Proposed Operation and Maintenance System**

1) Rural Areas Other than RGCs

As for the operation and maintenance of the boreholes with hand pump for the rural areas other than RGC areas, the management by present WSC is proposed to be continued under the supports by the district water offices. However, since numbers of boreholes are planned to be drilled in these areas, it is required to increase the number of the staff for mobilization as well as HPMs. Each WSC is to consist of one (1) chairman, one (1) treasurer, two (2) caretakers, one (1) committee member and one (1) secretary in accordance with the guidelines.

2) RGC Areas

Category I

The simple system of point water source consisting of deep borehole with motorized submersible pump, small overhead tank, on-site water kiosk and solar modules is planned to be

applied for the RGCs of Category I considering the easiness of operation and maintenance. Since the solar generation system is applied, they do not need to pay any fuel or electricity charges. Therefore, it is proposed to apply the same system of operation and maintenance as the borehole with hand pump.

Category II - IV

The piped water supply systems are applied for the RGCs of Categories II - IV. The private operator is basically hired for the operation of the piped water supply system of the project, but it is proposed not to hire the private operator immediately at the initial stage of operation. The operation and maintenance organization consisting of the water board and the technical staff as illustrated in Figure 7-10 is proposed for the initial stage. The technical staff having the technical capacity to operate the water supply facilities of RGCs is proposed to be hired as required to minimize the man power expenses.

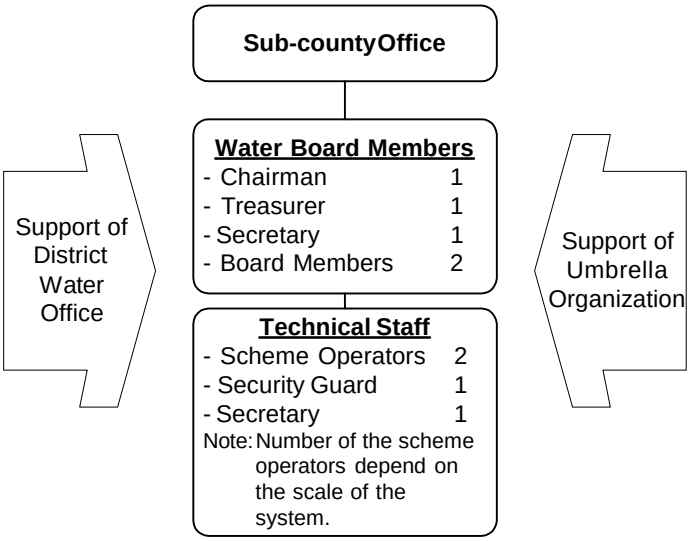


Figure 7-10 Proposed O & M Organization for RGCs of Categories II - IV

(5) **Capacity Building Plan**

For smooth implementation of the master plan for the priority districts, the capacity building of the operation and maintenance organizations, monitoring to grasp the operation and maintenance situations, the workshops and trainings are proposed to be conducted at the times of construction and rehabilitation of facilities by the district water office under the support of TSU as shown in Table 7-11. The targets of the activities are water users, WSC members, members of Water Supply Boards, scheme operators and extension workers of sub-counties.

7.3.7 Project Cost Estimate

(1) **Project Costs**

The project costs consist of construction costs for the contractors, costs for engineering services for detailed design and construction supervision, administration costs for the government administration and contingencies for price escalation and physical contingencies. The expenses for land acquisitions and compensations are not considered because the land for rural water supply facilities are constructed in the public lands and even if private lands are used such usage is agreed among the community members. The value added tax (VAT) is considered in the equipment and material cost

estimate. The estimated project costs are summarized in Table 7-12.

