Chapter 3
Socio-economic Conditions

CHAPTER 3 SOCIO-ECONOMIC CONDITIONS

3.1 Socioeconomic Conditions of Lake Kyoga Basin

3.1.1 General Conditions

(1) **Population and Ethnic**

According to the 2002 census carried out by UBoS (Uganda Bureau of Statistics), the total population in the basin is 7.7 million (country population = 24.2 million). The total number of households is 2 million. Number of people per household varies from 3.8 in Pallisa to 5.5 in Nakapiripirit. Considering the population of the sub-counties only within the basin, the population density varies as low as 13/sqkm in Abim and highest in Mbale, 642/sq km. Figure 3-1 shows the population density distribution by sub-county.

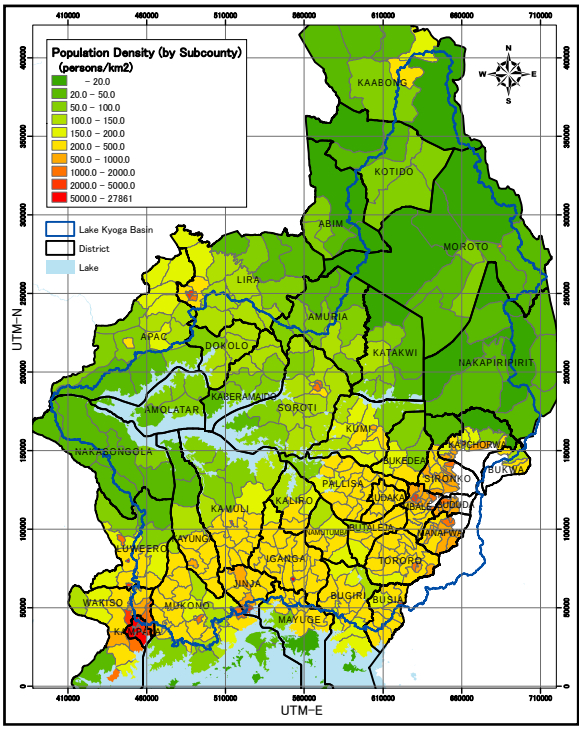


Figure 3-1 Population Density in the Lake Kyoga Basin by Sub-County

There are about twelve major ethnic groups share the basins. They are Karamojong in the north. Teso mainly live in the middle part of the basin covering Kaberamaido, Soroti, Amuria, Katakwi, Kumi and Bukedea districts. In the south-southwest part is shared by Bosoga and Baganda groups. Eastern part is by Bagisu, Beware, Japhadola, Sabiny and Baruri groups. In the north-western part Langi group of people live.

(2) **Industry**

1) **Agriculture and Livestock**

The people in the Basin maintain lively hood engaging themselves in agriculture, fishing and small retail businesses. Only a little percentage of people (5~10%) involved in employment. They grow variety of crops such as Maize, Cassava, Rice, Cotton, Coffee, Tea etc. Among horticultural products, Mango, Papaya, Pineapple, Jackfruits, Tomato, Onion, Sorghum, Cabbage, Groundnut are main.

While practice agriculture most of the families maintain small dairy and poultry firms as a side business. Cows, goats and pigs are the main animals. Local chickens are very popular as poultry.

2) **Fishery**

Fishery has been an important source of income among the communities living along the

lake-shores in the country. Lake Kyoga is an important source of Nile Perch, Tilapia and Cat fish. In Study area, Nakasongola, Kayunga, Kamuli, Kaliro, Soroti, Pallisa and Numutumba are the main districts where many inhabitants are involved in fishing activities and earn their living.

3) **Trade and others**

Many people earn their livings opening a road side retail shop of vegetable, operating small restaurant and many are engaged as Boda-Boda drivers in town centers.

3.1.2 Socio-Economic Survey

(1) **Outline of Socio-Economic Survey**

The socio-economic survey was conducted in selected villages as shown in Figure 3-3 to understand the socio-economic conditions of the Basin. The villages to be surveyed were selected considering three points as below.

- Number of sub-counties in each district
- Even distribution of villages in a whole survey area
- As close as possible to Rural Growth Center (RGC)

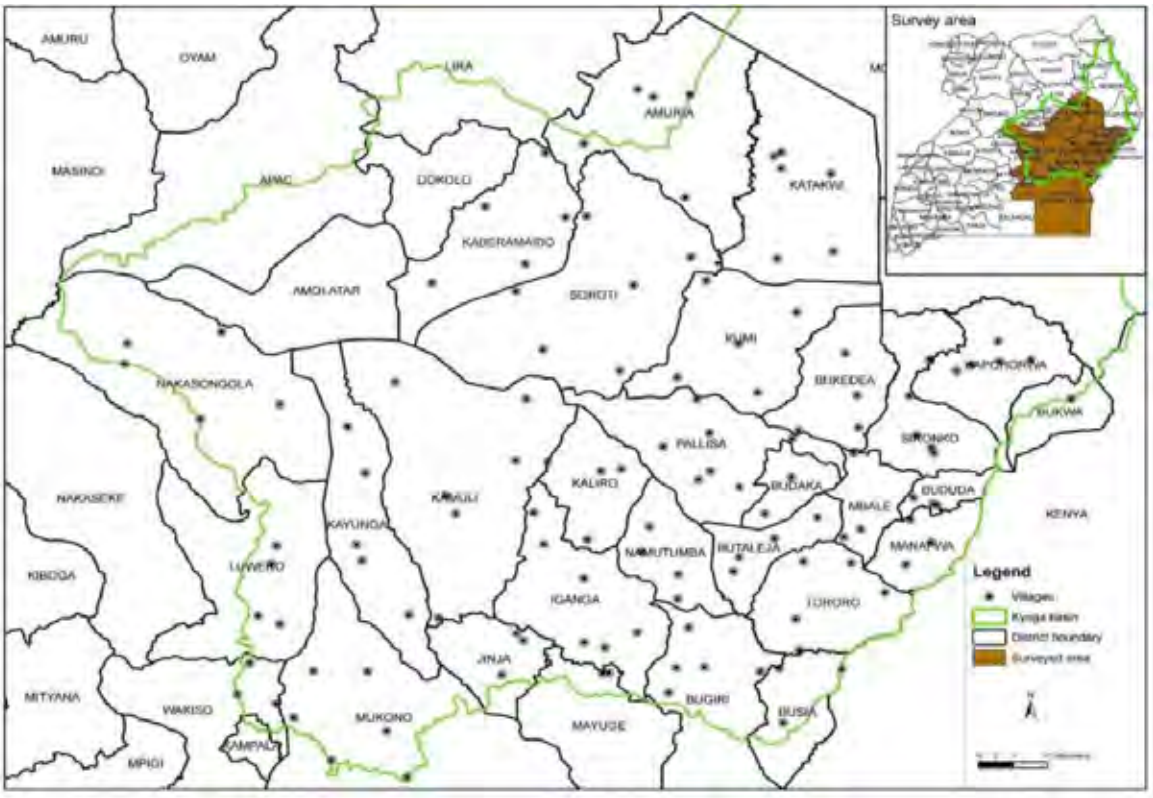


Figure 3-2 Location of Target Villages for Socio-Economic Survey

The survey consisted of “Village Survey” which made clear the general village conditions and “Household Survey” for selected three households in each village which investigated villagers conditions.

(2) Survey Results

1) Demographic Information

Village size is varying between 200 to 6,500 people and an average of it is 1,458 people. On the other hand, the averaqge household size is 4.5 people, which hamonizes with the result of the Census 2002 (UBoS). According to the "Household Survey", there are on average 8.2 people per household in the study area. The household size depends on the wealth of the household, with poor households having 6.8 members, and rich households having 10.1 members.

2) Socio-Economic Activities

The majority of the population is engaged in agriculture; part of these people also works as a daily laborer and/ or fisherman as shown in Table 3-1.

The average stated annual income is 1.66 Million UGX (750 US$), varying from an average of 0.40 Million UGX for poor households to an average of 4.87 Million UGX for rich households.

Table 3-1 Engagement in Economic Activities

Economic Activity	Av. % of Engagement
Agriculture	82.3
Fishing	6.5
Daily Laborer / casual	25.3

Average expenditure figures were derived from respondents establishing monthly and quarterly expenditures. The people are not saving money. On average, people have a loan of 0.25 Million UGX to finance their expenditures. Especially the relatively rich households borrow money, on average 0.72 Million UGX, which is 15% of their average yearly income. On average, 7% of the household's income is spent on domestic water.

3) Cultivated Area and Crops

On average, households own and cultivate 7.6 acres. The households classified as poor and medium own 5.5 acres, whereas the rich households on average own 17 acres. People usually cultivate some five different crops, as they to a large extent are subsistence farming. Often intercropping occurs, making it difficult to establish the amount of acres for a specific crop. The Figure 3-3 shows the kinds of cultivated crops. Maize field constitute 22% of the total stated cultivated area, with cassava and pineapple cultivation using 21% and 15% of the cultivated area, respectively.

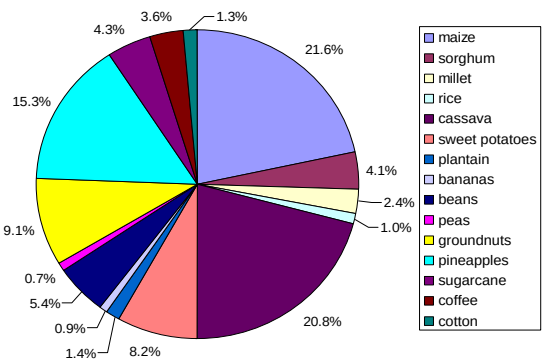


Figure 3-3 Ratio of Cultivated Area by Crops

4) Water Supply and Sanitation

i) Water Supply Facilities

The majority of the households inter-

viewed, 53% uses a borehole well as its main water supply, followed by the use of a protected shallow well or shallow borehole (8% of the respondents). Only two percent are using tap water. This means that 72% of the interviewed households uses safe water supply, whereas a quarter of the population uses unsafe water for drinking. Additionally, three households are using Rain Water Harvesting Tank.

As for water quality, 40% of the respondents answered "bad". The main reason stated is turbidity, hardness or salinity and odour.

