4.3 Groundwater Flow Analysis

Groundwater flow was analyzed by using static water level of NGWDB. Groundwater is flowing from higher position to lower position by gravity in the same manner as surface water. When the altitude of water level of each borehole is obtained, contour line of groundwater level altitude can be drawn. Therefore, groundwater flow can be drawn to be perpendicular to the contour line towards lower level.

4.3.1 Altitude of Static Water Level

The altitude of the static water level can be calculated by subtracting the static water level from the altitude of each well. However, altitude of each well is not mentioned in NGWDB. The altitude of each well is extracted from Digital Elevation Model (DEM) at the position of each well.

Figure 4-11 shows the distribution map of the altitude of static water level.

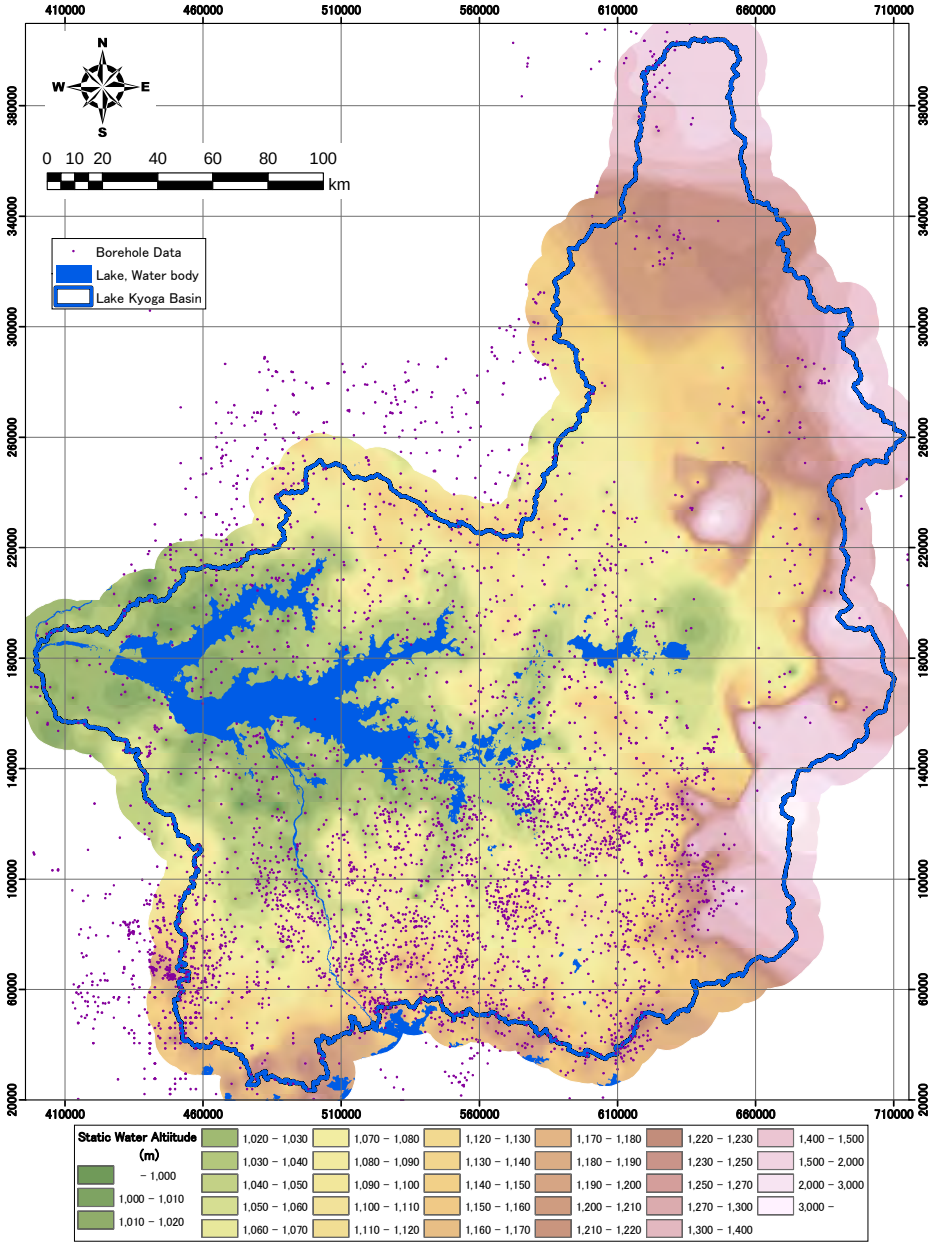

Figure 4-11 Altitude of Static Water Level Map

4.3.2 Direction of Groundwater Flow

Figure 4-12 shows the groundwater flow which is drawn to be perpendicular to the contour line towards lower level. Most of water is flowing towards Lake Kyoga, but there are some places which are storing water.

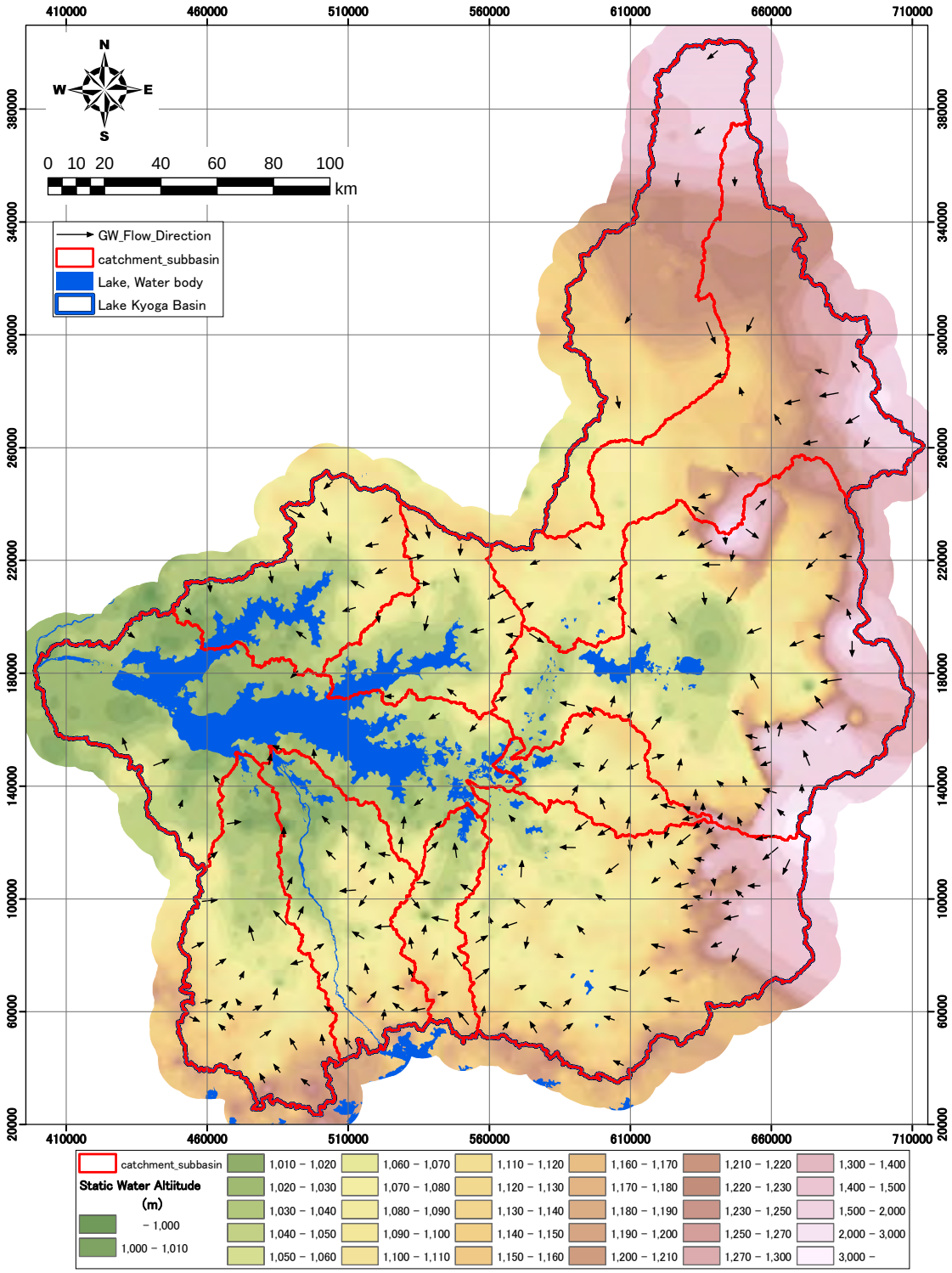

Figure 4-12 Direction of Groundwater Flow

4.4 Hydrogeological Condition by Geological Unit

In this section, hydrogeological condition in Lake Kyoga Basin is expressed based on each geological unit. Stratum aquifer is expected to be in the recent sediment area and weathered zone of rocky area. Other rocky areas, which are granitic rock, Metamorphic rock, and volcanic rock areas, are expected as fissure aquifer.

4.4.1 Pre-Cambrian

Geology of Pre-Cambrian in Lake Kyoga Basin can be divided to gneissic-granitic rock area and sedimentary rock area. gneissic-granitic area is occupying very wide area in the central part of Lake Kyoga Basin. Sedimentary rock area is corresponding to the area of Buganda-Toto System, Kyoga series, and Karoo system of Palaeozoic. It is distributed in the north shore of Lake Kyoga and a small part of Mukono district, Jinja district, and Bugiri district.

(1)Gneissic-Granitic Rock Area

Granite is a coarse grained igneous rock. Gneiss as metamorphic rock has coarse grain and banded structure. The original rock seems to be granite in this area. Characteristically, granite or Gneiss is easy to be weathered and has many fractures near the surface. Weathered granite forms sandy state near surface. Clay mineral called “Kaoline” derives from weathered granite. The low land such as pocket or small basin accumulates the clay. Although the clay formulates aquiclude layer, this is good material for brick. Therefore, brick production area seems to be bad groundwater recharge. Additionally, 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 granitic area.

Groundwater in weathered zone, which can be regarded as stratum water, and fissure water in fissure zone are expected in the granite area. However, both of these aquifers are different from ordinary aquifer in stratum like sand or gravel layer. It is more complex structures. Therefore, thickness of the weathered layer or the place which has much more fissures has to be investigated for groundwater development.

(2) Sedimentary Rock Area

Although these rocks are sedimentary rocks, these were formulated in Pre-Cambrian era, Since they have very high consolidation and cementation, it is not expected that the pore zone in the rock has water. Therefore, fissure water is expected in the bedrock as the same as granitic rock. However, if the weathered zone is relatively thick, deep groundwater is expected around the lower part of weathered zone and the upper part of bedrock.

4.4.2 Volcanic Rocks in Tertiary

The areas distributing volcanic rocks are eastern part of Lake Kyoga Basin, Kapchorwa district, Sironko district. Water level is very deep, and it is difficult to apply geophysical survey. Development of spring is suitable in this area. If protection facility for taking the spring water will be constructed, it can be avoid the contamination by constructing protection at the place where the spring is flowing out from rock or confined water is coming up directly.