Table 7-11 Workshops and Trainings

Timing/ Activities	Detail of Activities	Targets	Documents	Remarks
(1) Before construction Workshops & Site explanation	1) Announcement to water users	-Water users	-Broad casting -Bulleting -Pamphlet	-By central & Local government
	2) Explanation of the Facilities (Capacity, Specification etc.)	-Water users -WSC members -Extension workers -Board members of the scheme -Scheme operators -Sub-County chief	-Planning documents	-DWO should be the chairman of the work shops. -Members of DWD, TSU should attend and lead/assisst the work shops. -The minutes should be made by DWO
	3) Explanation of O/M including Minor & Major repairs		-Document for maintenance including repairs	
	4) Decision of Water Tariff and collection method			
	5) Capacity building of WSC and Water Supply Board members i)Role and responsibility of each member ii) O/M procedure and records	-WSC members -Board members -Scheme operators -Extension Workers -Hand Pump Mechanics	-O/M manual	
(2) During and after construction Workshops & site trainings	1) Capacity building of WSC and Water Supply Board members i)Role and responsibility of each member ii) Confirmation of O/M procedure and records	-WSC members -Board members -Scheme operators -Extension Workers -Hand Pump Mechanics	-O/M manual -Handling instructions	
	2) O/M by the WSC members and scheme operators	-WSC members -Scheme operators -Hand Pump Mechanics	-O/M manual -Handling instructions	
	3) Training of Hand Pump Mechanics i)Inspection, repair ii)Records of inspection & repairs iii)Spare parts supplier	-Hand Pump Mechanics	-Documents & drawings from supplier	
	4) Monitoring i) Records on O/M ii) Updated lists on household iii) Daily inspection of pumps and facilities vi) Collection v) Record on spare parts purchased	-WSC members -Board members -Scheme operators	-Daily report -Inspection Report	

Table 7-12 Summary of Estimated Project Costs

(Unit: UGX)

	Proposed Project Works	Short Term Plan (2010 - 2015)	Middle Term Plan (2015 - 2020)	Long Term Plan (2020 - 2035)
I. Iganga District	1. Construction of Boreholes with Hand Pump for the Areas Other than RGC	16,705,789,000	22,265,188,000	111,437,454,000
	2. Repair of Non-functional Water Supply Facilities for the Areas Other than RGC	77,649,000	77,961,000	-
	3. Replacement of Existing Boreholes with Hand Pump for the Areas Other than RGC	7,020,763,000	9,839,267,000	58,289,266,000
	4. Construction of New Piped Water Supply Facilities for RGC Areas	34,728,214,000	6,944,842,000	3,818,608,000
	5. Extension of Existing Piped Water Supply Facilities for RGC Areas	0	4,053,047,000	36,509,684,000
	Total for Iganga District	58,532,415,000	43,180,305,000	210,055,012,000
II. Pallisa District	1. Construction of Boreholes with Hand Pump for the Areas Other than RGC	21,654,908,000	20,017,847,000	90,624,471,000
	2. Repair of Non-functional Water Supply Facilities for the Areas Other than RGC	50,321,000	50,735,000	-
	3. Replacement of Existing Boreholes with Hand Pump for the Areas Other than RGC	6,254,891,000	9,108,279,000	50,687,144,000
	4. Construction of New Piped Water Supply Facilities for RGC Areas	17,752,767,000	8,791,179,000	0

Table 7-12 Summary of Estimated Project Costs

(Unit: UGX)

Proposed Project Works		Short Term Plan (2010 - 2015)	Middle Term Plan (2015 - 2020)	Long Term Plan (2020 - 2035)
	5. Extension of Existing Piped Water Supply Facilities for RGC Areas	0	2,911,999,000	26,272,041,000
	Total for Pallisa District	45,712,887,000	40,880,039,000	167,583,656,000
III. Soroti District	1. Construction of Boreholes with Hand Pump for the Areas Other than RGC	15,664,205,000	22,683,938,000	115,229,620,000
	2. Repair of Non-functional Water Supply Facilities for the Areas Other than RGC	92,364,000	93,189,000	-
	3. Replacement of Existing Boreholes with Hand Pump for the Areas Other than RGC	6,779,343,000	9,780,214,000	61,411,252,000
	4. Construction of New Piped Water Supply Facilities for RGC Areas	10,190,437,000	3,102,096,000	398,525,000
	5. Extension of Existing Piped Water Supply Facilities for RGC Areas	4,993,799,000	4,406,305,000	15,185,587,000
	Total for Soroti District	37,720,148,000	40,065,742,000	192,224,984,000