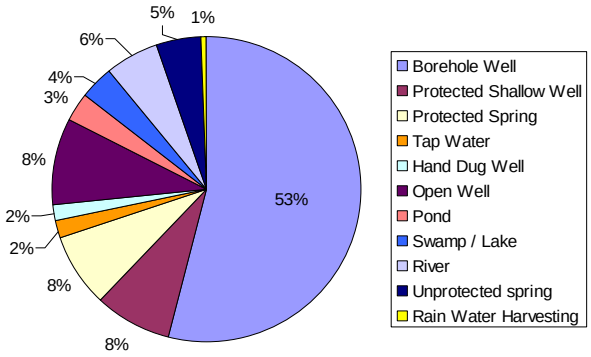


Figure 3-4 Ratio of Main Water Supply Facility

ii) Time Spent on Collecting Water

The average time required to fetch water is 95 minutes varying from 10 minutes to 6 hours daily. (refer to Figure 3-5) The interviewed people revealed that most of the time is taken by waiting at the water supply facility.

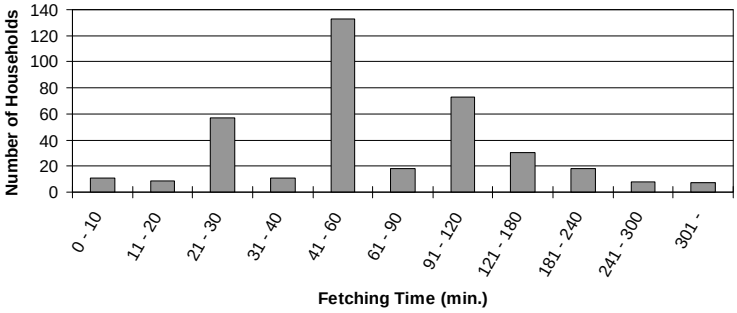


Figure 3-5 Time Spent on Collecting Water

iii) Water Consumption and Fee

People use on average 18 liter/capita/day for domestic purposes. Although someone pay the water fee monthly and others pay by jerrycan, etc., they are paying 1.47 UGX/liter in whole average. However, poor class people are paying less than 1 UGX/liter, they are considered to fetch water from river or pond which they don't need to pay water fee. They spent on average one and a half hours per day to collect water; this includes waiting time at the source. (refer to Table 3-2)

Table 3-2 Water Collection and Consumption

	Wealth Class of Household			Overall Average
	Poor	Medium	Rich	
Average of Time Required to Fetch Water (minute)	82	97	114	95
Average of Amount of Water Used in a Day (litters)	107	149	200	143
Average of Total Family Members	7	8	10	8.2
Average of water price per litter	1	1	2	1.47
Water Used (person/day/litters)	16	18	20	17.5
Willingness to pay for improved water system (% of yes)	95	89	99	93.1

iv) Willingness to pay and Operation & Maintenance

Water supply is a big issue in villages, and people spend a lot of time for collecting it. Most people indicate they would be willing to pay for the operation and maintenance cost of tap water supply system. Also, if the existing system is improved and an extra fee is charged,

the people are willing to pay for it .and in favor of applying strict rules for water fee collection.

v) Waterborne Diseases and Sanitation

Waterborne diseases are reported in 60 villages out of 125 surveyed villages. A total of 13,534 water-borne diseases were recorded. It follows that Diarrhea is most prevalent in the study area (with 36% of the reported cases of water borne diseases), followed by symptoms of vomiting According to the result of "Household survey", 33％ of the respondents indicated that household members suffered from waterborne diseases in the last year. Diseases mentioned included mostly diarrhoea, occurring in 30% of the cases. Other water borne diseases included Malaria, skin diseases, Typhoid and Cholera. Vomiting was also mentioned, which can be due to a variety of diseases. (refer to Figure 3-6)

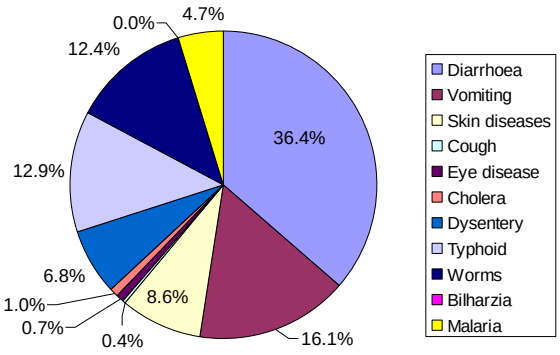


Figure 3-6 Occurrences of Reported Cases of Waterborne Diseases (Village Survey)

On average, the villages report that improved latrine coverage is 63%.

(3) **Development Needs in the Surveyed Villages**

According to the result of "Village survey", needs for development in the surveyed villages is the highest in the field of water supply (88% of the villages identified the need for water supply), followed by improvement of infrastructure. Improvement of infrastructure mainly aims at improvement of road condition. Needs in the agricultural field are introduction of farm machines and improved seeds. Needs for construction or extension of health centers/hospitals and schools are also high (refer to Figure 3-7).

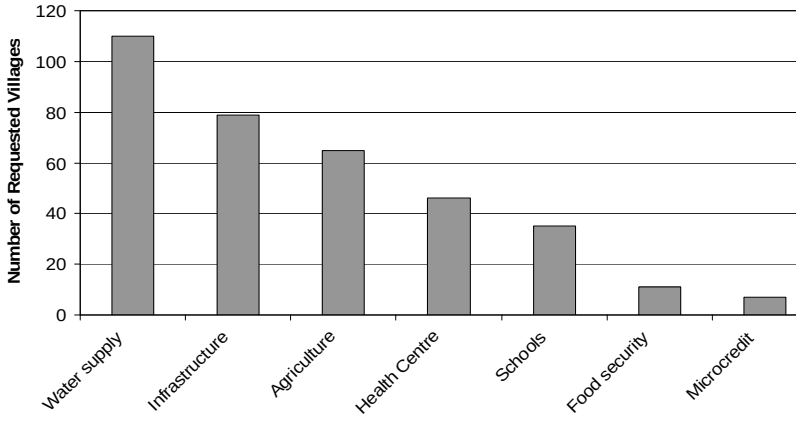


Figure 3-7 Needs for Development in the Surveyed Villages

3.2 Political, Legal and Organizational Frameworks

3.2.1 Policy and Legal Frameworks

The key policy and the legal frameworks in the field of water and environment sector are summarized in Table 3-3.

Table 3-3 Key Policies and Legal Framework

Category	Name	Contents
Legal Framework	(1) The Constitution, 1995	The Constitution includes basic policy statements related to the water sector. It stipulates the fallowing objectives. ・The state shall ensure that all Ugandans have right to access to clean and sage water. ・The state shall take measures to promote a good water management system at all levels. ・The state shall promote sustainable development and public awareness of the need to manage water resources.
	(2) Local Government Act, 2000	It provides for the system of local governance. And it has defined roles for different levels of governance in the management of water related services and activities.
	(3) Water Act, 1995	It provides the framework for the use, protection and management of water resources and supply. And it provides for constitution of water and sewerage authorities and facilities the devolution of water supply and sewerage under takings. The objectives are: (i) to promote the rational management and use of waters, (ii) to allow for the orderly development and use of water resources, (iii) to control pollution. The detailed provisions regarding acquisition of permits for water use are contained in "The Water Resources Regulations, 1998." As regards industrial and other activities that would result in the generation of effluent and waste water, the provisions for waste water discharge permits and related matters are contained in "The Waste Discharge Regulations, 1998." In the event that the developer seeks to construct a private sewer or establish a sewerage works, the provisions of "The Sewerage Regulations, 1999" should be taken into account. And also regarding water supply facilities, the provisions of "The Water Supply Regulations, 1999" should be followed.
	(4) The National Water & Sewerage Corporation Act, 2000	It provides for a corporation that operate and provide water and sewerage services in areas entrusted to it under the water Act, 1995. The main objectives are; (i) to manage the water resources in ways which are most beneficial to the people. (ii) to provide water supply services for domestic, industrial and environmental uses. (iii) to provide sewerage services where it may be appointed to do so under the water Act, 1995. (iv) to develop the water and sewerage system in urban centers and big national institutions throughout the Country.
	(5) National Environment Act	It provides tools for environmental management that had not been deployed, including EIAs. The Act imposes a duty on a project developer to have an environmental impact assessment (EIA) conducted before planning a project. EIA should be conducted based on the Act and "The Environment Impact Assessment Regulations, 1998." The provisions of "The National Environment (Standards for the Discharge of Effluent into Water or on Land) Regulations, 1999" require that prescribed standards. be met prior to discharge of any effluent into the environment to ensure sustainable development, similarly, provision is made in "The National Environment (Waste Management) Regulations, 1999" for management of all waste in an environmentally sound manner.
	(6) Land Act, 1998	The Constitution of the Republic of Uganda, 1995 and Land Act, 1998 set out the various land tenure systems in Uganda. Both Government and private owners of land can set up facilities on land they occupy and own. Any location of a water supply project must respect the proprietary rights of the landowner or occupier as protected by the constitution, 1995 and this Act.
Policy	(1) National Environment Management Policy, 1994	The main objective of this policy is the environmental quality management in harmony with the sustainable economic and social development. The policy clearly states that an environmental impact assessment (EIA) should be conducted for any policy on project that is likely to have adverse impacts on the environment.
	(2) National Water Policy, 1999	The policy states guiding principles with respect to domestic water supply, development of water for agricultural production, water for industrial development and the discharge of effluent from industrial areas.
	(3) National Gender Policy, 1999	On the basis of this policy, the level of women participation in decision-making is guaranteed. An organization has been nationally agreed and is respected. With respect to water, the policy. Recognizes women and children as the main carriers and users of water.
	(4) National Health Policy, 1999	The policy treats the main causes and measures of diseases including malaria, HIV/AIDS, TB and diarrhea. This is to be achieved trough the promotion of personal, household, institutional, community sanitation and hygiene.
	(5) The Water Action Plan, 1995	The plan was prepared through assistance by Danida. Improvements to the water resources management framework arising from the action plan include the creation of policy and legal framework comprising a National Water Policy, 1999 and regulations such as the Water Resources Regulations, The water (waste water) Discharge Regulations, National Water Quality Standards, and Water Supply Regulations.

3.2.2 Organizational Framework

The institutional framework for the sector comprises a number of institutions that participate directly in the provision of water and sanitation services at the national, district and community levels as indicated in Figure 3-8, and Figure 3-9 shows organization of MoWE as the main player of the sector.