4.4.3 Sediments in Quaternary

Sands and gravels layer in alluvium are very suitable layer for taking shallow groundwater. In Lake Kyoga Basin, especially around Lake Kyoga, alluvium area becomes swamp in rainy season, and it is difficult to develop groundwater in such a area. However, Karamoja area is higher than wetland around Lake Kyoga, and much alluvium area along rivers. It is reasonable to develop shallow groundwater in Karamoja area.

4.5 Estimation of Groundwater Amount

Groundwater has two kinds of configurations, namely, the stratum water like alluvium area and the fissure water existing in fractures in rocks. Rocky area is occupying mostly in this study area, but sedimentary area exists in limited area only along rivers. It is very difficult to estimate groundwater amount of fissure water, because it is difficult to investigate the distribution of fracture zone in wide area. And fissure water can not be expected much amount. In this study, weathered zone is recognized as aquifer, and the aquifer thickness is estimated from the static water level distribution discussed in the section 4.2.2 and the “depth to bedrock” distribution from NGWDB.

4.5.1 Estimation of Effective Porosity

To estimate the groundwater amount, effective porosity must be estimated mow much spaces in which groundwater can be. Because there are no data of effective porosity of underground, porosity was estimated from the analysis of pumping test data. The number of collected data was about 200. The data were collected evenly across the Lake Kyoga Basin preferably. However the number of boreholes which was conducted pumping test is few, and analyzable data were more few. Therefore, It cannot be collected in every geological unit.

Pumping test data are expressed by following formula (Cooper and Jacob, 1946),

$$sw = \frac{2.3Q}{4\pi T}\log\frac{2.25Tt}{r^2 S}$$

where, sw; drawdown (m), Q; pumping rate (m^3/h)、T; Transmissivity (m^3/h/m), t; period from starting pumping, r; distance from pumping well to observation well (m), S; Storage coefficient(no dimension).

T and S are calculated from this formula,

$$T = \frac{2.30Q}{4\pi\Delta sw}, \text{ and}$$

$$S = \frac{2.25Tt_0}{r^2}.$$

Storage coefficient (S) is the same meaning as effective porosity, if the aquifer is unconfined. Generally, storage coefficient has the range from 0.01to 0.5 in unconfined aquifer, and from 10-3 to 10-5 in confined aquifer. Therefore, the results were selected only concerning to unconfined aquifer from whole analyzed results. And it was processed statistically. The result is shown in Table 4-3.

Table 4-3 Average of Hydrogeological Indices by Geological Unit

	Geological Unit	Symbol	Data Number	Transmissivity (m^3/h/m)	Storage Coefficient (%)	Pumping rate (m^3/h)
1	Quaternary	P1 2	16	0.056	17.8	1.61
2	Alkali volcanics	T	1	0.122	26.5	1.53
3	Carbonatite	TC	1	0.075	13.2	0.70
4	Karoo System	KR	0	―	―	―
5	Aswa Shear Zone	CM	1	0.027	12.0	1.15
6	Karasuk serise	KS	5	0.087	23.1	2.55
7	Kyoga Series	B-K	10	0.446	22.8	3.94
8	Granite	G	0	―	―	―
9	Buganda-Toro System	B-T	5	0.131	15.9	3.51
10	Nyanzian System	NZ	2	0.148	22.5	2.94
11	Aruan Series	A	11	0.193	21.4	2.79
12	Watian Series	W	5	1.274	13.0	3.50
13	Gneiss-Granulite Complex	GC	96	0.127	13.2	2.06
14	Granitoid	GZ	0	―	―	―
Total			153	0.181	15.5	2.29

The hydrogeological indices are calculated by geological unit. However, data number concerning to Gneiss-Granite Complex is a lot predominantly. Therefore, 15.5 % is used as the value of effective porosity.

4.5.2 Estimation of Recharge Ratio at Groundwater Monitoring Station

Static water level and rainfall have been monitored at groundwater monitoring station. There are 3 monitoring stations in Lake Kyoga Basin. Figure 4-13 is a graph of time series of static water level and accumulated rainfall. Groundwater recharge system has many elements, for example, rainfall intensity, distance from rained place, geological structure, and so on. But, since change of static water level has periodicity in Figure 7-12, groundwater recharge ratio can be estimated by comparing between water level and cumulative rainfall. Now, the porosity of the layer is assumed as 10%

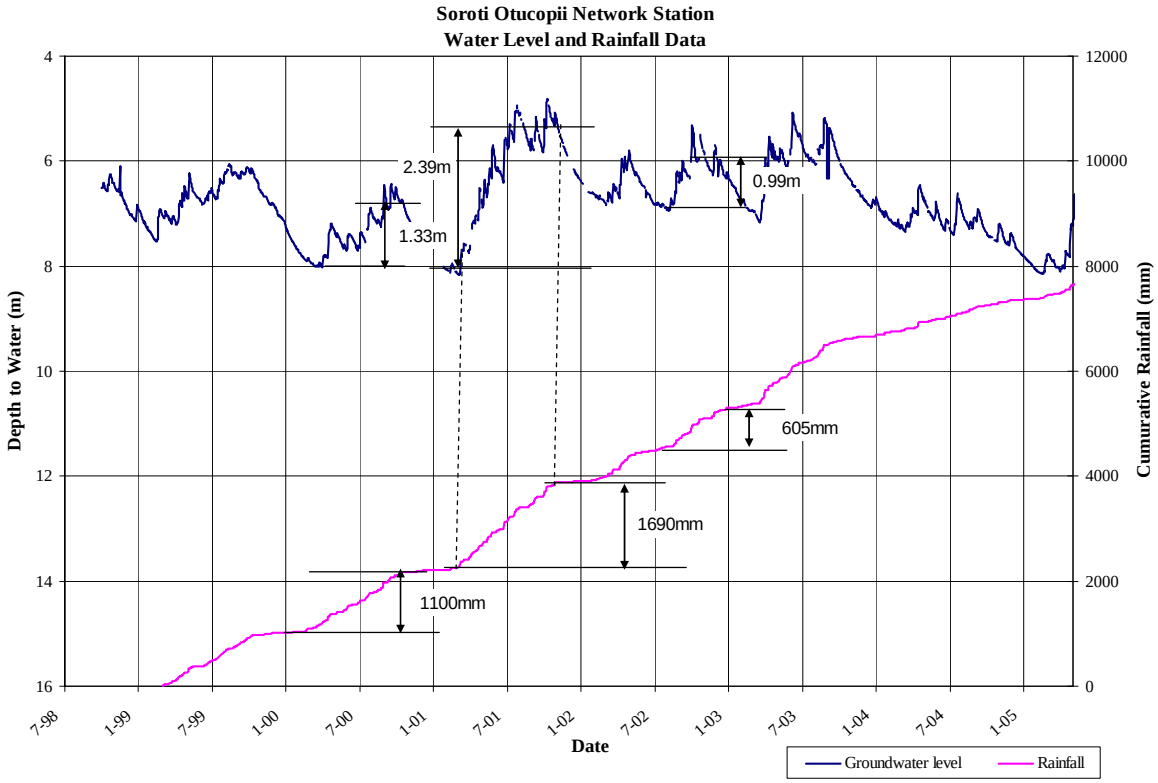

Figure 4-13 Groundwater Level Monitoring Data and Cumulative Rainfall at Soroti

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Table 4-4 Groundwater Recharge Rate Estimated from Groundwater Monitoring Data

Soroti Groundwater Network Station

	Date	Cumurative rainfall(mm)	Rainfall in the period (mm)	Date	Water level (m)	water level change in the period (m)	Rechage Rate
1	01-2-00	1021.4	1100.2	04-4-00	8.00	-1.33	0.19
	23-10-00	2121.6		26-10-00	6.67		
2	01-2-01	2204.3	1690.2	17-2-01	8.01	-2.39	0.22
	02-12-01	3894.5		08-12-01	5.62		
3	11-7-02	4470.2	605.1	29-7-02	6.83	-0.99	0.25
	14-11-02	5075.3		25-11-02	5.84		
					Average Recharge Rate		0.22

Table 4-4 shows groundwater recharge ratio estimated from the values read out from Figure 4-13. For example, 22% of rainfall infiltrates to underground at Soroti according to Table 4-4.

4.5.3 Estimation of Groundwater Amount

Figure 4-14 shows the distribution of bedrock depth. This figure is also formulated from the data "depth to bedrock" in NGWDB. The thickness of aquifer (Figure 4-14) can be calculated from the difference between Figure 7-13 and Figure 4-8 (Static Water Level Distribution). In this calculation, if bedrock depth is shallower than static water level, the aquifer thickness is zero. The groundwater amount can be estimated from this thickness multiplied by area and porosity. Porosity is assumed as

15.5% as discussed in section 4.5.1. Groundwater amounts of each sub basin are shown in Table 4-5.

According to this result, groundwater amount of Lake Kyoga Basin is estimated as 103 billion cubic meters.

Table4-5 Groundwater Amount by Sub Basins

	Sub Basin Name	Amount (m^3)
1	Okok	9,589,030,630
2	Okere	2,922,102,539
3	Awoja	20,329,020,776
4	Lwere	3,195,531,233
5	Akweng	7,300,739,111
6	Abablang	6,360,398,966
7	Kyoga Lakeside	13,988,414,696
8	Mpolongoma	20,909,912,335
9	Lumbuye	2,658,165,193
10	Victoria Nile	7,587,625,861
11	Sezibwa	8,645,544,997
	Total	103,486,486,337