(2) **Operation and Maintenance Costs**

The operation and maintenance cost of the planned piped water supply facilities for RGCs are composed of salary of operation staff, fuel cost for diesel generation and electricity charge, and spare parts, etc. The operation and maintenance cost for the piped water supply facilities for RGCs in each priority district are summarized in Table 7-13.

Table 7-13 Operation and Maintenance Cost for Piped Water Supply Facility

(Unit: UGX/year)

District	Items	Short Term Plan (2015)	Middle Term Plan (2020)	Long Term Plan (2035)
Iganga District	Man Power	1,008,119,000	1,337,622,000	2,104,343,000
	Energy	91,727,000	162,323,000	299,490,000
	Spar Parts, etc.	351,505,000	467,037,000	883,323,000
	Total	1,451,351,000	1,966,982,000	3,287,156,000
Pallisa District	Man Power	467,986,000	743,426,000	1,113,783,000
	Energy	23,849,000	59,623,000	123,787,000
	Spar Parts, etc.	177,527,000	297,358,000	560,077,000
	Total	669,362,000	1,100,407,000	1,797,647,000
Soroti District	Man Power	376,120,000	528,002,000	844,282,000
	Energy	47,808,000	137,919,000	291,471,000
	Spar Parts, etc.	153,817,000	236,449,000	405,534,000
	Total	577,745,000	902,370,000	1,541,287,000

7.4 Selection of Priority Projects

(1) **Basic Concept of Selection**

Since the present coverage values of RGCs are considered quite low comparing with the other rural areas, the most effective way to improve the coverage values of each district is considered to push up such low coverage values of RGCs to the levels above average values of the whole district. Further, it is urgent to reinforce the basic infrastructures such as water supply facilities to avoid worsening the water supply situations. In SIP the government of Uganda intends to put emphases on the construction of piped water supply schemes.

(2) **Prioritization of Project Works**

In prioritization of the projects, the following parameters are considered.

- -Urgency of implementation: Coverage of safe water supply
- Importance of target RGC: Nnumbers of the public and administrative facilities and the business facilities in RGCs
- Natural conditions: Expected yield at the RGC site and its success rate
- Impact of implementation: Population of RGCs
- Efficiency of water supply facility: Population served by one (1) borehole
- Easiness in implementation: Availability of electricity supply in RGCs
- Continuity of assistance: Yields observed at the test boreholes

The values of each parameter are scored, and the total scores are worked out for each RGC. Ranking is put on the respective RGC.

(3) **Selection of Priority Projects**

There are 39 RGCs for the implementation of the short term plan, and then they are divided into three (3) groups as shown in Table 7-14. The first priority group to be implemented most urgently consists of 13 schemes; seven (7), three (3) and three (3) schemes in the Iganga, the Pallisa and the Soroti districts, respectively. The locations of the RGCs of the prioritized groups are shown in Figure 7-10.