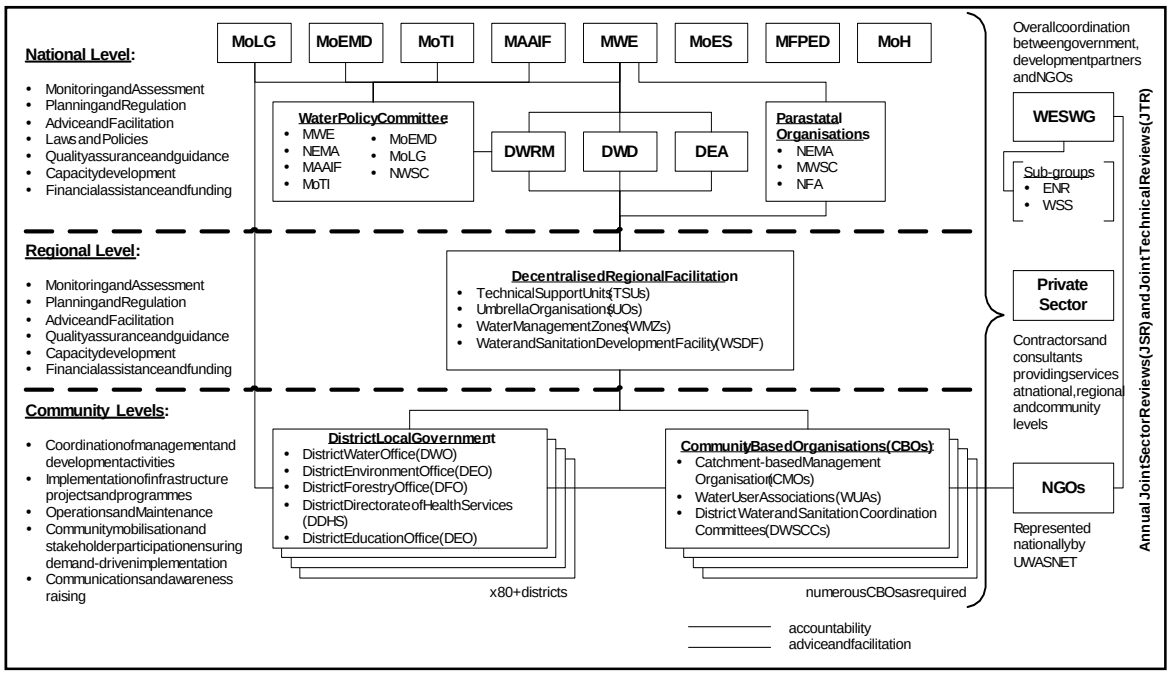


Figure 3-9 Institutional Setting for Water and Environment Sector

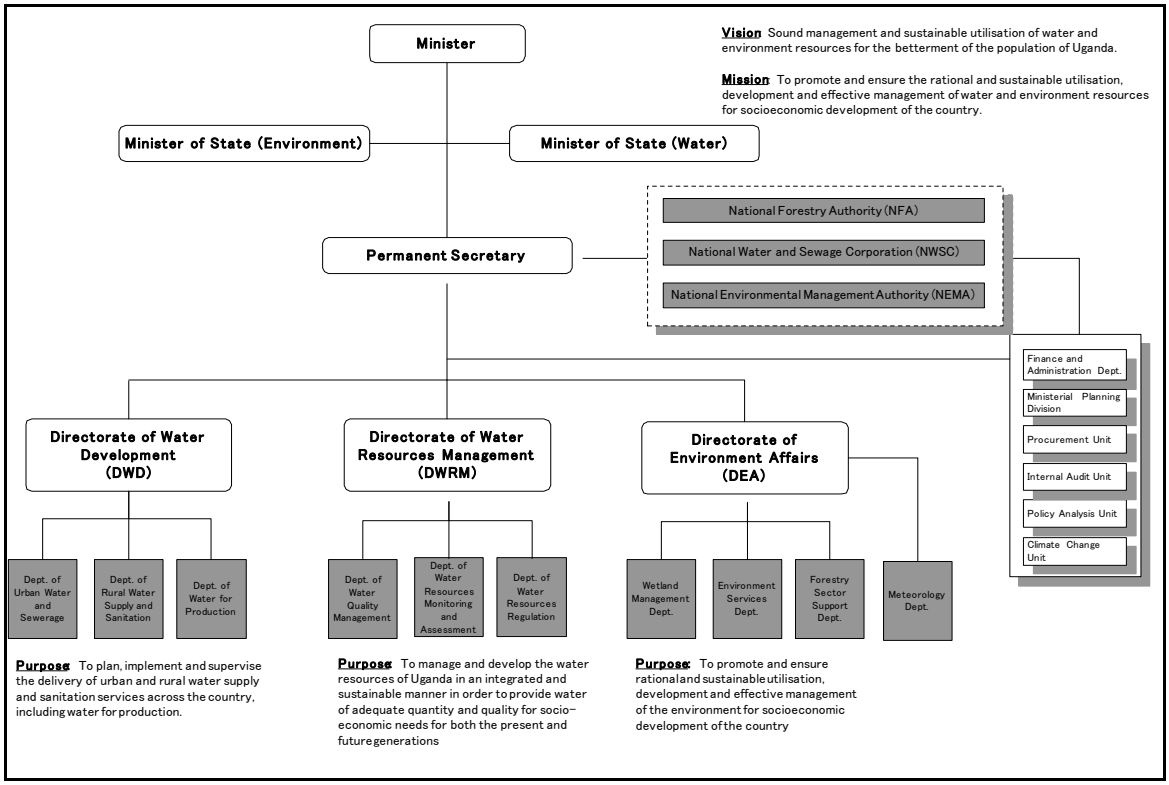


Figure 3-8 Organization of Ministry of Water and Environment

3.3 Present Situation of Water and Sanitation

3.3.1 Water Supply

(1) Drinking Water Supply

In Uganda, the drinking water supply is categorized into the rural and the urban water supplies as follows:

- Urban water supply covers the small towns of which populations are more than 5,000, and large towns such as district capitals.
- Rural water supply covers the villages and towns of which populations are less than 5,000.

1) **Urban Water Supply**

The urban water supply includes all urban areas, namely: town boards, town councils, municipalities and the city of Kampala. It is divided into large urban towns and small towns.

i) Large Towns

Large towns gazetted for operation by National Water and Sewerage Corporation (NWSC) inclusive of 30 other satellite urban areas are supplied by 23 NWSC systems. In the Lake Kyoga Basin, there are the following large-scale piped water supply systems under the operation of NWSC as shown in Table 3-4.

ii) Small towns

As for the systems for small towns, the following systems as shown in Table 3-5 are in operation in the Basin. The private operators contracted by water authority of municipalities, town councils and town boards are responsible to supply water.

Approximately 90 % of the urban water supply takes their water from surface water resources such as rivers, streams and lakes in the Basin.

Table 3-4 Large Scale Water Supply Systems in Lake Kyoga Basin

Area	Water Supplied (m^3/day)	Water Sold (m^3/day)	Total No. of Accounts	Active Accounts (No.)	Inactive Accounts (No.)	Metered Accounts (No.)	Total No. of Kiosks	Length of Water Mains (km)	Length of Sewer Mains (km)	Sewer Connections (No.)
Jinja/Lugazi	4,452	3,349	12,391	10,061	2,330	12,391	17	274.5	0.0	16
Tororo	909	804	3,552	3,226	326	3,533	11	125.9	7.1	16
Mbale	1,221	1,109	6,656	5,704	952	6,656	6	268.6	30.1	36
Soroti	749	499	3,524	2,913	611	3,524	4	108.5	0.0	8
Total	7,331	5,761	26,123	21,904	4,219	26,104	38	778	37	76

Source: Water and Sanitation Sector Performance Report (Sep. 2008)

2) **Rural Water Supply**

The rural water supply covers the rural communities of which population is less than 500 and the rural growth centers (RGCs) having population from 500 to 5,000. The district headquarter of which population is less than 5,000 is to be treated as a small town, and the piped urban water

supply systems are provided for such towns. According to "Long-term Strategy for Investment Planning, Implementation and Operation & Management of Water Supply and Sanitation in Rural Growth Centers, 2005", piped water systems are recommended for the RGCs of which population is more than 1,500, but such pipe systems are simple without treatment facilities.

The RGC generally consists of a core-trading center and a fringe. Most of the RGCs have settlements around the commercial or core zone, which tends to be densely populated.

Table 3-5 Water Supply Systems for Small Towns

District	Small Town	Water Source	Water Supplied (m^3/y)	Water Sold (m^3/y)	Total Connection	Active Connection
Kayunga	Kangulumira	Groundwater	18,618	17,052	288	282
	Kayuhnga	Sezibwa River	37,036	22,164	677	571
Mukono	Nkoikonjeru	Groundwater	13,174	7,387	250	-
Nakasongola	Nakasongola	Lake Kyoga	17,661	15,835	270	236
Budaka	Budaka	Groundwater	16,008	9,625	246	143
Bugiri	Bugiri	Groundwater	26,973	23,829	671	579
Bukedea	Kachumbala	Groundwater	1,304	1,216	81	-
Busia	Busia	Groundwater	187,453	141,711	723	611
Butalejja	Busolwe	Groundwater	17,209	14,681	254	-
Iganga	Busembatya	Groundwater	44,026	39,392	236	225
Jinja	Buwenge	Groundwater	38,560	30,413	653	603
Kaliro	Kaliro	Groundwater	20,573	18,884	345	260
Kamuli	Kamuli	Groundwater	56,484	46,530	936	825
Kapchorwa	Kapchorwa	Tim Tim River	145,521	41,954	425	386
Katakuwi	Katakwe	Groundwater	18,641	16,993	158	146
Kumi	Kumi	Groundwater	19,658	17,684	318	219
	Ngora	Agu River	56,599	33,920	182	139
Manafuwa	Lwakhakha	Sovro River	20,336	14,154	338	306
Palisa	Pallisa	Lake Lemwa	25,596	17,235	522	-
Sironko	Budadiri	Gibala River	38,238	13,094	507	414
	Sironko	Sironko River	5,909	5,615	424	394
Soroti	Serere	Groundwater	7,457	4,876	58	55
Dokolo	Dokolo	Groundwater	22,937	17,949	81	-
Kotido	Kotido	Groundwater	33,857	27,044	126	94
Total			889,828	600,237	8,769	-
Sub-total for Groundwater:			346,896			
Sub-total for Surface Water:			542,932			

Source: Water and Sanitation Sector Performance Report (Sep. 2008)

The RGCs are centers in rapid transition from villages to small towns. The social settings and decision-making systems in the rural areas are breaking up, and new and more urban structures are created. The population in the RGCs is more complex and less stable than in the rural hinterland, which makes the RGCs more subject to rapid and major changes.

i) Water Sources for Drinking Water Supply

The types of water sources i.e. spring, groundwater, surface water and rainwater as presented in Table 3-7 are considered for rural water supply in the country. Spring, groundwater, surface streams and rain water are utilized for drinking water supply in Uganda. Most of the water supply system of NWSC takes surface water such as Lake Victoria, etc. and such systems have a system consisting of coagulation, sedimentation, rapid filtering and chlorination. In the rural areas, point water sources are widely applied of which utilizing springs and groundwater with shallow and deep wells and such facilities are managed by the respective communities. The communities of centers of trading and commerce of which population are rather dense are provided with the pipe water schemes consisting of reservoirs, kiosks and simple distribution pipelines. It is recommended by the government to apply the piped water schemes for such RGCs population of which are 1,500 - 5,000 to realize effective water supply as well as to improve the coverage of water supply. Table 3-6 shows the ratio of water sources for each district.