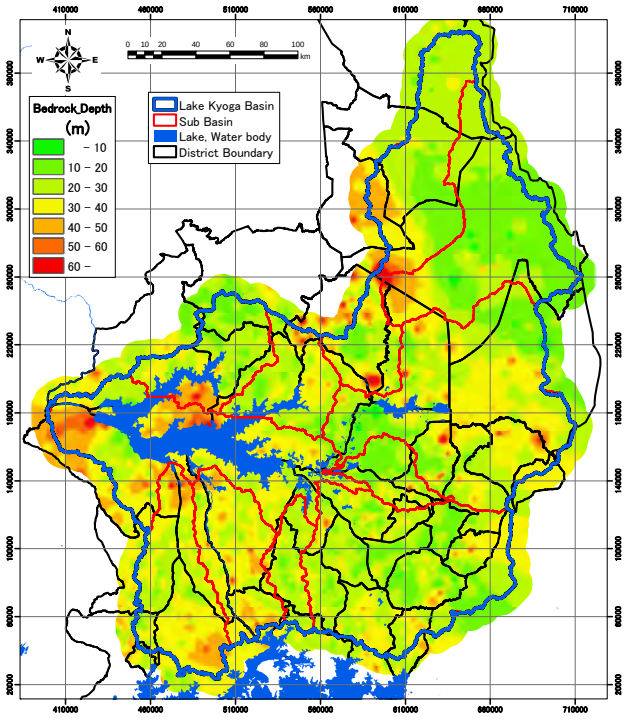

Figure 4-14 Bedrock Depth Distribution Map

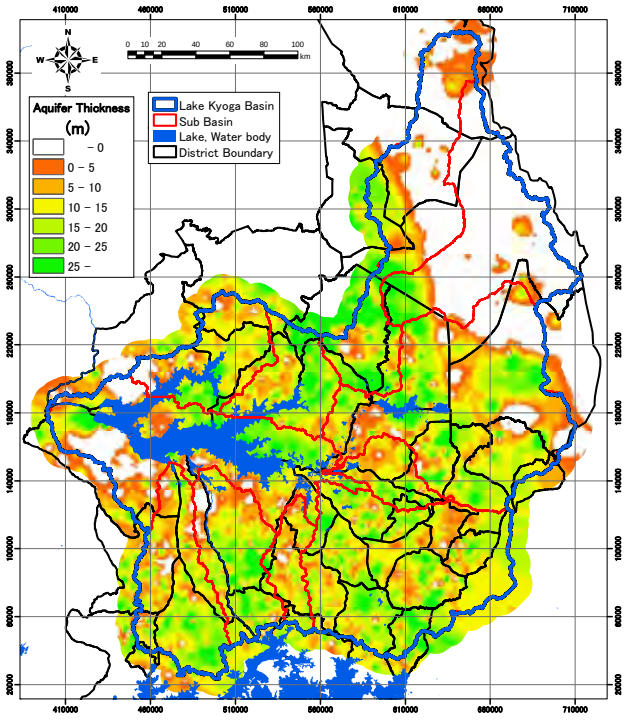

Figure 4-15 Aquifer Thickness Distribution Map

4.5.4 Estimation of Usable Groundwater Amount

Total groundwater amount is estimated as 104 billion cubic meters.

However, the amount can not be used of all. As maximum sustainable usable groundwater amount should be at the same level as groundwater recharge amount. Therefore, the infiltration amount which is discussed in chapter 10 can be recognized as usable groundwater amount. Table 4-6 shows the usable groundwater amount by sub-basins. Usable groundwater amount is very few in Karamoja area in the north-eastern part of Lake Kyoga Basin and Nakasongola district in the southern shore of Lake Kyoga.

Table 4-6 Usable Groundwater Amount by Sub Basins

	Sub Basin Name	Amount (m^3)
1	Okok	292,683,553
2	Okere	861,875,185
3	Awoja	2,616,695,259
4	Lwere	439,308,094
5	Akweng	541,560,779
6	Abablang	840,308,098
7	Kyoga Lakeside	693,160,402
8	Mpolongoma	2,365,437,246
9	Lumbuye	366,697,086
10	Victoria Nile	773,658,112
11	Sezibwa	663,386,608
	Total	10,454,770,420

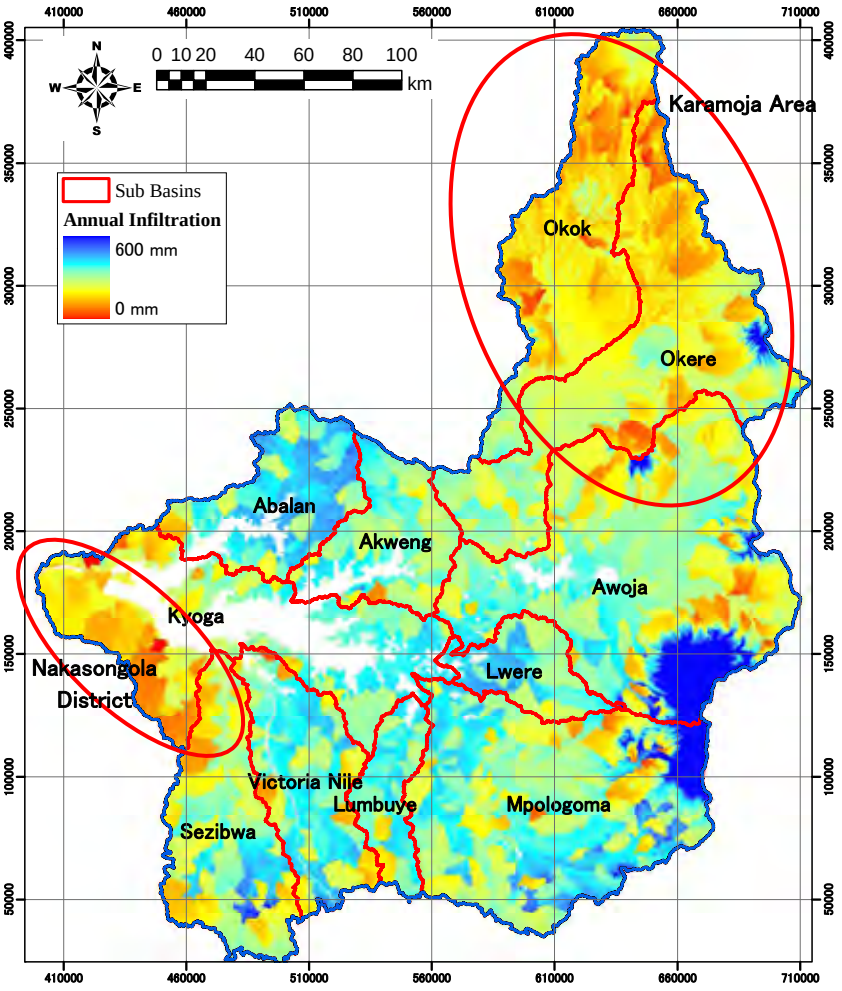

Figure 4-16 Annual Groundwater Infiltration

4.6 Interim Result of Water Level Monitoring at Test Boreholes

Water level monitoring is carrying out at the test borehole in this project every month. From February 2010, measurements were done four times in each borehole. Generally, dry season is from January to March, and rainy season is from April to June in Uganda. Water levels are decreasing up to the end of May in most boreholes. It is expected to rise up from June.

Table 4-7 Water Level Monitoring at Test Boreholes (February to May, 2010)

No.	District	County	Subcounty	RGC	UTM-E (m)	UTM-N (m)	Altitude (m)	WATER LEVEL (m bgl)			
								February	March	April	May
JTB-1	Iganga	Kigulu	Nambale	Nabitende	555211	93570	1087	1.270	1.100	0.510	0.150
JTB-2	Iganga	Kigulu	Nambale	Nabitende	556605	94312	1078	3.540	3.410	2.800	2.400
JTB-3	Iganga	Luuka	Ikumbya	Ikumbya	536283	110016	1102	15.910	15.870	15.895	15.615
JTB-4	Iganga	Luuka	Ikumbya	Ikumbya	536549	108910	1105	13.240	13.275	13.330	12.845
JTB-5	Iganga	Luuka	Bukooma	Naigobya	540745	90151	1064	1.840	1.450	0.770	0.480
JTB-6	Iganga	Luuka	Bukooma	Naigobya	540671	90044	1067	7.140	7.045	6.660	6.230
JTB-7	Iganga	Luuka	Irongo	Lambaala	525603	79395	1081	7.010	6.770	6.530	5.795
JTB-8	Iganga	Luuka	Irongo	Lambaala	526207	78988	1082	3.530	3.440	3.385	3.200
JTB-9	Palisa	Butebo	Kibale	Kibale	587203	133792	1114	7.200	7.140	6.230	6.405
JTB-10	Palisa	Butebo	Kibale	Kibale	586100	135077	1108	7.600	7.600	6.365	6.140
JTB-11	Paliisa	Pallisa	Kameke	Kameke	584571	139941	1098	3.060	2.550	1.970	2.000
JTB-12	Palisa	Palisa	Kameke	Kameke	584623	139770	1102	3.600	3.125	2.655	2.630
JTB-13	Palisa	Kibuku	Kadama	Kadama	599409	113709	1111	3.220	2.840	2.610	2.230
JTB-14	Palisa	Kibuku	Kadama	Kadama	597907	114227	1102	2.050	1.820	1.460	1.090
JTB-15	Palisa	Kibuku	Kabweri	Kabweri	598108	117233	1082	4.660	4.625	4.575	3.895
JTB-16	Palisa	Kibuku	Kabweri	Kabweri	599036	117098	1089	5.100	5.110	5.030	4.905
JTB-17	Soroti	Kasilo	Pingire	Kidetok	545498	162649	1060	8.880	8.660	7.755	6.480
JTB-18	Soroti	Kasilo	Pingire	Kidetok	546246	162351	1065	13.420	13.590	13.020	10.235
JTB-19	Soroti	Kasilo	Pingire	Kidetok	547671	165028	1095	12.695	13.110	11.800	7.860
JTB-20	Soroti	Soroti	Tubur	Acuna	553725	220705	1092	5.710	4.980	4.875	3.565

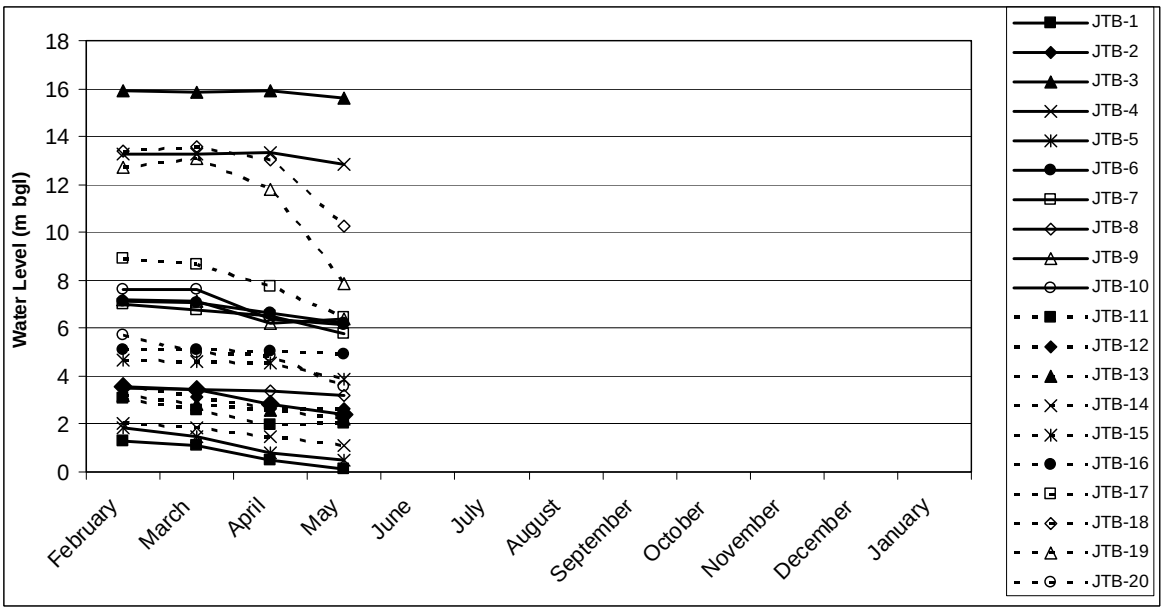

Figure 4-17 Water level at Each Test Borehole

CHAPTER 5 TEST BOREHOLE DRILLING

5.1 Hydrogeological Analysis

Based on the topographic maps of 10 Rural Growth Center (RGC) prepared by utilizing GIS, geomorphologic conditions such lineaments, drainage pattern and hydrogeological structures are studied and made out before site reconnaissance.