Figure 7-11 Location of Priority Projects

Table 7-14 Results of Prioritization of Piped Water Supply System

Priority Group	Iganga District				Pallisa District				Soroti District			
	Rank	RGC	Score	Population	Rank	RGC	Score	Population	Rank	RGC	Score	Population
First Priority Group	1	Nabitende B.	36.0	17,459	3	Kadama	32.4	12,888	2	Kidetok	32.5	1,265
	4	Namungalwe	32.0	14,474	10	Kasassira	22.2	6,666	5	Tubur	26.6	2,433
	6	Nambale	25.1	5,717	13	Kameke	20.8	3,194	7	Acuna	24.6	2,069
	8	Nakabugu	22.8	5,814	15	Kapala	18.9	2,574	19	Mugarema	18.1	5,125
	9	Nakalama	22.3	6,905	18	Buseta	18.1	2,839	25	Kagwara P.	17.3	3,796
	11	Lambala	21.6	2,515	21	Kibale P.	17.8	2,833	35	Mulondo	12.8	2,214
	12	Naigobya	21.3	1,942	23	Nabisuwa	17.4	2,074	36	Pingire Etem	12.6	1,582
Second Priority Group	14	Busesa	19.7	4,825	24	Kabweri	17.3	1,562				
	16	Kyanvuma	18.7	2,050	28	Butebo	15.6	1,358				
	17	Nakivumbi	18.2	2,750	30	Agule	15.0	2,988				
	20	Nondwe	17.9	4,264	33	Boliso ITC	13.0	1,253				
	22	Nabitende K.	17.6	2,822								
	26	Bukooma	17.1	2,533								
Third Priority Group	27	Kiwanyi	16.3	3,033								
	29	Namusisi	15.4	1,960								
	31	Ikumbya	14.3	1,508								
	32	Busiiro	13.1	2,231								
	34	Busalamu	13.0	1,972								
	37	Buwologoma	10.8	2,262								
	38	Bumanya	10.3	2,280								
	39	Nawampiti	9.1	2,485								

7.5 Economic and Financial Evaluation of Master Plan

7.5.1 Economic Evaluation of Total Master Plan

(1) **Evaluation Procedure**

The master plan was evaluated by NPV, B/C and IRR. FIRR（Financial Internal Rate of Return）could not be calculated because of the current economic conditions of Uganda, income conditions in the rural area of the districts and no other gaining from the projects except water charge.

(2) **Cost and Benefit**

Items of cost and benefit are as shown in Table 7-15. Calculation and evaluation result shows in Table 7-16. The rural water supply master plan was well-evaluated its adequacy, effectiveness, availability and efficiency, and confirmed large positive impacts to Uganda.

Table 7-15 Cost and Benefit

Cost	Construction cost	Construction cost for water supply system
	Operation and maintenance cost	Operation and maintenance cost for water supply system
	Increment of water charge	Expense increases by upgrading to new water supply system
Benefit	Reduction of water collection time	Reduction time will contribute to income
	Reduction of waterborn diseases	To save medical expense and avoid lost of working hours. They will contribute to income.

Table 7-16 Calculation and Evaluation Result

Items	Result	Evaluation criteria	Evaluation
B/C	2.6	B/C>1.0	Good
NPV	+493,974millionUGX	NPV>0	Good
EIRR	107%	EIRR>10.0%	Good

7.5.2 Financial Evaluation of O&M Stage

(1) **Evaluation Procedure**

FIRR is used for financial evaluation as revenue is expected from water charges with the master plan. The project is evaluated by three cases as follows.

- **Case1** : E**n**tire Area of Master Plan
- **Case2** : Outside RGC (Water Supply System Type: Deep Borehole with Handpump)
- **Case3** : Inside RGC (Water Supply System Type: (i) Deep Borehole with Submersible Pump and Transmission Pipe Line or (ii) Deep Borehole with Submersible Pump and Storage Tank)

(2) **Cost and Revenue**

Cost and revenue are as follows.

- **Cost**: operation and maintenance cost of the water supply system
- **Revenue**: water charges

(3) **Calculation Result and Evaluation of Entire Master Plan (Case1)**

Table 7-17shows the result of the financial evaluation of the entire rural water supply project. Although B/C is almost 1.0 and FIRR is close to the hurdle rate of 10%, the revenue from water charges is not enough to support the O&M of the water supply without funding from the national and local government. The estimated amount of a necessary obligation price witch present value at the first project year is approximately 3 billion UGX. Since the water resource situation is quite different inside and outside the RGC, financial evaluation was also performed separately described below.