Table 3-7 Definition of Main Improved Water Supplies

Type of Water Source	Facility	Definition
(1) Spring	Small Spring	Construction of collection box with one spout delivery (1 - 2 liter/s)
	Medium Spring	Construction of collection box with two spouts delivery (2 - 4 liter/s)
	Extra large Spring	Construction of collection box with three spouts delivery (> 4 liter/s)
	Piped Water Supply System (Gravity Flow Scheme)	Protection of the spring, construction of treatment plant, laying of pipes and construction of taps
(2) Groundwater	Shallow Well - Hand Dug	Construction of max 15m depth at 1 - 2 m diameter using hand tools in high water table area, installed with hand pump.
	Shallow Well - Hand Augured	Construction of max 15m depth at 200 mm diameter using a tripod and winch with drill bits and rods in high water table area, installed with hand pump.
	Shallow Well - Motorised Drilled	Construction of max 30m depth at 200 mm diameter using drilling rig in high water table area, installed with hand pump. Can be consolidated or unconsolidated formation.
	Deep Boreholes Drilling (Hand Pump)	Drilling more than 30m depth, abstraction is by a hand pump. Can be consolidated or unconsolidated formation.
	Deep Borehole Drilling (Motorised Pump)	Drilling more than 30m depth, abstraction is by powered motorisation (usually a submersible pump).
	Piped Water Supply System (Borehole Pumped)	Siting and drilling of borehole, laying of pipes and construction of taps
(3) Surface Water	Valley Tanks	Construction of tank with a volume of (maximum of 3,000 m^3)
	Dams	Construction dam
	Piped Water Supply System (Surface Water)	Construction of treatment plant, laying of pipes and construction of taps
(4) Rainwater	Domestic Roof Water Harvesting	Collection of rainwater from household rooftops and storage at the home.

Source: District Implementation Manual March 2007

Table 3-6 Ratio of Water Sources for Each District

(Unit: %)

Districts	Spring	Deep Groundwater	Shallow Grolundwater	Spring/Stream Water	Other Sources Rainwater etc.	Districts	Spring	Deep Groundwater	Shallow Grolundwater	Spring/Stream Water	Other Sources Rainwater etc.
Kayunga	3	68	28	0	0	Katakwi	0	87	12	0	1
Luwero	1	52	44	0	3	Kumi	12	53	28	0	7
Mukono	38	22	18	20	2	Manafwa	21	12	0	65	1
Nakasongola	0	77	9	0	14	Mayuge	14	47	20	20	0
Wakiso	23	29	46	2	1	Mbale	9	11	1	79	0
Amuria	2	86	11	0	1	Namtumba	5	47	45	0	3
Budaka	8	91	1	0	0	Pallisa	9	74	16	0	0
Bududa	25	1	0	74	0	Sironko	11	2	1	85	0
Bugiri	21	48	22	0	9	Soroti	8	66	21	0	5
Bukedea	14	11	14	57	5	Tororo	15	81	3	0	0
Bukewa	8	0	0	91	1	Abim	0	90	10	0	0
Busia	25	62	8	0	5	Amolatar	0	100	0	0	0
Butaleja	1	35	3	61	1	Apac	17	51	20	0	12
Iganga	3	71	24	0	2	Dokolo	15	23	25	36	1
Jinja	27	34	40	0	0	Kaabong	0	85	11	0	4
Kareramaido	7	69	18	0	7	Kotido	0	98	0	0	2
Kaliro	0	96	4	0	0	Lira	19	20	17	43	0
Kamuli	0	71	29	0	0	Moroto	0	55	0	45	0
Kapchorwa	23	1	0	75	1	Nakapiripirit	2	77	5	8	8
Numbers of the districts where the respective water source is the most predominant:							**1**	**25**	**2**	**10**	**0**

ii) Coverage and Equity of Access to Safe Water

The present coverage rate of water supply in the related 38 districts to the Basin is shown in Table 3 8. The ratio of urban and rural water supply is high in the central region (uraban: 69%, rural:63%) and low in the northern region (urban: 51%, rural:44%).

In the case of rural water supply, the increased coverage rate of safe water supply to rural communities is directly affected by the distribution of the water points. Equity is concerned with fair distribution of improved water facilities to communities. An indicator of equity in access to safe water is defined as the mean sub-county deviation form the district average in persons per water point as shown in Figure 3-10. In the Basin, the indicator values of the Bugiri and the Kaabong districts are found to be very high in comparison with other districts.

Table 3-8 Population Served and Coverage of District

No.	Region	District	Urban Water Supply					Rural Water Supply		
			Town	Category	Targeted Population	Coverage Population	Coverage Rate (%)	Targeted Population	Coverage Population	Coverage Rate (%)
1	Central	Kayunga	Kayunga	Small Town	22,700	22,440	99	306,541	185,706	61
2		Luweero	Luweero	Small Town	28,000	26,600	95	329,683	243,927	74
			Bombo	Small Town	19,900	14,082	71			
			Woblenzi	Small Town	22,400	12,672	57			
			Kikyusa	Town Board	2,679	900	34			
			Busula	Town Board	6,750	2,700	40			
			Zirobwe	Town Board	2,069	1,200	58			
			Bamunanika	Town Board	3,203	600	19			
			Ndejje	Town Board	6,482	1,500	23			
3		Mukuno	Nkonkonjeru	Small Town	13,300	10,872	82	764,775	585,622	77
			Katosi	Town Board	8,856	450	5			
			Buikwe	Town Board	12,969	3,150	24			
			Nakifuma	Town Board	6,256	2,682	43			
			Kasawo	Town Board	7,430	3,900	52			
4		Nakasongola	Nakasongola	Small Town	7,500	7,125	95	135,259	94,771	70
			Migyeera	Town Board	3,735	3,522	94			
5		Wakiso	Wakiso	Small Town	19,400	17,256	89	1,061,167	524,169	49
			Kakiri	Small Town	5,600	5,320	95			
Sub-total/Average			-	-	199,229	136,971	**69**	2,597,425	1,634,195	**63**
6	Eastern	Amuria	Amuria	Small Town	4,600	900	20	257,129	214,442	83
7		Budaka	Budaka	Small Town	20,400	8,184	40	164,062	96,464	59
8		Bududa	Bududa	Small Town	3,800	2,280	60	147,123	113,082	77
9		Bugiri	Bugiri	Small Town	23,500	21,864	93	518,023	173,606	34
			Nankoma	Town Board	6,435	1,344	21			
10		Bukedea	Bukedea	Small Town	33,500	2,418	7	156,775	127,250	81
			Katumbala	Town Board	3,136	3,004	95			
11		Bukwa	Bukwa	Small Town	4,400	1,068	24	62,324	34,342	55
12		Busia	Busia	Small Town	44,300	23,679	53	220,016	152,617	69
13		Butaleja	Butaleja	Small Town	7,900	1,200	15	183,939	110,298	60
			Busolwe	Small Town	7,900	5,988	76			
14		Iganga	Busenbatia	Small Town	14,600	8,023	55	602,843	350,917	58
			Namungalwe	Town Board	7,048	450	6			
			Idudi	Town Board	8,169	600	7			
			Kiyunga	Town Board	7,249	750	10			
15		Jinja	Jinja	Large Town	260,600	199,883	77	348,571	236,027	68
			Buwenge	Small Town	17,200	15,689	91			
16		Kaliro	Kaliro	Small Town	12,700	9,468	75	185,912	106,500	57
			Nakaikoke	Town Board	4,644	450	10			
			Namwiwa	Town Board	3,635	900	25			
			Bulumba	Town Board	4,128	450	11			
17		Kapchorwa	Kapchorwa	Small Town	11,700	11,115	95	168,938	110,259	65
18		Kamuli	Kamuli	Small Town	14,200	13,490	95	650,676	367,100	56
			Kasambira	Town Board	8,962	2,160	24			
19		Kaberamaido	Kaberamaido	-	-	-	-	163,677	149,916	92
20		Kumi	Kumi	Small Town	11,900	11,496	97	330,913	174,900	53
			Ngora	Town Board	31,419	5,094	16			
21		Katawaki	Katawaki	Small Town	7,700	7,128	93	161,423	114,421	
22		Mayuge	Mayuge	Small Town	11,100	1,950	18	379,788	144,850	38
23		Mbale	Mbale	Large Town	86,200	61,542	71	312,454	161,400	52
24		Manafwa	Manafwa	Small Town	14,800	3,180	21	313,799	128,669	41
			Lwakhakha	Small Town	10,000	9,500	95			
			Tsakhana	Town Board	3,116	300	10			
			Buwangani	Town Board	2,578	300	12			
			Bugobero	Town Board	3,259	450	14			
			Magale	Town Board	6,382	900	14			
			Bukhaweka	Town Board	2,066	300	15			
			Masaaka	Town Board	1,031	300	29			
			Butiru	Town Board	3,112	1,200	39			
			Bumbo	Town Board	6,042	1,050	17			
25		Namutumba	Namutumba	Small Town	10,000	2,658	27	201,567	161,562	80
26		Pallisa	Pallisa	Small Town	30,000	14,652	49	433,264	222,800	51
			Kibuku	Town Board	6,219	1,500	24			
			Tirinyi	Town Board	6,586	2,100	32			
			Kabwangasi	Town Board	2,500	450	18			
27		Soroti	Soroti	Large Town	62,400	28,915	46	433,264	222,800	51
			Serere	Town Board	3,784	2,442	65			
28		Sironko	Sironko	Small Town	13,300	12,635	95	313,933	221,838	71
			Buyaga	Town Board	3,077	750	24			
			Muyembe	Town Board	5,577	2,676	48			
			Budadiri	Town Board	16,396	14,220	87			
			Bulegeni	Town Board	1,025	1,002	98			
29		Tororo	Tororo	Large Town	50,300	37,775	75	402,463	249,374	62
			Nagongera	Small Town	11,200	8,484	76			
			Merikit	Town Board	2,056	-	-			
			Magodesi/Molo	Town Board	1,643	600	37			
Sub-total/Average			-	-	961,474	570,906	**59**	7,119,492	4,269,296	**60**
30	Northern	Amolator	Amolator	Small Town	14,000	1,836	13	116,958	60,300	52
31		Abim	Abim	Small Town	15,700	750	5	91,646	29,000	32
32		Apac	Apac	Small Town	12,900	750	6	495,826	293,060	59
			Aduku	Town Board	10,746	7,086	66			
33		Dokolo	Dokolo	Small Town	16,702	6,708	40	157,322	129,841	83
34		Kotido	Kotido	Small Town	20,300	7,302	36	243,319	70,503	29
35		Lira	Lira	Large Town	102,200	81,229	79	528,666	324,000	61
36		Moroto	Moroto	Small Town	11,000	10,450	95	254,825	129,200	51
			Matany	Town Board	7,662	1,050	14			
			Kangole	Town Board	10,182	2,700	27			
37		Nakapiripirit	Nakapiripirit	Small Town	2,400	1,140	48	214,591	89,647	42
38		Kaabong	Kaabong	Small Town	20,900	2,700	13	610,382	70,824	12
Sub-total/Average			-	-	244,692	123,701	**51**	2,713,535	1,196,375	**44**
Total/Average			-	-	1,405,395	831,578	**59**	12,430,452	7,099,866	**57**

Source:Water and Environment Sector Performance Report 2009

iii) Functionality

The functionality defined as the ratio in % of functional facilities to the whole number of facilities is also calculated in the table for each district. The functionalities of deep and shallow wells are calculated to be 85 % and 82 %, respectively, for the entire basin, varying from 61 % to 98 % for deep wells and from 33 % to 100 % for shallow wells in each district. .