5.2 Site Reconnaissance on Geomorphology and Hydrogeology

A site reconnaissance was carried out in parallel with geo-electric resistivity survey in order to confirm and capture the geomorphologic conditions. Following items became clear as a result of the site reconnaissance.

- There are many out crops of granite in Kibale, Kameke and Kadama RGC, but other RGCs are thickly covered by overburden so that no outcrop is found,
- Only two springs are found in Nabitende and Kameke RGC,
- Swamp is spreading around all 10 RGCs,
- Faults, folds and alluvium fans can not be clearly found in all 10 RGCs,
- Catchments area for ground water recharge are relatively small scaled in 10 RGCs,
- Forty seven (47) existing boreholes were confirmed and the coordinates of them were measured by GPS. Functioning boreholes are 39 out of 47sites.
- Borehole data were collected at DWD and Iganga district water office. 15 boreholes out of 47 confirmed boreholes can be specified, and the data were used for this survey. Especially, estimated yield data is 11 only, and depth of hard rock is totally none.

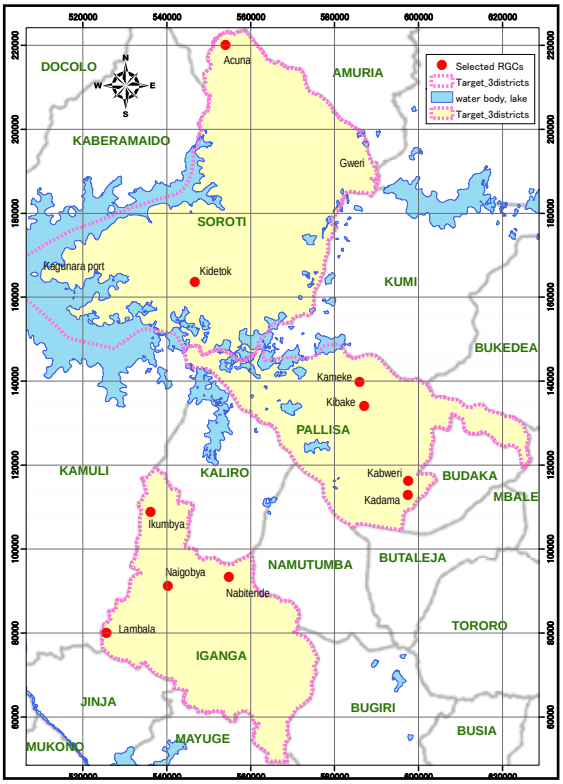

Figure 5-1 Location of RGCs for Test Borehole Drilling Survey

Based on the above-mentioned, sites for resistivity profiling to be conducted before vertical electric sounding (VES) were selected in consideration of the following conditions:

- Catchments area of RGC should be relatively extensive.
- In case that some parameter of groundwater of existing borehole contains higher than the value of maximum allowable concentration (MAC) of rural water supply, the area should be out of survey target.
- Profiling sites are to be far from the existing boreholes,

- Vegetation grows thickly,
- Upstream side of valley which has gentle slope and wide,
- Easy access for a drilling rig with supporting vehicles.

5.3 Resistivity Survey

Resistivity survey consists of Profiling, VES and calibration survey. Calibration survey consists of Profiling and VES at existing borehole sites to know resistivity characteristics of Profiling and VES prior to carrying out them at new survey sites.

Profiling was conducted along 58 lines in total in 10 RGSs and fifty three (53) points are selected along them for VES. Table 5-1 shows quantities of the resistivity survey.

Table 5-1 Quantity of Resistivity Survey

District	RGC	Calibration	Profiling	VES
Iganga	Nabitende	1	6	5
	Ikunbya	1	5	6
	Naigobya	1	6	5
	Lambala	1	6	5
Pallisa	Kameke	1	4	4
	Kibale	1	6	6
	Kadama	1	6	5
	kabweri	1	7	6
Soroti	Achuna	1	6	6
	Kidetok	1	6	5
Total		10	58	53

An example of procedure for selecting VES points is described below:

Figure 5-2 shows Profiling lines of P-1 and P-2 in Ikumbya RGC with selected VES points of VES 1 to 3. These VES points are selected among lower apparent resistivity points along the lines with considering the topographic feature around the site. The lines of P-1 and 2 are set up in parallel with about 50 meters interval. Comparing with apparent resistivity of 2 profiling lines, direction of adjacent lower resistivity points is perpendicular to the Profiling lines. Electrodes of VES are basically set up along the direction, when VES is conducted at a selected point.

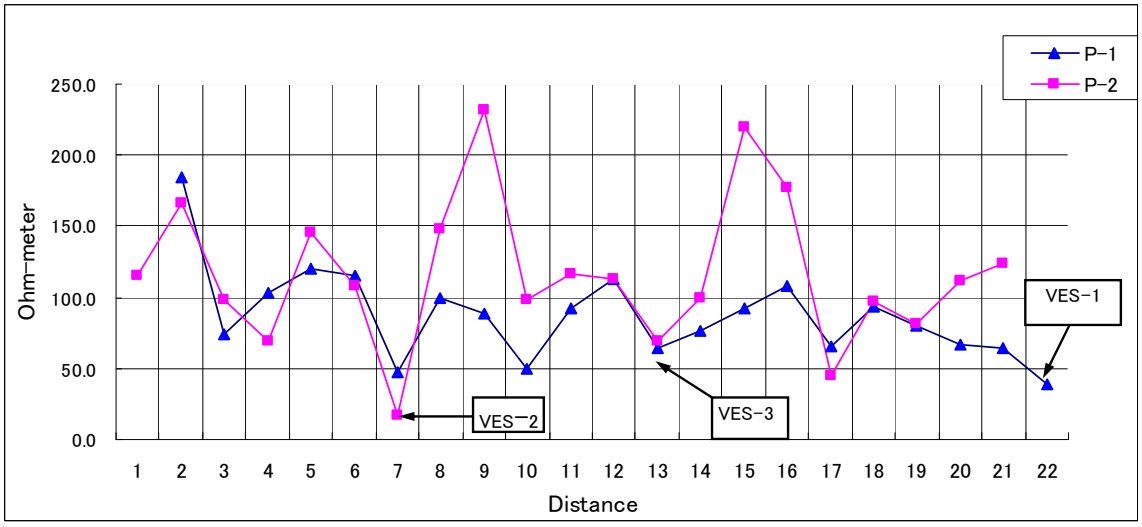

Figure 5-2 Resistivity Profiling Data in Ikumbya

5.4 Selection of Test Borehole Drilling Sites

Test borehole drilling sites were selected by following criteria.

- Depth of basement rock having more than 2,000 ohm-meter shall be more than 30 meters,
- Resistivity of expected aquifer is more than about 60 ohm-meter,
- Depth of expected aquifer shall be lower than 15 meters,
- Resistivity of expected fissure water zone is lower than 1200 ohm-meter and higher than 200 ohm-meter,
- Expected aquifer and fissure water zones is relatively deeper and thicker among VES result in a RGC,
- One drilling site shall be chosen in a catchments area as much as possible.

Apparent resistivity-depth curves obtained by VES were analyzed. As a sample, following Figure 5-3 and 5-4 shows typical resistivity logs in Ikumbya RGC. The site of Figure 5-3 has shallow bedrock depth and very high resistivity (over 2,000 Ωm) of the rock. Therefore, this site is not selected as drilling site. On the other hand, the site of Figure 5-4 is satisfied above conditions, and this site is selected.

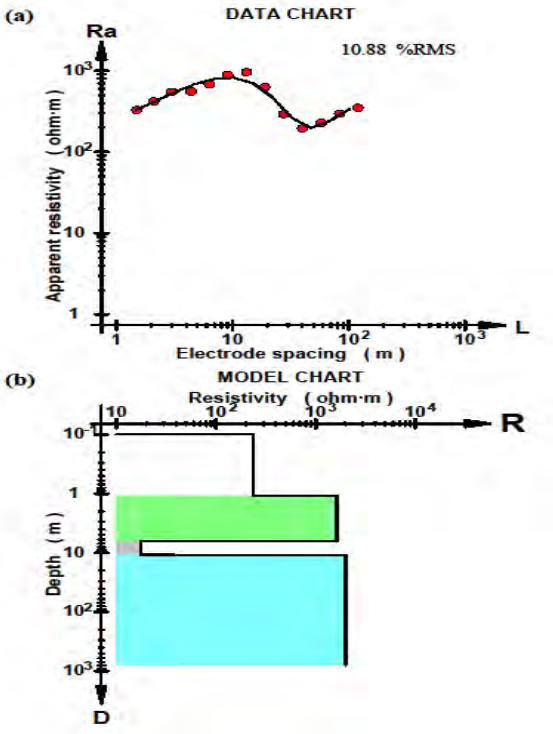

Figure 5-3 Example of Analysis Result for Unselected Site

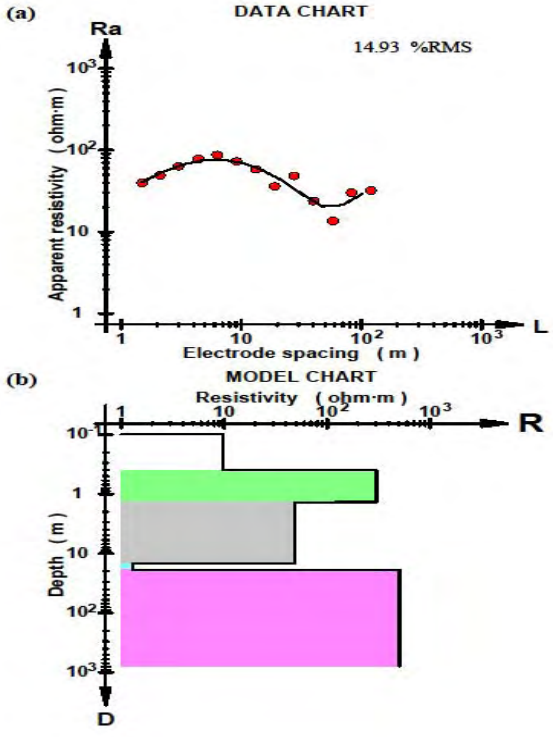

Figure 5-4 Example of Analysis Result for Selected Site

Table 5-2 shows selected borehole sites in accordance with criteria mentioned above.