Table 7-17 Calculation and Evaluation Result (1)
(Case-1: Entire Master Plan)

Items	Result	Evaluation criteria	Evaluation
B/C	0.95	B/C>1.0	NG
NPV	-2,789 millionUGX	NPV>0	NG
FIRR	8.30%	FIRR>10.0%	NG

(4) **Calculation Result and Evaluation of Outside RGC (Case2)**

Table 7-18 shows the result of the financial evaluation outside the RGC. The water charge of UGX 1,013/person/year and UGX185/m^3, estimated from the survey of 375 households, was used for the evaluation.

Table 7-18 Calculation and Evaluation Result (2)
(Case-2: Outside RGC)

Items	Result	Evaluation criteria	Evaluation
B/C	0.72	B/C>1.0	NG
NPV	-4,802millionUGX	NPV>0	NG
FIRR	-.-%	FIRR>10.0%	NG

In order to fund the O&M of the water resources, UGX 1,440 /year/person needs to be collected. Or, it is necessary to improve the collection rate of the water charge plus 12%. An amount of willingness to pay for water charge given by the socio-economic survey in the Study is average 2,914UGX/person/year. Therefore, the management of such water system

could well-functioned by setting up the water charge collection system, and explaining the importance of the water charge payment.

(5) Calculation Result and Evaluation of Inside RGC (Case3)

On the other hand, sustained O&M supported by high B/C, NPV, and FIRR is expected inside RGC as shown in Table 7-19. This is based on the water charge of about UGX 2,025/person/year used by DWD in small towns, RGC, and large gravity schemes. A system to collect water charge without delinquency is needed to maintain the expected revenue.

Table 7-19 Calculation and Evaluation Result (3)

(Case-3: Inside RGC)

Items	Result	Evaluation criteria	Evaluation
B/C	1.05	B/C>1.0	Good
NPV	2,013million UGX	NPV>0	Good
FIRR	11.30%	FIRR>10.0%	Good

7.6 Initial Environmental Evaluation

The impacts on the environment caused by construction and operation of the rural water supplies described in the master plan were assessed quantitatively. Air and water pollution, and noise generated during construction will not be of a big concern and will only occur during the construction. Effects on the local ecosystem and cultural heritages in and around the construction sites can be avoided by conducting surveys on them and planning facility construction around the survey results.

Installation of new water supplies as basic social infrastructure will improve the health conditions of local communities and workload of women and children who daily carry water. On the other hand, those new water sources can cause differentials between those who benefit from them and those who do not. The differentials can be minimized by careful planning after consultation with local communities. In addition, the differentials will eventually diminish with installation of more facilities supported by the national plan of improving the rural water supply rate to 100%.

Chapter 8
Conclusion and Recommendations

CHAPTER 8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Based on the wide-range data corrected for water resource development and management and the survey results obtained from the study over two years since March 2009, "The Basic Plan on Water Resources Development and Management" covering the Lake Kyoga basin based on the IWRM concept and "Rural Water Supply Master Plan" targeting three priority districts has been established. The conclusion of the study is summarized below.

(1) Water Resources Potential Evaluation

The ground and surface water of the entire Lake Kyoga basin was evaluated based on the survey results of this study. One of the key results is the estimated total available water resource of 556.1 MCM/year and 650.5 MCM/year in 1/10 and 1/3 drought years, respectively. This estimate with 1/10 drought year implies water resource shortage to occur by 2020.

(2) Major Issues on Water Resources Development and Management

Eleven major issues on water resources development and management found in the study are listed below.