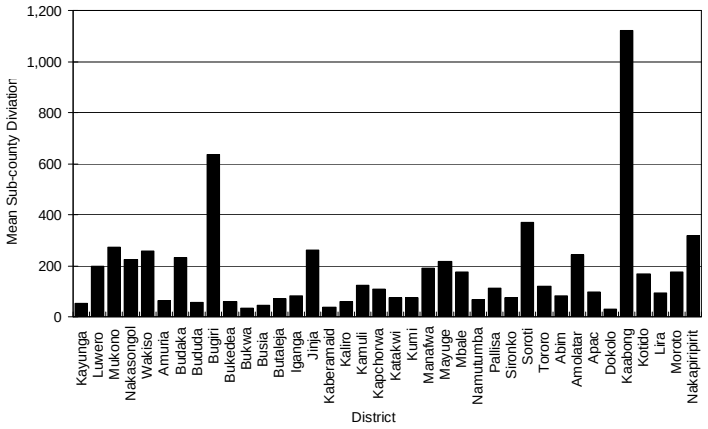


Figure 3-10 Equity of Access to Safe Water for Each District

In Uganda, the functionality is considered as one of the important factor to indicate the extent of mobilization ofcommunity, the decrease of the functionality is considered as one of the issue in the rural water supply sub-sector providing the high priority of budget allocation to the rehabilitation of such non-functional facilities.

(2) **Water for Production**

1) **Irrigation Water Supply**

Since the total areas of related 38 districts to the Basin are approximately 100,000km^2, their total cultivated lands including commercial farmlands which amount for 50,006 km^2 is almost half of them. Most of crops are grown under rainfed cultivation. Paddy cultivation is recently appreciated as one of the cash crops, and its cultivated lands are increasing mainly in low-laying wet lands. Irrigation of such paddy lands is also made by the farmers for supplemental purpose, and the irrigated water volume is considered quite less. Most of the schemes are small except for Kibimba Rice Scheme, Doho Rice Scheme and Lwoba Rice Scheme

Table 3-9 Irrigation Water Requirements for Doho and Lwoba Schemes

Month	Water Req. (m^3/s)	
	Doho	Lwoba
January	2.08	0.88
February	1.25	0.52
March	0.00	0.00
April	2.44	1.02
May	0.73	0.31
June	1.39	0.59
July	1.33	0.56
August	0.66	0.28
September	0.00	0.00
October	2.61	1.09
November	1.75	0.73
December	1.81	0.76
計	16.05	6.74
	506.2 mcm/y	212.6 mcm/y

(mcm/y:Million Cube Meter/year)

The command areas of the Doho and the Lwoba schemes extend along the same Manafwa river, and both schemes are in conflict each other of the use of river water especially during the dry season from January to April when the water flow of the Manafwa river decreases. This river is one of the water sources of the NWSC water supply system for Mbale town. Its use for town water supply and at least 1.2 m^3/s of the maintenance flow for downstream ecological

requirements has to be assured. It is proposed to construct a storage facility of 7,000,000m^3 capacity to realize the irrigation for both schemes throughout a year. The irrigation water requirements of both schemes are summarized in Table 3-9 Irrigation Water Requirements for Doho and Lwoba Schemes.

2) **Livestock**

In the Lake Kyoga Basin, the livestock animals shown in Table 3-10 are fed, and indigenous (local) cattle, goats and sheep are considered as the predominant animals. The districts are categorized into Cattle Corridor (CC) and non-CC districts according to the economic importance of livestock in the districts. In CC districts the livestock water facilities are considered important to feed their animals especially in the dry season.

Table 3-10 Number of Livestock

District	Exotic Crossbreed Cattle (no.)	Indigenous Cattle (no.)	Goats (no.)	Sheep (no.)	Pigs (no.)	Poultry (no.)
Abim	5,205	247,088	209,825	202,088	2,869	108,504
Amolatar	664	27,427	63,202	6,362	2,616	159,785
Amuria	255	40,121	52,988	14,072	7,281	132,179
Apac	885	36,570	84,269	8,482	3,488	213,046
Budaka	704	24,408	25,739	3,290	1,891	104,690
Bududa	3,304	23,731	21,391	1,548	4,973	142,943
Bugiri	662	14,751	23,771	1,486	1,637	113,834
Bukedea	525	68,691	66,506	6,344	14,486	185,238
Bukwa	2,035	12,439	9,737	991	638	36,920
Busia	2,031	31,659	22,993	1,408	2,637	67,134
Butaleja	485	34,709	29,440	3,860	5,370	164,591
Dokolo	1,250	31,582	67,045	6,430	3,454	159,932
Iganga	1,817	36,686	36,849	1,924	4,059	213,025
Jinja	6,730	15,458	27,339	762	5,678	247,353
Kaabong	5,205	247,088	209,825	202,088	2,869	108,504
Kaberamaido	498	23,864	47,734	12,595	6,911	102,186
Kaliro	1,817	36,686	36,849	1,924	4,059	213,025
Kampala	27,558	20,864	10,293	1,561	4,761	390,771
Kamuli	7,959	204,036	166,048	6,005	19,122	807,883
Kapchorwa	4,747	29,023	22,721	2,313	1,488	86,148
Katakwi	255	40,121	52,988	14,072	7,281	132,179
Kayunga	4,405	46,755	30,861	2,729	6,779	120,624
Kotido	6,940	329,451	279,767	269,451	3,825	144,672
Kumi	525	68,691	66,506	6,344	14,486	185,238
Lira	2,916	73,690	156,438	15,004	8,060	373,175
Luweero	11,731	195,039	31,125	7,215	18,374	199,972
Manafwa	3,304	23,731	21,391	1,548	4,973	142,943
Mayuge	2,730	15,155	25,466	899	1,508	106,628
Mbale	4,405	31,641	28,522	2,064	6,630	190,591
Moroto	13,326	289,337	190,374	211,886	1,494	33,543
Mukono	18,947	53,666	59,598	6,553	31,473	516,314
Nakapipirit	2,817	326,468	178,473	108,421	978	56,289
Nakasongola	12,818	179,684	34,604	4,601	9,472	134,969
Namutumba	662	14,751	23,771	1,486	1,637	113,834
Pallisa	939	32,544	34,319	4,387	2,522	139,586
Sironko	8,154	42,295	30,625	3,932	6,381	205,561
Soroti	1,545	87,087	114,299	17,241	13,170	262,800
Tororo	1,133	80,987	68,692	9,008	12,530	384,046
Wakiso	41,535	32,679	26,320	4,887	41,282	721,122
Sub-total	213,423	3,170,653	2,688,703	1,177,261	293,142	7,921,777
Sub-total of TLU	213,423	2,219,457	403,305	176,589	117,257	47,531
Total TLU			3,177,562			

Note: The shaded districts are those considered as Cattle Corridor. Source: DWD

According to "Design Standards for Rural Water Supply System" (EWRA: Ethiopian Water Resources Authority (1976), livestock needs 20 to 30 l/ TLU/day. TLU: Tropical Livestock Units are considered to estimate the carrying capacity (the number of cattle to be fed in the available lands). One (1) TLU is equivalent to one (1) exotic crossbreed cattle, 0.7 indigenous cattle, 0.15 goats or sheep, or 0.4 pigs in Uganda. When a unit water demand per one TLU is 25 l, total present water demand of livestock becomes 29.0 MCM/year.

There are many small earth dams and valley tanks mainly for livestock and domestic use in the Basin. At present, most of existing facilities have largely decreased their original capacities by silting, and some of small earth dams has not been functioned by silting or dike break. They have not only water supply function but also flood control function.

Table 3-11 Fish Pond and Production

Sub-basin	Area of Ponds (m^2)	Talapia (t)	Catfish (t)	Carp (t)	Nile Perch (t)	Prawns (t)	Total (t)
(1) Okok	16,704	10.9	14.3	0	0	0	25.1
(2) Okere	65,490	20.1	30.2	0.2	0	0	50.5
(3) Awoja	160,488	72.9	118.3	7.3	0	0	198.5
(4) Lwere	51,271	27.9	59.1	1.4	0	0	88.3
(5) Akweng	161,651	67.6	81.9	2.8	0	0	152.3
(6) Abalan	111,833	124.5	158.5	0.8	0	0	283.8
(7) Kyoga	234,447	92.1	144.9	0.5	0	0	237.6
(8) Mpologoma	576,500	408.5	599.3	9.9	0	0	1,017.70
(9) Lumbuye	96,784	75.7	101.6	0	0	0.1	177.4
(10) Victoria Nile	475,840	202.3	287.4	0.6	0	1.3	491.6
(11) Sezibwa	529,515	238.3	317.7	1.5	0.4	0	557.9
Total	2,480,523	1,340.90	1,913.20	25.1	0.5	1.4	3,281.00

Source: SIP

3) **Fishery**

The fishery is also considered one of the important activities requiring the water resources in the basin. As shown in the Table 3-11, there are many fish ponds of which total surface area is measured to be 2,480,523m2. Main fish products are catfish, carp, Nile parch and prawns and total production of such fishes is calculated to be 3,281 ton in the Basin.