Table 5-2 Selected Borehole Sites and the Result of Resistivity Survey

RGC	Borehole No.	UTM-E (m)	UTM-N (m)	Estimated aquifer depth (m)	Estimated Resistivity of aquifer (ohm-meter)	Scheduled drilling depth (m)
Nabitende	JTB-1	555211	93570	3.0 - 20.7	80	70
	JTB-2	556605	94312	2.0 – 93.0	166, 262	90
Ikumbya	JTB-3	536283	110016	24.0 – 70.0	501	70
	JTB-4	536549	108910	4.2 – 57.0	106	80
Naigobya	JTB-5	540745	90151	4.6 – 45.0	1200	65
	JTB-6	540671	90044	7.5 – 25.0	200	40
Lambala	JTB-7	525603	79395	11.5 – 53.0	60, 800	65
	JTB-8	526207	78988	15.0 – 31.5	138	60
Kibale	JTB-9	587203	133792	11.0 – 68.0	200, 250	80
	JTB-10	587168	133833	5.0 – 24.0	144, 900	60
Kameke	JTB-11	584511	139903	13.0 – 55.0	302	70
	JTB-12	584571	139941	7.8 – 40.0	143	60
Kadama	JTB-13	599409	113709	31.0 – 70.0	100, 504	90
	JTB14	597907	114227	2.6 – 43.5	300, 801	60
Kabweri	JTB-15	598108	117233	4.2 – 42.0	496	50
	JTB-16	599036	117098	7.0 – 33.0	170	45
Kidetok	JTB-17	545498	162649	4.0 – 75.0	147	100
	JTB-18	546246	162351	4.0 – 90.0	135	100
	JTB-19	547671	165028	5.5 – 85.0	298, 86	100
Achuna	JTB-20	553725	220705	12.0 – 20.0	160	45

5.5 Test Borehole Drilling

Royal Techno Industries Company (local drilling company) has completed twenty (20) test boreholes in Iganga, Pallisa and Soroti districts by 2nd February 2010 since 3rd December 2009.

5.5.1 Drilling Works

Depths of aquifer and fissure water zone were recorded by the supervisor of the Study Team and drillers during drilling work. The supervisor confirmed with borehole logging chart at the site for making plan of the casing schedule.

Table 5-3 shows the result of drilling.

During drilling at JTB-2, lost circulation occurred at 91 meters in depth, although meeting water strike in some fractures at 89 meters in depth with more than 10 liter/min.

Another phenomenon occurred at JTB-7 in Lambala is remarkably reported, that is, the yield with

more than 100 liter/min during drilling has gradually decreased to 5 liters/min at the development time.

Table 5-3 Result of Test Borehole Drilling

RGC	Borehole No.	Drilled depth (m)	Casing depth (m)	Depth of aquifer and fissure water zones (m)	Estimated yield at development (m^3/hour)
Nabitende	JTB-1	71.00	70.5	Dry hole	0.0
	JTB-2	101.00	100.00	Dry hole	0.0
Ikumbya	JTB-3	78.00	69.09	39-45, 53-62, 64- 67	2.4
	JTB-4	83.00	82.49	40-49, 55-61, 64-72, 76-78	3.78
Naigobya	JTB-5	65.00	65.00	Dry hole	0.0
	JTB-6	45.00	45.00	21.98-30.80, 33.74-39.62	3.6
Lambala	JTB-7	65.00	65.00	30-36, 40-55, 59-62	0.3
	JTB-8	60.00	60.00	33-48, 51-57	1.5
Kibale	JTB-9	80.00	80.00	36-45, 71-77	0.18
	JTB-10	60.00	60.00	Dry hole	0.0
Kameke	JTB-11	70.00	70.00	29-38, 44-50, 52-58, 61-67	12.24
	JTB-12	70.00	70.00	45-48, 50-59, 62-68	3.36
Kadama	JTB-13	87.00	87.00	52-58,61-64,69-72,75-87	0.91
	JTB-14	55.00	55.00	36-39, 42-54	0.6
Kabweri	JTB-15	55.00	55.00	35-41, 44-53	0.25
	JTB-16	55.00	55.00	23-31, 40-52	1.3
Kidetok	JTB-17	80.00	80.00	51-54, 57-65, 68-77	7.62
	JTB-18	80.00	80.00	39-42, 54-62, 65-78	20.4
	JTB-19	87.00	87.00	40-43, 46-52, 60-72, 75-84	2.1
Achuna	JTB-20	50.00	50.00	22-25, 27-33, 42-48	0.3
Total		1400.00	1383.49	-	-

5.5.2 Borehole Logging

Borehole logging has been conducted with a logger manufactured by Oyo Corporation. The logger records automatically spontaneous potential, apparent resistivity and natural gamma ray intensity at the same time and shows the values of them as a chart. Gamma logs clearly hit depth of fractures in rocks comparing with SP and apparent resistivity logs as shown in figure 5-5.

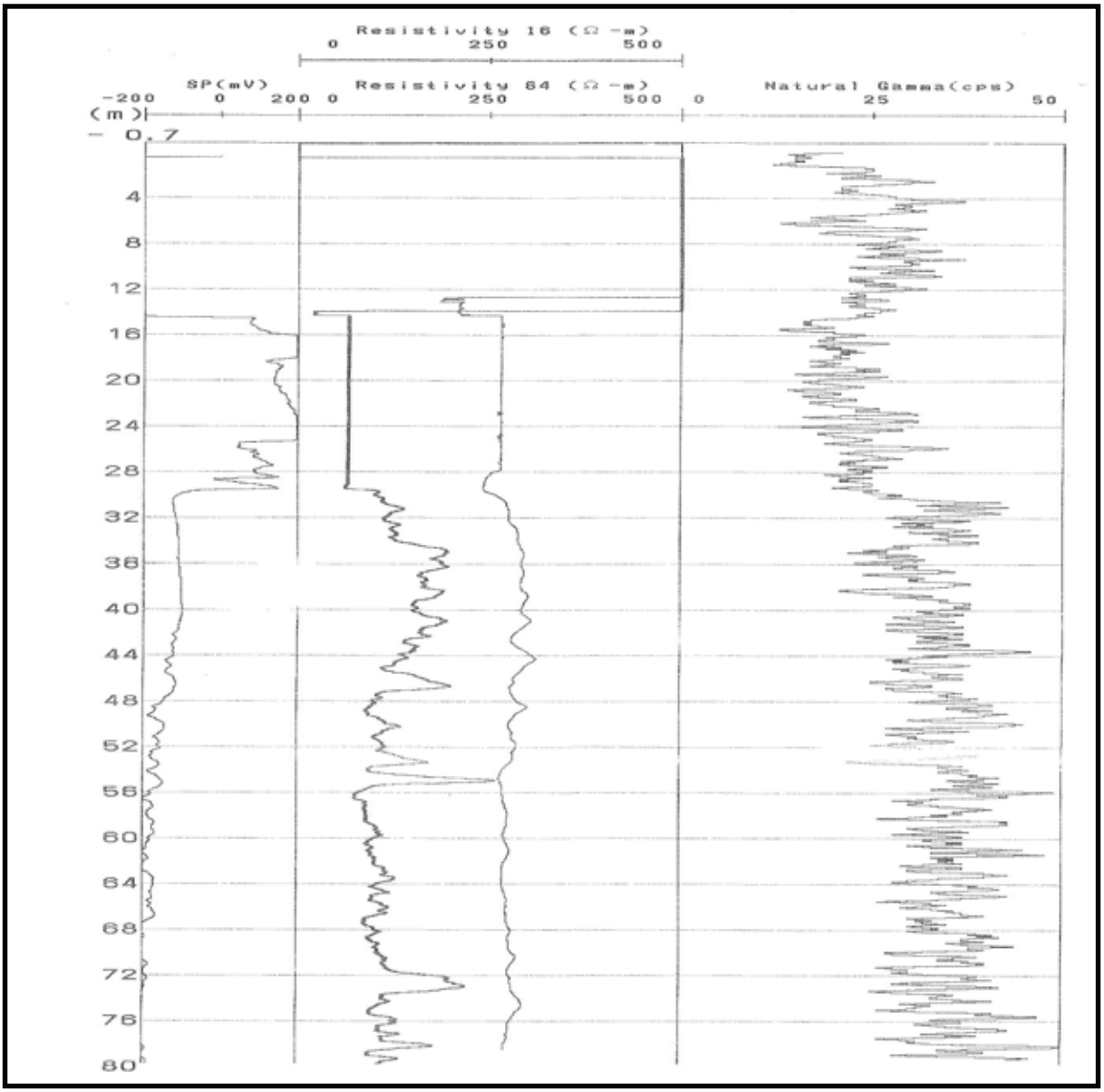

Figure 5-5 Example of Borehole Logging Result
(from left, Spontaneous potential, resistivity, and Natural Gamma)

5.5.3 Development

Immediately after gravel packing was done according to the casing schedule, all the borehole development have been carried out for 2 to 5 hours or until pumping water is clean.

5.6 Aquifer Test

Two (2) teams carried out a series of aquifer test consisting of step drawdown test (Step-test), constant rate pumping test (Continuous test), and recovery test. Table 5-4 shows the quantity of the tests and sampling. The field water quality tests were conducted with portable water quality meter during the aquifer tests.

Table 5-4 Quantity of Aquifer Test and Field Water Quality Test

RGC	Borehole No.	Step test (times)	Constant rate test (times)	Field Water Quality Test			Water Sampling (bottles)
				pH	EC (μS/cm)	Temperature (℃)	
Nabitende	JTB-1	0	0	-	-	-	0
	JTB-2	0	0	-	-	-	0
Ikumbya	JTB-3	2	2	6.55	213	25.7	2
	JTB-4	1	1	6.62	192.1	26.1	2
Naigobya	JTB-5	0	0	-	-	-	0
	JTB-6	1	1	6.45	394	25.6	2
Lambala	JTB-7	1	0	6.79	55.8	29.1	2
	JTB-8	1	1	6.75	274	26.5	2
Kibale	JTB-9	1	0	6.77	316	27.8	2
	JTB-10	0	0	-	-	-	0
Kameke	JTB-11	1	1	6.88	370	26.3	2
	JTB-12	1	1	6.83	363	29.0	2
Kadama	JTB-13	1	1	6.92	239	26.4	2
	JTB-14	1	1	6.92	145.3	30.6	2
Kabweri	JTB-15	1	0	7.16	492	32.2	2
	JTB-16	1	1	6.75	1317	29.1	2
Kidetok	JTB-17	1	1	6.92	239	26.4	2
	JTB-18	1	1	7.12	625	27.1	2
	JTB-19	1	1	6.89	358	28.8	2
Achuna	JTB-20	1	0	7.07	400.9	31.0	2
Total		17	13	-	-	-	32

Figure 5-6 shows an example of record of step drawdown test and constant rate pumping test with recovery data.