- Shortage of reliable basic data for water resources development and management
- Uncertain potential of water resources: surface water and groundwater
- Restriction of access to the surface water due to the Nile Water Agreement
- Climate change
- Lack of water supply and demand balance
- Insufficient rural water supply coverage
- Inadequate stakeholders collaboration for water resources development and management
- Lack of ambient water quality standards for conservation of water environment
- Lack of flood and sediment disaster mitigation
- Insufficient man power and organizing ability
- Insufficient community participation

(3) Water Balance of Supply and Demand in Each Sub-basin

The water supply and demand of each sub-basin in the Lake Kyoga basin was evaluated. Five sub-basins: Okok, Okere, Lwere, Kyoga Lakeside, and Mpologoma, will face shortage of agricultural water in near future. Mpologoma sub-basin was found in the worst condition of agricultural water shortage among the sub-basins.

(4) Formulation of the Basic Plan on Water Resources Development and Management

The Basic Plan on the Water Resources and Management for Lake Kyoga Basin consists of four items: i) Comprehensive Water Resources Management, ii) Effective, Stable and Equitable Water Supply, iii) Prevention of Flood and Sediments Disaster to Protect Lives and Properties, and iv)

Conservation of Water Environment. It was formulated for the short term to 2015, middle term to 2020, and long term to 2035.

(5) Priority Evaluation of the Basic Plan

Rural water supply was selected as the top priority item by comprehensive evaluation of the relative contribution of each item in the Basic Plan to the eight millennium development goals.

(6) Evaluation of the Basic Plan

There are no technical difficulties for implementation of the structual and non-structual measures in the Basic Plan. In terms of the economic evaluation, the validity of the rural water supply project has been confirmed based on the 12.7% EIRR which is larger than the discount rate of 10%. However, external funding is essential for implementation of basic infrastructures such as water supplies given the current financial situation of Uganda. The results of the social environment evaluation pose no unavoidable negative factors that affect forestation as well as construction of facilities such as water supply, storage, and filtration facilities.

(7) Selection of the Priority Districts for the Rural Water Supply Master Plan

Three priority districts, Soroti, Pallisa, and Iganga, were selected by evaluating five indices on both the natural and social condition for the Rural Water Supply Master Plan, which is the top priority project of the Basic Plan.

(8) Formulation of the Rural Water Master Plan

The Rural Water Master Plan for the three priority districts was formulated. It was concluded that implementation of piped water system for the Rural Growth Centre (RGC) would be very effective for drastic improvement of the rural water supply coverage as that of RGCs is considerably (10% to 40%) lower than the sub-county average and also the average of non-RGC rural areas according to the results of RGC survey and WATSUP.

(9) Evaluation of the Rural Water Supply Master Plan

The master will provide economical benefits to Uganda. However, external funding to support construction of facilities is inevitable given the financial situation of the country. Even for operating and maintaining the existing water supply facilities, the water charge collection rate of 75% must be achieved for wells with a hand pump, and roughly UGX 2,000/m^3 water charge must be collected without delinquency for the piped water supply system in RGCs. In terms of the social environmental and social consideration, there are slight potential impacts, but they are avoidable.

(10) Selection of the Priority Projects

In order to meet the short-term goal of 77% rural water coverage by 2015, target RGCs of the priority projects were selected in the following manner. The total scores of the following items for every (61) RGCs in the three districts in the basin were used for the initial selection of 39 RGCs.

- Coverage rate of safe water supply
- The number of the existing public, administrative, and business facilities
- Expected water yield at the RGC site and its success rate
- Population
- Population served per each borehole
- Availability of electricity
- Yields observed at test boreholes

The selected RGCs were further classified into three priority groups. The following 13 RGCs belong to the first priority group.

- Soroti District：Kidetok, Tubur, and Acuna
- Pallisa District：Kadama, Kasassira, and Kameke
- Iganga District：Nabitende B., Namungalwe, Nambale, Nakabugu, Nakalama, Lambala, and Naigobya

8.2 Recommendations

Most of the recommendations on the water resources development and management of the Lake Kyoga basin, which are the main purpose of the study, are reflected in the Basic Plan. The recommendations mainly focus on water supply rather than sanitation, agriculture, power generation, or biodiversity though they are based on the concept of IWRM. Further expansion of this study by Uganda or DWRM is strongly recommended to address those areas to formulate the Integrated Water Resources Management Plan (IWRMP) hereafter. The main recommendations of the study are described below.