4) **Industrial Water Supply**

The extraction of water either groundwater or surface water has to be implemented subject to the permission by the DWRM. Industrial water in the Basin based on SIP. is estimated to approximately 3.8 MCM/yer (2008).

3.3.2 Sanitation

(1) **Sanitation in Urban Areas**

Table 3-12 Present Situation of Sewerage System in Urban Areas

Name	Coverage (%)	Capacity of Treatment Plant (m3/day)	Capacity Utilization (%)
Jinja	6	16,000	10
Lira	2	900	27
Mbale	7	4.6	23
Soroti	4	3,000	8
Tororo	5	2,000	19

Sourdce:NWSC

The coverage of urban sewerage system in the urban areas controlled by NWSC is quite low as shown in Table 3-12. The present capacity of treatment facility is enough, but the collection network is provided only in the core areas of town resulting in low utilization of the capacity. Peoples who do not connect to collection networks still uses the ordinary toilet as same as in the rural areas. It is necessary to provide the collection networks to increase the connection. In the small towns, there is no such urban sewerage system provided, since they have to concentrate the expansion of water supply system at present, and the people in the small town uses the ordinary toilet.

(2) **Sanitation in Rural Areas**

Table 3-13 Latrine Coverage of Districts (2008)

District	Latrine Coverage (%)	District	Latrine Coverage (%)	District	Latrine Coverage (%)
Northern		Eastern		Manafuwa	62
Amolatar	49	Budaka	60	Mayuga	68
Apac	53	Bugiri	65	Mbale	65
Dokolo	49	Bukuwa	60	Namutunba	52
Lira	52	Bukudea	60	Pallisa	60
North-Eastern		Bududa	59	Sironko	57
Abim	2	Busia	82	Soroti	68
Amuria	24	Butaleja	89	Tororo	82
Kaabongo	2	Iganga	65	Central	
Katakwi	55	Jinja	71	Kayunga	59
Kotido	2	Kaberamaido	52	Luwero	73
Moroto	10	Kaliro	86	Mukono	81
Nakapiripirit	3	Kamuli	74	Nakasongola	71
		Kapchorwa	58	Wakiso	73
		Kumi	56		

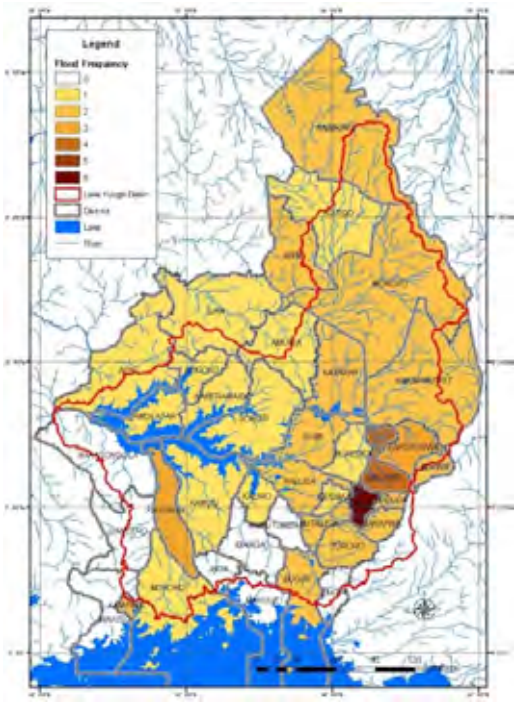
Source: Water and Sanitation Sector Performance Report September 2008

Most districts started a campaign to enforce the Public Health Act with emphasis on construction of latrines. As a result, the national latrine coverage reached to 62.4 % in 2008, and in the Basin 55.5 %. The coverage of household latrines is rather higher in the districts of the Eastern and the Central regions, and the coverage of some districts such as the Abim, Kaabong, Kotido and Nakapiripirit is as low as two (2) % as shown in Table 3 13.

3.4 Flood, Sediment Disaster and Drought

Figure 3-11, 12 and 13 show frequency of water related disasters: flood, sediments disaster and

drought in the Bain based on EM-DAT (Emergency Events Database). Since 2007 flood affected extremely wide area, most of districts in Lake Kyoga Basin have experienced flood damage. Highly frequent affected areas by flood are the north-eastern area of the Basin and surrounding area of Mt. Elgon. Droughts have occurred in Karamoja region in northern part of the Basin.

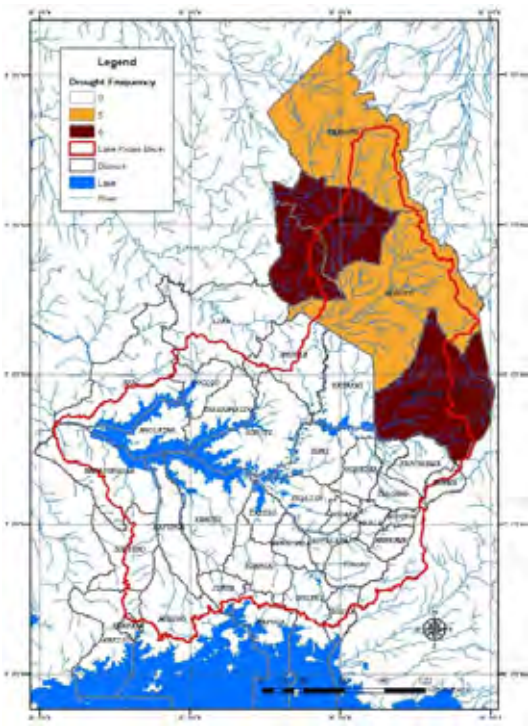


Source: EM-DAT

Figure 3-11 Flood Frequency

Source: EM-DAT

Figure 3-12 Sediments Disaster Frequency



Source: EM-DAT

Figure 3-13 Drought Frequency

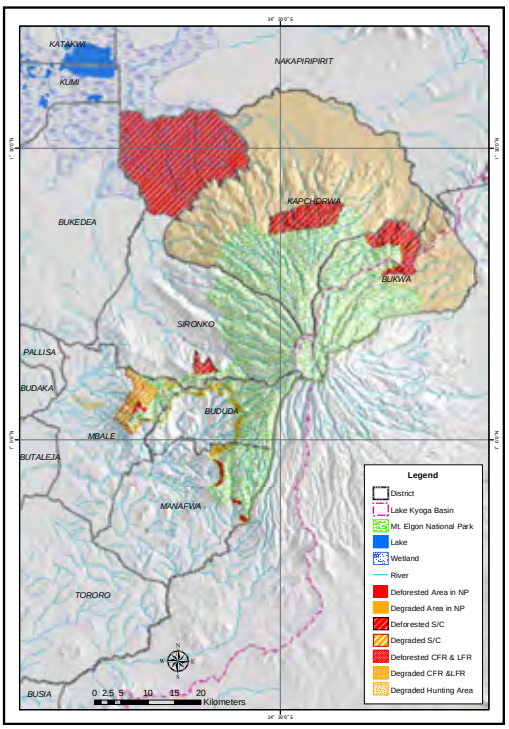


Figure 3-14 Heavily Deforested & Forest Degraded Area in and around Mt. Elgon

Droughts have frequently occurred four times in recent ten years and affected hundreds of thousands of people. Landslide has been recorded only in Mbale district.

3.4.1 Present Condition on Deforestation and Forest Degradation

The present condition on deforestation and forest degradation, which is one of the main triggers against flood and sediments disaster in and around Mt. Elgon area are presented in Figure 3-13

The persons in charge of DEOs have the same opinion about major factor of expansion of deforestation and forest degradation, and that opinion is "Deforestation is conducted and expanded for production of firewood and cultivation due to human activities to be expanded and needed by rapid population increase." It clearly shows that forest was logged and cultivated even in such mountainous area. Such cultivated slopes were observed in every mountainous area around Mt. Elgon.

3.4.2 Present Condition on Flood and Sediment Disaster

The survey results of the present conditions on sediment disaster and flood in and around Mt. Elgon are presented in Figure 3-15. It reveals that past disaster occurrence area and disaster prone area of sediment disasters spread in mountainous area around National Park, and flood prone area locates at downstream of sediment disasters prone area.

(1) **Flood Disaster**

Flood damage in the survey area is mainly caused by inundated type of flood in middle and downstream part since disasters of mountainous area are recognized as sediment disasters. It is frequently heard that flood is caused by riverbed rising due to sediment deposition produced in high volume in the upstream area, but quantitative data cannot be acquired.

Although condition in flood could not be observed, it is considered that sediment transportation as bed load is not much since alluvial cone is hardly seen in the survey area. Therefore, it is difficult to consider that riverbed rising which may cause flood has occurred due to sediment deposition. In the survey area, mountainous land features quickly change to plain field with very gentle slope, therefore, it may be considered that the root cause of flood is an increase of runoff ratio due to deterioration of upstream area if flood frequency becomes higher in recent years.

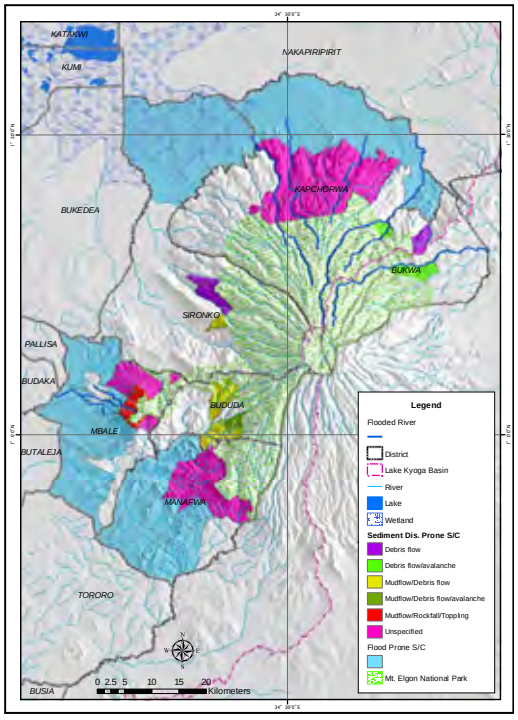


Figure 3-15 Flood and Sediments Disaster Prone Area in and around Mt. Elgon

(2) **Sediment Disaster**

Sediments disaster does not caused by flash flood but mud flow or debris flow. This seems to be strongly related to the topographical and geological conditions of Mt. Elgon. Although sediment disasters have frequently occurred, there are not so many disasters cause heavy damage until now. However, heavy damage can be occurred in the case that a disaster happens in densely-populated area, for example, about 350 persons were dead or missing by sediment disaster in Bududa district in March 2010. This implies that a potential of such disaster occurrence in the area becomes high.