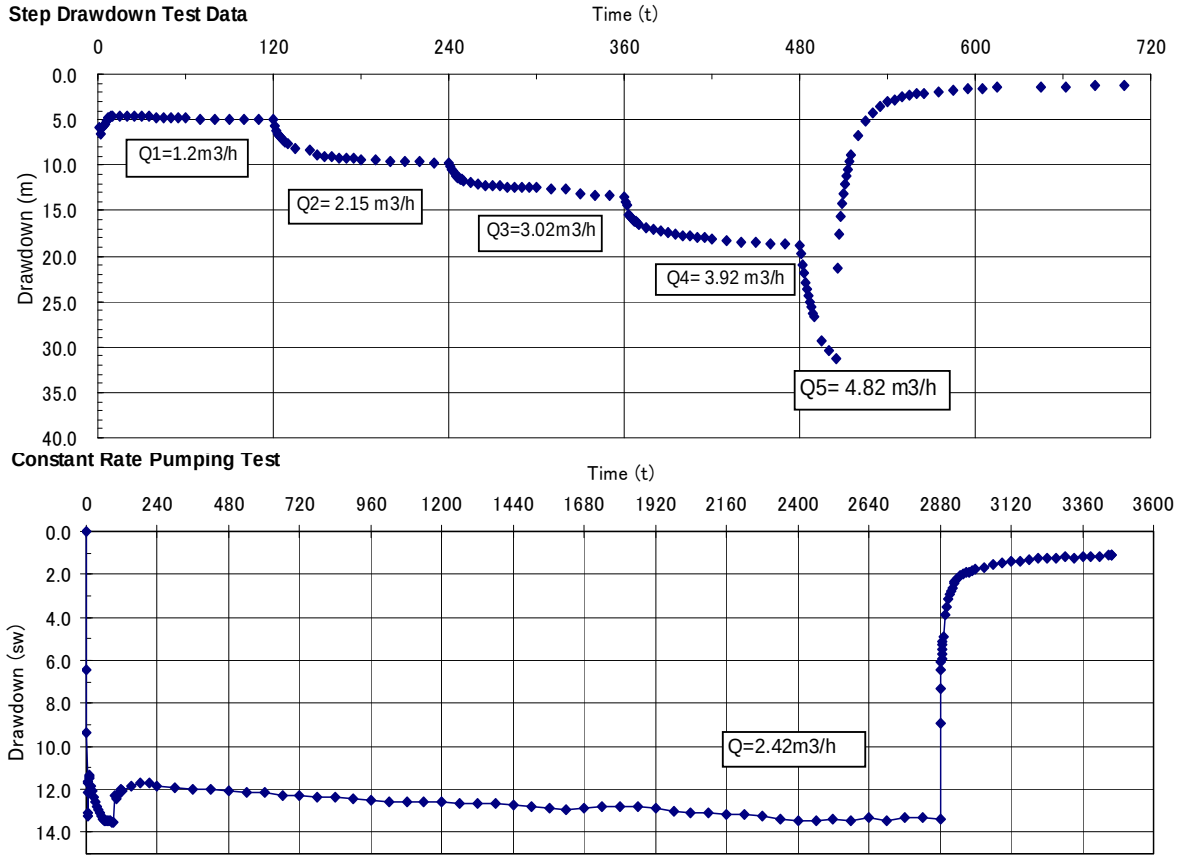

Figure 5-6 Example of the Records of Step Drawdown Pumping Test and Constant Rate Pumping Test

Safe yield of the borehole is obtained from the result of step drawdown test. Figure 5-7 shows the example of analysis. By plotting Yield (Q) versus drawdown (sw), and fitting straight lines through some points, flexion point is found. Yield value corresponding to the flexion point is defined as the maximum safe yield.

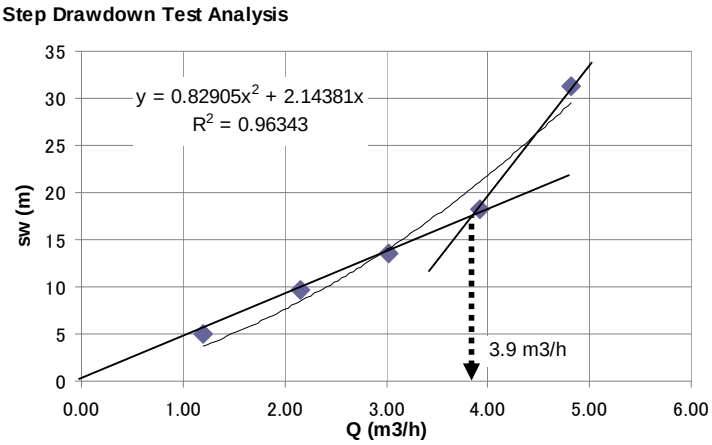

Figure 5-7 Example of Step Drawdown Test

Safe yield found by above procedure is defined by only the borehole, not defined in the groundwater basin. In case of groundwater management, safe yield should be defined from water balance in the groundwater basin. Additionally, economical yield shall be estimated in the condition of water demand, daily supply quantity, pump capacity, total head of supply system and etc.

Generally, pumping test data are expressed by following formula (Cooper and Jacob, 1946),

$$sw = \frac{2.3Q}{4\pi T}\log\frac{2.25Tt}{r^2 S}$$

where, sw; drawdown (m), Q; pumping rate (m^3/h)、T; Transmissivity ($m^3/h/m$), t; period from starting pumping, r; distance from pumping well to observation well (m), S; Storage coefficient(no dimension).

By plotting time (t) versus drawdown (sw) on semi-logarithmic graph, and fitting straight lines through some points, the gradient (Δsw) and intercept (t_0) are obtained.

T and S are calculated from the following formulas by substituting Δsw and t_0,

$$T = \frac{2.30Q}{4\pi\Delta sw}, \text{ and } \quad S = \frac{2.25Tt_0}{r^2}.$$

In case of recovery test, elapsed time from stopped time and started time of pumping (t/t') is used instead of t. Figure 5-8 shows the analysis examples of constant rate test and recovery test.

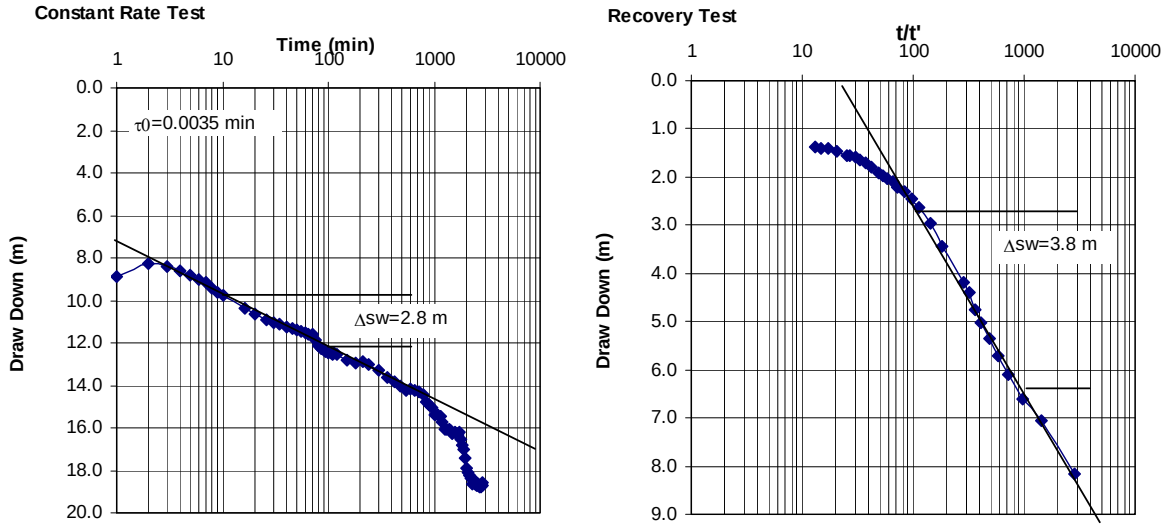

Figure 5-8 Analysis Examples of Constant Rate Pumping Test and Recovery Test

Table 5-5 shows the result of aquifer test.

Table 5-5 Result of Aquifer Test

JTB codes	SWL (GL-m)	Step Drawdown Test		Constant Rate Pumping Test			Recovery Test	
		Estimated safe yield (m^3/h)	Dynamic water level (GL- m)	Pumping rate (m^3/h)	Transmissivity (T) ($m^3/h/m$)	Storage Coefficient (S)	Transmissivity (T) ($m^3/h/m$)	Recovery Ratio (%)
JTB-1	Dry	-	-	-	-	-	-	-
JTB-2	Dry	-	-	-	-	-	-	-
JTB-3	16.00	3.9	30.21	2.42	0.246	0.016	0.256	89.4
JTB-4	13.19	1.2	32.62	1.21	0.058	$2.3x10^{-4}$	0.025	95.6
JTB-5	Dry	-	-	-	-	-	-	-
JTB-6	6.80	3.65	19.21	3.68	0.842	$3.4x10^{-6}$	0.808	92.8
JTB-7	7.13	0.32	20.55	-	-	-	-	-
JTB-8	3.60	1.2	17.60	1.24	0.075	$4.5x10^{-4}$	0.053	99.3
JTB-9	7.00	0.32	36.00	-	-	-	-	-
JTB-10	Dry	-	-	-	-	-	-	-
JTB-11	3.45	7.2	23.16	7.3	0.194	0.28	0.123	68.3
JTB-12	3.36	1.8	32.32	1.24	0.061	0.008	0.061	90.9
JTB-13	4.03	0.6	33.13	0.65	0.007	0.054	0.006	45.1
JTB-14	1.93	0.6	9.98	0.75	0.042	0.004	0.029	92.4
JTB-15	4.71	0.32	36.55	-	-	-	-	-
JTB-16	5.02	1.5	17.83	1.53	0.102	0.002	0.074	91.8
JTB-17	8.64	7.2	22.69	7.2	0.186	0.433	1.014	95.7
JTB-18	13.20	13.2	32.12	10.55	0.508	0.406	0.429	90.1
JTB-19	12.42	1.8	37.26	1.57	0.025	0.051	0.015	95.9
JTB-20	5.3	< 0.3	37.77					

5.7 Water Quality Analysis

Water quality analysis for the samples taken from the boreholes except dry holes carried out by the laboratory of National Water and Sewerage Corporation. Table 5-9 shows result of water quality analysis. Water quality of the entire sample is within the maximum permissible limits of the national standards for potable water.