(1) Improvement of the Water Resources Monitoring System

In addition to its amount, the accuracy and continuity of the fundamental data, such as meteorological, hydrological, and hydrogeological, data are essential for Integrated Water Resources Management (IWRM). The current monitoring system needs to be significantly improved in this respect.

(2) More Human Resources and Capacity Development

More human resources and their capacity development (C/D) are needed for more efficient water resources development and management in the Lake Kyoga basin.

(3) Arbitration of Conflicts between Water Resources Stakeholders

Conflicts between water resources stakeholders are expected along with their development. Arbitration of such conflicts by basin or sub-basin lead by the Water Resources Management Zone Office (WRMZO) and the Sub-basin Liaison Council is needed.

(4) Improvement of the Rural Water Coverage

New facilities are needed to improve the plateau of the rural water supply coverage. However, appropriate O/M of the existing facilities should not be neglected.

(5) Establishment of the O/M System for Water Supply Facilities

Collection of water charges without delinquency is the most important requirement for independent operation and maintenance of the water supply facilities by Uganda as explained in the financial evaluation in the Rural Water Supply Master Plan. Though maintainable O/M systems have been sought in Uganda, establishment of a feasible and efficient O/M system without delay is desired.

(6) Public Awareness of Water Saving

The analysis of water supply and demand shows rapid increase of water demand expected in near future in the Lake Kyoga Basin. Therefore, public awareness of water saving is important to cope with the increasing demand.

(7) Acquisition of Funding Sources for the Rural Water Supply Master Plan

Roughly UGX 340 million/year is needed just to execute the Rural Water Supply Master Plan which is only for three out of about 80 districts in Uganda. Given the annual budget of UGX 1,500 million/year for the water related sector of Uganda, this amount is considerably large. Therefore, acquisition of funding sources needs to be seriously considered.

(8) Early Start of the Priority Projects and Acquisition of Groundwater Resources

The priority projects for the 13 selected RGCs should be started as soon as possible to improve the water coverage rate of the rural water supply. More detailed groundwater exploitation survey is necessary to acquire withdrawal volume for implementation of the projects.

(9) Water Supply Facilities for Rural Areas outside RGC

Water supply facilities, mainly deep wells with a hand pump, need be constructed in the rural areas outside RGC. Roughly 200 wells need to be installed every year in the three districts. A framework to accommodate that needs to be soon established. In addition, delinquency of water charges needs to be reduced for the level-1 operation and maintenance of the wells including the existing ones.

(10) Acquirement of Agricultural Water

Shortage of crop water is of a concern in five sub-basins, Mpologoma in particular. Planning and construction of flood water storages, valley tank and pond for example, as supplemental water storage should be carried out immediately.

(11) Dealing with Flood and Sediments Disasters

Destruction of the natural environment around the Mt. Elgon, along with the climate change, appears to have increased flooding and sediment disasters in the area. A basic survey to grasp the condition of the natural environment should be started soon.

(12) Environmental and Social Consideration

The water supply projects for the RGCs in the districts will go through the stages of F/S, basic design, detailed design, and implementation by turns. At the F/S stage, DWD needs to prepare application documents for NEMA based on "The Guideline for Environmental Impact Assessment in Uganda (1997)". Though will be eventually resolved, some differentials between those who benefit from new water supply facilities and those who do not may initially emerge. Therefore, an appropriate explanation of the project to the local communities is needed to avoid unnecessary conflicts.

(13) Population Control

The rapid population increase in Uganda, which ranks the third place in the world, is one of the main the causes of the rapid rise of the water demand and destruction of the natural environment around Mt. Elgon. Water supply planning and implementation with the population growth in consideration is of course important, but that with population control would be more effective.

(14) Expansion of the Study to Other Basins

Expansion of the water resources operation and management plan of this Study to other seven districts is strongly recommended.