3.5 Environmental and Social Considerations

In 1995, Uganda enacted "National Environment Statue" calling for Environmental Impact Assessment (EIA) for all development activities likely to negatively impact on the environment before they are implemented. National Environment Management Authority (NEMA) has been created and dated to operation and implement this request. Table 3-14 lists up related statutes, regulations and guidelines on EIA and water resources. EIA framework is shown in Figure 3-16.

During 1996 to 2003, over 950 projects have been subjected to EIA, out of which no less than 800 have been approved for implementation, while up-to 20 have not been approved. Like this, EIA system in Uganda seems to be established itself.

Table 3-14 Statue, Regulation and Guideline on EIA and Water Resources

Statute	Constitution of the Republic of Uganda, 1995
	The National Environmental Statute, 1995
	The Water Statute, 1995
Statutory Instrument Regulations	The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, 1999
	The Environmental Impact Assessment Regulations, 1998
	The National Environment (Waste Management) Regulations, 1998
	The National Environment (Waste Discharge) Regulations, 1998
	The Sewerage Regulations, 1999
	The Water Supply Regulations, 1999
	The National Environment (Designation of Environmental Inspector) Notice, 2001
	The National Environment (Conduct and Certification of Environment Practitioners) Regulation, 2003
Guideline Guideline Note	Guideline for Environmental Impact Assessment in Uganda, 1997
	Environmental Standards and Preliminary Environmental Impact Assessment for Water Quality and Discharge of Effluent into Water and Land in Uganda
	Operational Guidelines for Environmental Inspectors, 1999
	Environmental Audit Guidelines for Uganda,1999
	Environmental Inspection Report (Form)

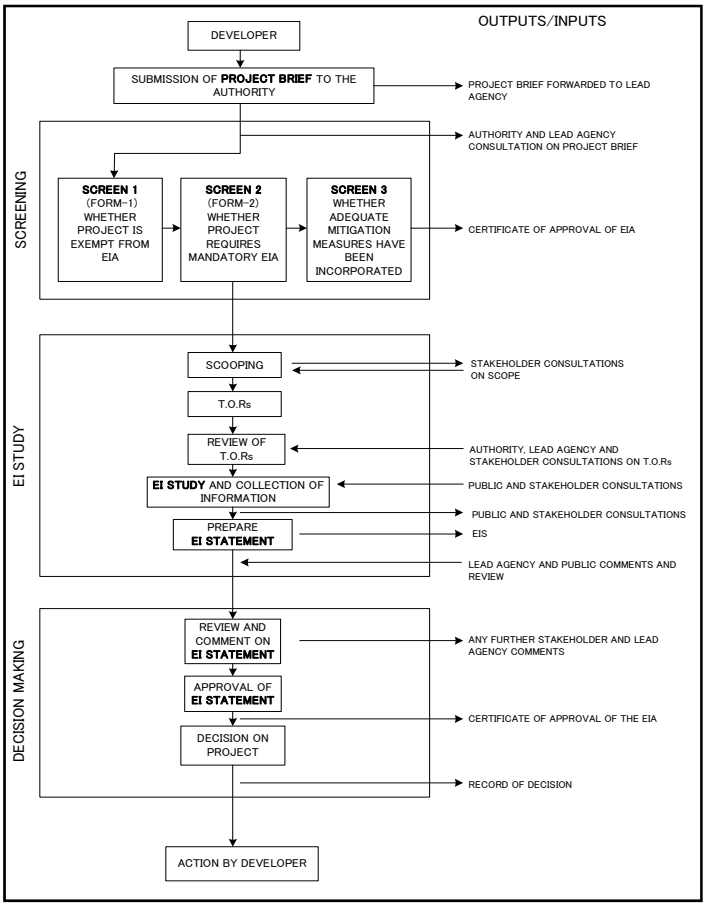


Figure 3-16 EIA Process Flow in Uganda

Chapter 4
Water Resources Potential Evaluation

CHAPTER 4 WATER RESOURCES POTENTIAL EVALUATION

4.1 Estimation of Infiltration (Groundwater Recharge)

Based on the estimated precipitation, evapotranspiration and runoff ratio in this study, the infiltration reflecting the groundwater recharge volume can be estimate by the following equation.

$$I_{est} = P_{est} - AET_{mak} - P_{est} \times R_{ratio}$$

I_{est} (mm): amount of infiltration

P_{est} (mm): precipitation

AET_{mak} (mm): evapotranspiration value

R_{ratio}: runoff ratio from the runoff index.

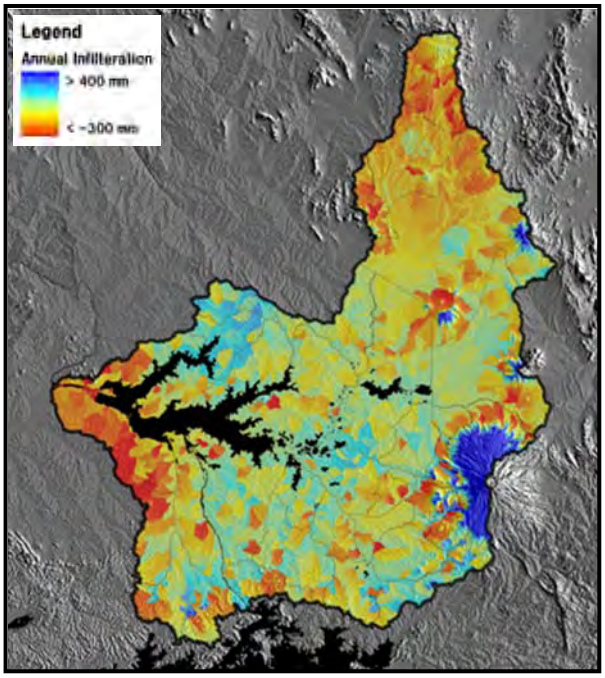


Figure 4-1 Estimated Annual Infiltration

Distribution of the annual infiltration in the Basin on a grid basis is shown in Figure 4-1. High values were generally obtained for mountainous area in the eastern part, because precipitation is higher in the high altitude area than in the plain area. The infiltration of plain area with low precipitation, especially the northern part and the outlet area of the Lake Kyoga are very low. As for the central plain in the basin, the infiltration varies a great deal depending on its surface conditions.

4.2 Potential Evaluation of Surface Water Resources

Simulation was carried out using the simulation software: Mike Basin to estimate surface water resources in each sub-basin in two steps as follows

Building up simulation model

- Data preparation (rainfall, evapotranspiration, river discharge and water usage.
- To setup catchment parameter (rainfall, evapotranspiration, run-off ratio and so on)
- Calibration (adjusts run-off analysis and observed river discharge)
- To simulate an initial condition of water resources during 1950 to 1979

Simulating future conditions in a specific drought year under future water demand

- To prepare the future water demand in 2035
- To prepare drought rainfall
- To simulate surface water conditions in future drought year
- To evaluate future condition of water resources

4.3 Simulation Results of Runoff

Simulation for grasping basic runoff characteristic of each sub-basin under future water demand in 2035 was carried out by the formulated simulation model. It made clear the low water and drought water discharges of each sub-basin, which are calculated as basic runoff characteristic of them and surface water potential.

Simulation was conducted in the following conditions aiming at contributing to water allocation investigation by grasping monthly tendency of entire Lake Kyoga Basin on future water demand and confirming utilization manner of this simulation model.

- Simulation period: One year (From January to December)
- Water demand: Future water demand in 2035
- Rainfall condition: Rainfall time series in 1/10 drought year

Simulation results are shown in Table 4-1and Figure 4-2. The negative values in the table and figure mean that monthly runoff amount is not enough against water demand even if water is properly allocated within a sub-basin. From the simulation result, the following characteristics of Lake Kyoga Basin can be pointed out although the simulation was conducted under regulated conditions.

- In the case of drought year with 10 year return period under future water demand in 2035, water deficit occurs in almost all sub-catchments.
- Sub-basins where water deficit frequently occur are Okok, Okere, Lwere, Kyoga Lakeside Zone and Mpologoma. Especially, Okok and Okere sub-basin are severer.
- The seasons when water deficit frequently occurs are January to April and November to December.

Table 4-1 Water Resources of each Sub-basin in 1/10 Drought Year

Unit: million m^3 per month

Sub-basin Name / Month	(1) Okok	(2) Okere	(3) Awoja	(4) Lwere	(5) Akweng	(6) Abalang	(7) Kyoga Lakeside Zone	(8) Mpologoma	(9) Lumbuye	(10) Victoria Nile	(11) Sezibwa
January	-2.17	-2.75	3.43	0.10	5.87	8.70	-1.54	0.11	2.47	13.30	0.82
February	-1.93	-2.67	-0.43	-1.42	1.72	2.39	-3.23	-3.52	0.09	2.41	-0.27
March	-0.93	-2.47	4.40	-0.17	3.10	8.79	-3.83	-4.20	-0.40	-0.35	0.97
April	2.07	-0.21	13.02	10.31	17.51	34.38	6.69	49.71	8.07	35.10	21.31
May	8.74	4.48	31.46	8.32	22.20	26.13	3.38	49.63	6.21	20.48	12.32
June	2.82	1.57	49.92	13.96	20.03	26.60	-1.23	52.24	2.06	18.16	10.52
July	10.90	27.19	128.61	33.51	41.72	48.05	19.51	90.62	7.23	27.66	14.99
August	4.95	10.72	61.74	11.87	22.49	24.28	15.99	43.75	2.46	7.60	7.51
September	4.44	2.23	75.74	13.92	38.61	30.27	26.06	44.57	5.34	10.20	10.32
October	4.55	0.08	37.27	4.48	43.62	47.34	11.89	26.04	2.77	2.25	4.16
November	-0.20	-1.42	15.85	-0.17	13.62	16.43	2.71	11.27	1.14	0.04	1.66
December	-1.61	-2.42	4.03	-1.57	3.35	2.82	-3.07	-2.96	-0.20	-1.78	-0.47