Table 5-6 Water Quality Analysis of Test Borehole

Site No.	Temp. (℃)	pH	EC (μS/cm)	Turbidity (NTU)	Total Residue (TDS) (mg/L)	Hardness (CaCO3) (mg/L)	Ca (mg/L)	Mg (mg/L)	Bi-Carbonate CaCO3 (mg/L)	Mn (mg/L)	Cl (mg/L)
JTB-03	25.7	6.63	253	0.3	162	100	24.0	9.6	128	0.001	0.44
JTB-04	26.1	6.53	484	0.2	241	280	49.6	37.4	242	0.010	0.46
JTB-06	25.6	5.80	249	0.4	125	120	24.0	14.4	52	0.000	0.24
JTB-07	29.1	6.24	1409	8.5	703	800	192.0	76.8	136	0.020	7.50
JTB-08	26.5	6.32	353	0.2	177	144	24.4	21.1	100	0.000	0.31
JTB-09	27.4	6.59	317	1.6	159	112	24.0	12.5	160	0.020	0.33
JTB-11	26.3	6.88	370	0.8	237	180	28.8	25.9	192	0.002	0.40
JTB-12	28.0	6.68	359	0.7	177	188	36.8	23.0	200	0.010	0.61
JTB-13	26.4	6.51	399	2.8	198	176	33.6	22.1	192	0.010	0.50
JTB-14	30.6	6.60	623	0.1	312	352	75.2	39.4	352	0.020	1.86
JTB-15	32.2	6.97	479	4.6	241	260	59.2	26.9	260	0.010	2.00
JTB-16	29.1	6.26	1429	0.6	713	492	144.0	31.7	216	0.000	8.40
JTB-17	26.1	6.98	827	0.0	529	340	30.4	63.4	468	0.000	2.39
JTB-18	27.1	7.15	599	0.5	383	224	24.0	39.4	324	0.000	1.86
JTB-19	28.8	6.89	278	0.2	180	128	35.2	9.6	144	0.000	0.55
JTB-20	31.0	6.88	446	4.3	285	192	40.0	22.1	248	0.001	0.48
MAC		5.0 - 9.5		30.0	1500	800				2.0	500

Site No.	F (mg/L)	As (mg/L)	Fe (total) (mg/L)	SO_4 (mg/L)	Nitrate -N (mg/L)	Nitrite -N (mg/L)	Ammonia -N (mg/L)	Na (mg/L)	K (mg/L)	Total Coliforms (pcs/mL)	General Bacteria (pcs/mL)
JTB-03	0.13	<0.001	0.01	2	0.010	0.003	0.000	6.28	2.90	0	0
JTB-04	0.01	<0.001	0.00	1	0.004	0.000	0.000	3.16	1.42	0	0
JTB-06	0.00	<0.001	0.00	10	0.002	0.000	0.000	2.40	1.59	0	0
JTB-07	0.03	<0.001	0.13	86	0.080	0.024	0.006	8.02	3.80	1	3
JTB-08	0.00	<0.001	0.00	23	0.000	0.000	0.000	2.59	1.26	0	0
JTB-09	0.12	<0.001	0.08	0	0.020	0.001	0.002	6.24	2.81	0	2
JTB-11	0.10	<0.001	0.12	0	0.010	0.001	0.000	2.20	1.16	0	1
JTB-12	0.14	<0.001	0.02	1	0.010	0.001	0.000	4.12	1.98	0	1
JTB-13	0.00	<0.001	0.01	2	0.010	0.001	0.000	2.86	1.04	0	1
JTB-14	0.01	<0.001	0.00	0	0.001	0.000	0.000	4.11	1.77	0	0
JTB-15	0.16	<0.001	0.10	0	0.020	0.003	0.000	3.11	1.86	0	2
JTB-16	0.22	<0.001	0.01	9	0.030	0.005	0.000	9.32	4.10	0	0
JTB-17	0.33	0.002	0.00	2	0.020	0.003	0.001	8.61	3.59	0	0
JTB-18	0.26	0.001	0.00	1	0.000	0.001	0.000	6.12	2.86	0	0
JTB-19	0.12	<0.001	0.05	0	0.000	0.000	0.000	2.44	1.00	0	2
JTB-20	0.25	<0.001	0.04	0	0.010	0.000	0.000	3.16	1.12	1	3
MAC	4.0		2.0	500.0	50.0					10	100

MAC: Maximum Allowable Concentration

CHAPTER 6 SOCIO-ECONOMIC CONDITIONS

6.1 General Socioeconomic Conditions of Uganda

The Republic of Uganda is a land-locked country in East Africa. It is bordered on the east by Kenya, on the north by Sudan, on the west by the Democratic Republic of the Congo, on the southwest by Rwanda, and on the south by Tanzania. The southern part of the country includes a substantial portion of Lake Victoria.

The country has been relatively stable over the last two decades. Relative peace has now returned to the whole country since the current president, Mr. Yoweri Kaguta Museveni came to power in January 1986. And a comprehensive Peace, Recovery and Development Plan for Northern Uganda is scheduled for implementation by the Government starting 2000.

The culture of Uganda is made up of a diverse range of ethnic groups. Lake Kyoga forms the northern boundary for the Bantu-speaking peoples. In Uganda they include the Baganda and several other tribes. In the north live the Lango and the Acholi. To the east are the Iteso and Karamojong.

In the late 1980s, Ugandan officials estimated that 66 percent of the population was Christian--almost equally divided among Protestants and Roman Catholics. Approximately 15 percent of Ugandans were Muslims. Roughly 19 percent of the people professed belief in local religions or denied any religious affiliation.

Uganda's ethnic groups are most broadly distinguished by language. In southern Uganda, most of the population speak Bantu languages, Sudanic speakers inhabit the northwest; Nilotic speakers, principally the Acholi and Langi, live in the north; and the Iteso and Karamojong in the northeast.
Uganda has at least forty languages in usage. Luganda is the most common language. English is the official language of Uganda. Luganda, a language widespread in the central Uganda.

6.2 System of the Government

Uganda has an unicameral National Assembly of 305 members. The members serve five-year term. The executive of the country is headed by the president and assisted by the vice-president, prime minister and cabinet ministers. The president of Uganda is head of the state, head of the government and commander-in-chief of the Uganda peoples' defense forces.

The key function of the judiciary is the adjudication of civil and criminal cases. In addition, it interprets the constitution and gives effect to its provisions, as well as providing the expertise in interpreting of the laws.

The Ministry of Local Government oversees local governments' administration. As of May, 2009, there are 80 districts in the country. The districts are again divided in Counties, Sub-counties,

Parishes and Villages. Villages are the lowest setup in the local government and called as LC 5, Parishes as LC 4, Sub-counties as LC 3, Counties are LC 2 and districts are LC 1.

6.3 Socio-Economy

Uganda is one of the fastest growing economies in Africa with sustained growth averaging 7.8 percent since 2000. However, this growth has to be sustained in order for per capita income to rise beyond the current US$370. Though the country has made tremendous strides in recovering from years of economic breakdown in the 70s, the social economic indicators show that a lot still needs to be done. Life expectancy at birth is currently around 50 years and a population growth rate of about 3.4 percent remains one of the highest in the world, which could pose serious development challenges, unless addressed.

Agriculture is the most important sector of the economy, employing over 80% of the work force. Coffee is the major export crop and accounts for the bulk of export revenues. Since 1986, the government - with the support of foreign countries and international agencies - has acted to rehabilitate and stabilize the economy by undertaking currency reform, raising producer prices on export crops, increasing prices of petroleum products, and improving civil service wages. The policy changes are especially aimed at dampening inflation and boosting production and export earnings. In 1990-2000, the economy turned in a solid performance based on continued investment in the rehabilitation of infrastructure, improved incentives for production and exports, reduced inflation, gradually improved domestic security, and the return of exiled Indian-Ugandan entrepreneurs.

The country's firm commitment to poverty reduction, as spelled out in the Poverty Eradication Action Plan (PEAP) --Uganda's Poverty Reduction Strategy Paper -- and the World Bank's and other Development Partners' contributions brought the country closer to reaching the Millennium Development Goals (MDG):

The poverty headcount dropped from 56 percent in 1992 to 31 percent in 2006. Poverty, however, remains undisputable high in rural areas and Northern and Eastern Uganda. The Second Uganda Participatory Poverty Assessment Program, carried out by the government in 2003, identified several factors leading to high poverty levels. These includes heavy burden of disease; limited access to land and other assets, insecurity, lack of control over productive resources by women and high fertility rates. Uganda’s high population growth rate of 3.4 percent per year poses a significant challenge in reducing poverty and inequality.

The HIV/AIDS prevalence reduced dramatically from 18% at its peak in1992 to around 6.4% where it has stagnated over the last eight years. Though this is still well below the MDG target for HIV/AIDS, recent evidence indicates that new infections are on the rise with 132,500 new infections reported in 2006.

Some basic economic indicators and general information about Uganda are presented below.

Table 6-1 Economic Indices and General Information of Uganda

Item	Description
GDP - real growth rate	6% (2007 estimate)
GDP - official exchange rate	$11.23 Billion (2007 est.)
GDP - composition by sectors	Agriculture:30.2%,Industry:24.7%,Services:45.1%(2007 est.)
Budget	Revenues:$2.211Billion,Expenditure:$2.443Billion(2007est.)
Public debt	20.6% of GDP
Inflation rate	6.1% (2007 est.)
Current account balance	-$744.7 Million (2007 est.)
Reserve foreign exchange and gold	$2.56 Billion (2007 est.)
Total labor force	14.02 Million (2007 est.)
Labor force by sector	Agriculture: 82%, Industry: 5%, Services: 13% (1999 est.)
Industries	Sugar, brewing, tobacco, cotton, textile, cement, steel production
Industrial growth rate	5.8% (2007 est.)
Agricultural products	Coffee, tea, tobacco, cassava, potato, corn, livestock, poultry etc.
Export amount	$1.686 Billion (FOB, 2007 est.)
Export commodities	Coffee, tea, fish, fish products, flowers, gold etc.
Export partners	Netherlands (10%), Belgium (9.8%), Germany (7.9%), France 7.2%), Rwanda (5.6%) as of 2007 estimate
Import amount	$2.983 Billion (2007 est.)
Import commodities	Capital-equipment, vehicles, petroleum, medical supplies, cereals
Import partners	Kenya (32%), China (8%), South Africa (6%), India (5%), Japan (5%) as of 2007 estimate
Economic aid received	$1.198 Billion (2005)
Debt - external	$1.498 as of Dec 31, 2007
Exchange rate	Uganda shilling 1,696 to 1 US$ (2007)
Fiscal year	1 July ~30 June
Independence day	9th October

Source: CIA Factbook (Dec. 2008)

6.4 Study Area Socio-Economy

The Study area covers Lake Kyoga Basin of 57,669 sq km involving 38 administrative districts, five fall under Central region, 24 under Eastern region and rest nine within Northern region.

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/sqkm. Figure 6-1 shows the population density distribution by sub-county. District-wise area, population, household (HH) size and some selected data are presented in Table 6-2.

There are about twelve major ethnic groups share the basin. They are Karamojong in the north. Iteso 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.