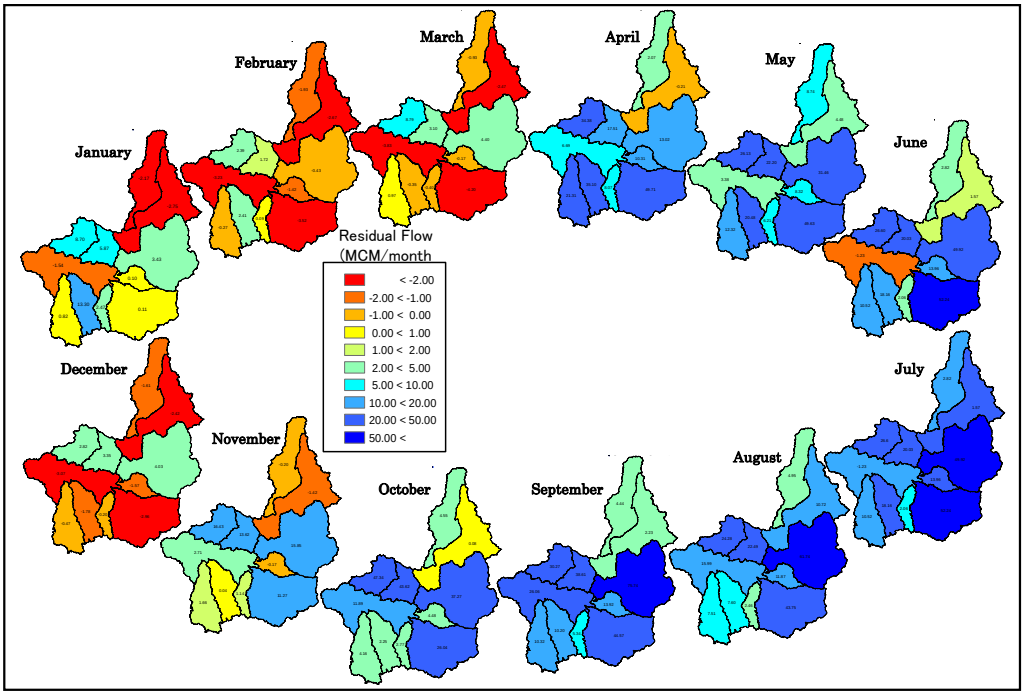


Figure 4-2 Simulated Monthly Surface Water Resources in 1/10 Drought Year

4.4 Groundwater Potential Evaluation

Groundwater potential evaluation for a groundwater development plan was carried out based on the results of hydrogeological and water balance analysis.

4.4.1 Indices for Groundwater Potential Evaluation

Five indices were selected to evaluate the groundwater potential from hydrogeological and hydrological point of view: i.e. well yield, drilling depth, static water level, total dissolved solid (TDS) as water quality and infiltration for groundwater recharge. These indices are analyzed for each sub-basin.

4.4.2 Potential Evaluation for Groundwater Development

Evaluation score was set up by the values of each index shown in Table4-4. A comprehensive potential evaluation for groundwater development can be conducted by substituting the spatial distribution value of each index to evaluation score and summation of each index score. Each index had same weight in this study.

Figure 4-3 shows evaluation score distribution in the Basin based on the evaluation score as

Table 4-2 Potential Evaluation Scores of Each Index for Groundwater Development

Score		(1)Yield (m^3/h)	(2)Static Water Level (m)	(3)Drilling Depth (m)	(4)Water Quality [TDS] (mg/l)	(5)Infiltration (mm)
10	Better	15 <	< 3	< 20	< 30	500 <
9		10 - 15	3 - 5	10 - 30	30 - 100	400 - 500
8		5 - 10	5 - 7	20 - 40	100 - 150	300 - 400
7		3 - 5	7 - 10	30 - 50	150 - 200	250 - 300
6		2 - 3	10 - 15	50 - 60	200 - 300	200 - 250
5		1.5 - 2	15 - 20	60 - 70	300 - 450	150 - 200
4		1 - 1.5	20 - 30	70 - 80	450 - 600	100 - 150
3		0.7 - 1	30 - 40	80 - 100	600 - 900	50 - 100
2	Worse	0.5 - 0.7	40 - 50	100 - 150	900 - 1200	0 - 50
1		< 0.5	50 <	150 <	1200 <	< 0

shown in Table 4-2. Groundwater potential in Lwere, Akweng, Mpolongoma and Lumbuye sab-basins is high but Okok, Okere and Kyoga Lakeside sub-basin is low.

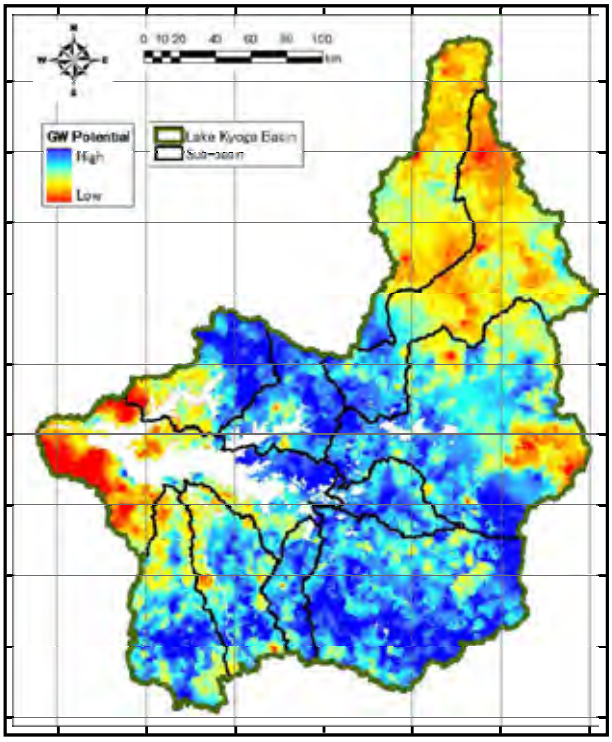


Figure 4-3 Groundwater Development Potential

4.5 Exploitable Water Resources

It is very important factor to formulate any development plan to assess how much water is exploitable within the Basin.

4.5.1 Surface Water

According to the simulation results, exploitable surface water resources in 10-year drought conditions are quite limited. Therefore, exploitable surface water volume of each sub-basin is estimated with 3-year drought water discharge and 3-year low water discharge as illustrated in Figure 4-4. Since a maintenance flow discharge in Uganda is defined as one percent of mean flow discharge, the maintenance volume has been already deducted from them. The figure indicates that the northern part of the Basin: Okok and Okere sub-basin is under the very sever condition of surface water resources.

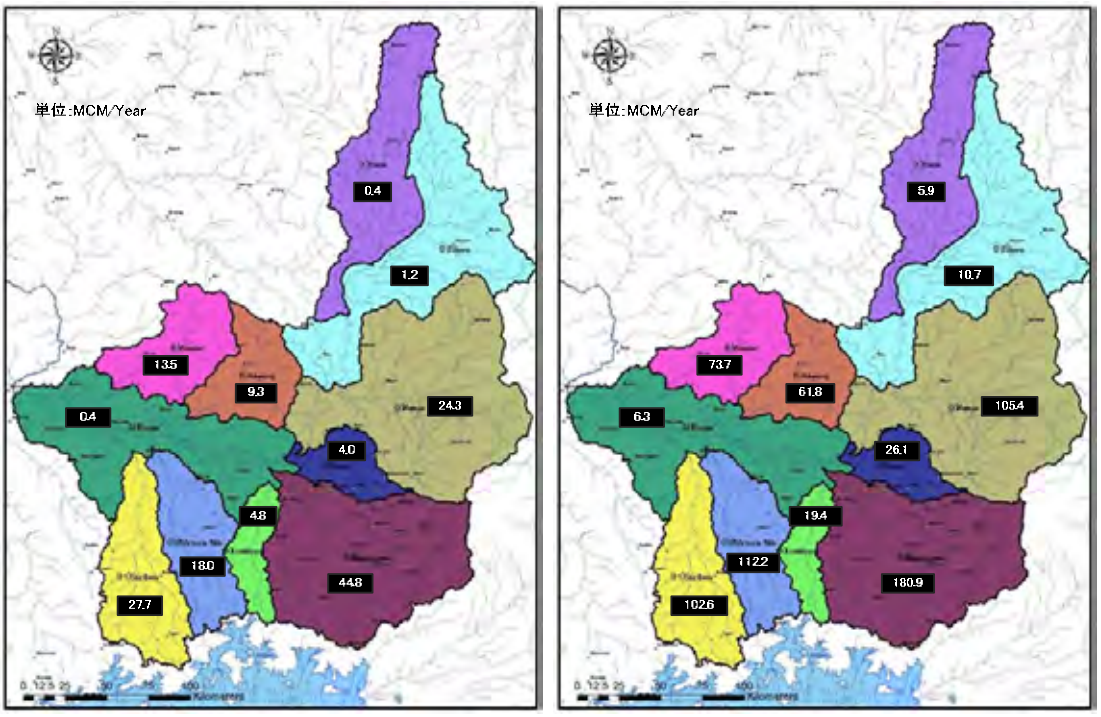


Figure 4-4 Estimated Exploitable Surface Water Volume in each Sub-basin with 3-Year Drought Water Discharge (left) and 3-year Low Water Discharge (right)

4.5.2 Groundwater

In the case of groundwater, total exploitable volume in the Basin is estimated as 502.1MCM/year in drought year under the following assumptions. Figure 4-5 shows exploitable groundwater volume each sub-basin and indicates that the northern two sub-basins are also under the very sever condition.

- Average Effective Porosity = 15.5%
- Average Recharge Rate = 22%
- Practical Development Rate = 10%
- Drought Factor = 50%

Although the above-mentioned estimation may have accuracy issues, however; it is possible to think that nobody can take an optimistic view on water resources conditions until the target year. Then, it is necessary to take into consideration the relationship between water resource's potentiality and future water demand in the Basin in order to formulate the Basic Plan.

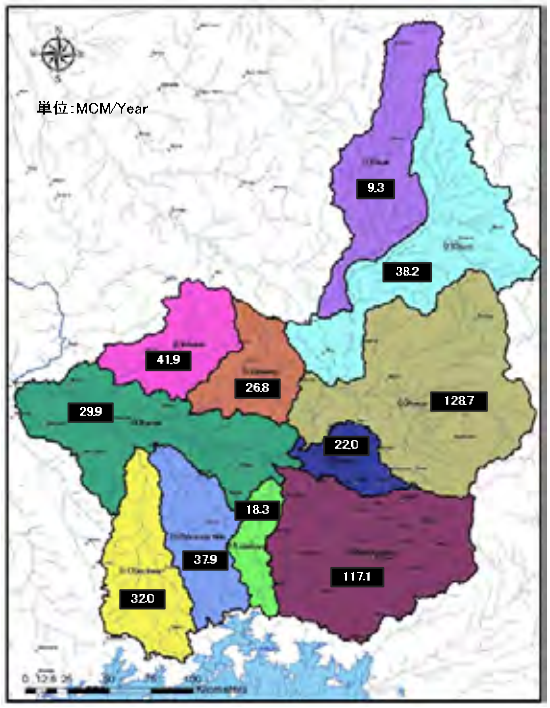


Figure 4-5 Exploitable Groundwater Volume in each Sub-basin in Drought Year