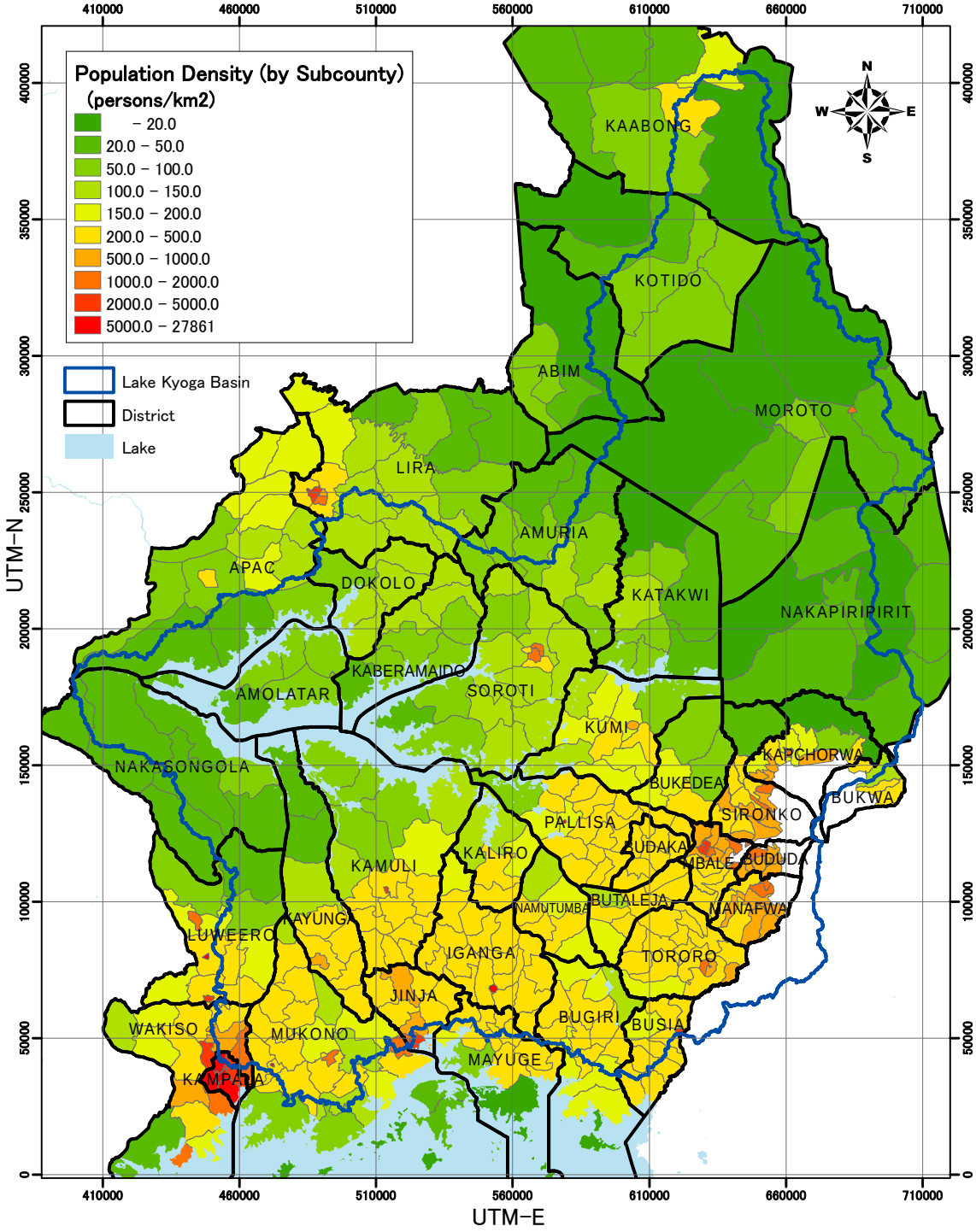

Figure 6-1 Population Density in the Lake Kyoga Basin by Sub-County

Table 6-2 General Information of Related Districts in Lake Kyoga Basin

No.	Region	District	Area within Study area	Population within Study area	HH within Study area	Average HH size	S/C in Study Area	Economic Activity		Source of Water					Coverage	Accsess to Health Clinic
								Farming	Employment	BH	Open Water	GFS	Protected S/W	Piped water	(WSSP Report)	
			(sq.km)	Persons	Number	Persons	Number	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	Central	**Kayunga**	1,702	294,613	62,039	4.7	9	73	9	59	2	-	8	2	61	47
2		*Luweero*	1,180	152,748	45,304	4.4	9	68	14	58	27	-	7	-	74	40
3		*Mukuno*	1,933	519,983	137,215	4.0	21	49	26	19	24	-	44	9	74	41
4		*Nakasongola*	2,499	94,625	18,901	4.9	7	60	27	43	48	-	4	-	70	40
5		*Wakiso*	247	156,540	137,467	4.1	4	27	45	13	-	-	33	30	49	85
6	Eastern	*Amuria*	1,498	116,348	27,984	4.6	8	86	6	46	41	-	-	-	83	40
7		**Budaka**	411	136,475	26,655	5.1	7	86	5	35	38	-	24	2	59	85
8		**Bududa**	274	123,103	27,909	4.4	8	-	-	1.2	36	-	57	0.4	77	68
9		*Bugiri*	1,068	268,827	67,854	5.0	12	84	6	28	61	-	8	2	34	46
10		**Bukedea**	1,055	122,433	25,767	4.7	5	85	4.7	-		-	-	-	81	60
11		*Bukwa*	172	14,642	6,901	5.0	3	85	6	-	42	14	19	0.4	55	78
12		*Busia*	473	147,252	31,126	4.7	10	75	6.3	37	44	-	19	0.4	69	52
13		**Butaleja**	655	157,489	31,977	5.0	7	85	5	65	29	-	4	1.3	60	70
14		**Iganga**	1,663	540,999	106,511	5.0	19	72	9	65	25	-	7	2.3	58	85
15		*Jinja*	636	296,300	69,741	4.5	10	43	31	27	7	-	18	47.0	68	97
16		**Kaliro**	869	154,667	29,172	5.3	5	85	10	83	14	-	2	1.0	57	54
17		*Kapchorwa*	1,179	141,439	29,350	4.8	13	78	7	-	39	2.8	49	6.4	65	84
18		**Kamuli**	3,433	552,665	261,545	5.1	18	80	-	-	-	-	-	-	56	-
19		**Kaberamaido**	1,624	131,650	25,994	5.0	8	88	5	55	34	-	10	-	92	59
20		**Kumi**	1,794	267,232	52,672	5.1	11	84	7		-	-	-	-	53	77
21		**Katawaki**	2,432	118,928	25,811	4.6	8	86	8	57	33	-	9	-	71	49
22		*Mayuge*	216	78,007	30,082	5.1	7	72	12	24	-	-	-	13.0	38	67
23		**Mbale**	518	332,571	76,358	4.4	15	72	10	14	-	3	25	14.0	52	-
24		**Manafwa**	581	262,566	58,251	4.1	11	85	4.3	15	20	-	50	2.0	41	81
25		**Namutumba**	813	167,691	33,741	5.0	6	84	3.9	63	30	-	7	-	80	48
26		**Pallisa**	1,581	384,089	100,144	3.8	20	86	5.0	43	41	0.9	13	0.9	51	-
27		**Soroti**	3,378	369,789	70,455	5.2	16	76	11.0	50	31	-	14	4.2	79	66
28		**Sironko**	1,093	283,092	67,394	4.2	16	81	5.0	15	36	12	34	2.1	71	49
29		**Tororo**	1,194	379,399	80,334	4.8	17	78	15.0	48	31	1	12	8.0	62	53
30	Northern	**Amolator**	1,709	96,189	19,637	4.9	5	81	6.0	76	19	-	2	-	32	46
31		*Abim*	524	6,701	5,526	4.7	2	-	-	-	-	-	-	-	-	-
32		*Apac*	1,492	79,917	31,425	4.7	8	88	6	-	-	-	-	-	59	-
33		**Dokolo**	1,077	129,385	25,801	5.0	5	91	4	27	32	2	35	3.0	83	49
34		*Kotido*	2,264	123,747	29,011	4.7	4	-	-	-	-	-	-	-	-	-
35		*Lira*	783	99,972	47,824	4.8	6	79	13	21	-	1	33	8.0	61	-
36		*Moroto*	7,284	168,220	31,460	5.2	10	71	12	68	27	1	4	-	51	65
37		*N piripirit*	3,942	101,464	21,610	5.5	7	70	8	55	34	1	6	-	44	45
38		*Kaabong*	1,838	113,304	24,481	4.7	4	-	-	-	-	-	-	-	-	-
Total/Average			57,083	7,685,060	2,001,429	5	361								62	73

Notes 1. Districts in Italic are not 100% within the Study Araea 2. Data sources are: UBOS, Sanitation Sector Performance Report
3. Area means area within Study area only 4. S/C are only within Study area 5. WSSP: Water Supply Sector Performance 6. GSF: Gravity Scheme Flow

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, Beans, Sorghum, Potato, Banana, Sugarcane 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.

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.

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.
During the field visits it was noticed that there are many young people collect water from the distant sources using bicycles or even small trucks and sell them in the townships. One 20 liter Jerrican of water costs only 100 UGX.

A Roadside Vegetable Vendor

Making Charcoal is also another way to make some money for living. It was observed that in some places bushes have been cleared and trees are used for charcoal and the land is for cultivation.

Someone might think that why Ugandan have to suffer from water shortage when it is endowed with fresh water lakes/rivers and reasonable about of annual rainfall. They might also question why majority of Ugandan don't have access to the clean water? Why Ugandan women and children have to spend much of their valuable time in collecting drinking water from far distances? Yes, the truth is

A Drinking Water Source

Water Vendor with Filled Jerricans

still national coverage of water supply is 65% (as of 2004). The condition within the Lake Kyoga Basin is not better compared to the national average. Among the three regions that cover Study area, Central has an average coverage of 62%, Eastern has 60% and Northern has 57% (Water and Sanitation Sector Performance Report, 2008). The reason of the low coverage is inferred; the efficiency of water distribution is low in rural area because of the scattered houses, and the water yield of one borehole is relatively small amount because of the hydrogeological condition in case of groundwater use. The responsible organization for water supply for urban centers which are profitable even though surface water treatment facilities were constructed is National Water and Sewerage Corporation (NWSC). On the other hand, District Water Office (DWO) is responsible for water supply of small towns and rural areas directly.

Generally speaking there are four types of sources that are used for drinking water. They are Boreholes (deep and shallow), Protected springs, Open water/Gravity flow schemes and Tapped water. Only in the bigger townships have tapped water supply, rests are BH, Springs or Open water/gravity flow. The quality of water is generally good, however, there are complaints that some BHs are turbid. Among other problems in drinking water supply are seasonal variations of supply, non-functional BHs.

The access to sanitation coverage in the country is not bad. Recently number of pit latrines has increased significantly. But they are mainly in urban areas. In the rural areas the situation still needs to be improved. In the Study area, covered-pit-latrines share the most (47 ~72%), but 10% of the families have no latrines in the central, 25% in the east and 31% in the northern districts. Although standard hygiene and excreta disposal is an influential aspect in the prevalence of diseases and their spread people ease at bushes.

The distance itself and transportation means to the district hospitals, insufficient number of doctors, and lack of stock of medicines are the main constraints for proving adequate services to the people.

A Protected Spring

A hand pump (shallow BH)

6.5 Socio-Economic Survey

6.5.1 Outline of Socio-Economic Survey

The purpose of the socio-economic survey is to collect basic data/information for understanding the socio-economic conditions of the inhabitants living in the Lake Kyoga Basin. Apart from the general socio-economic information, the survey is designed to cover the areas of water resources and water supply conditions in the Study area, status of public participation in O&M of water supply facilities, health, hygiene and sanitation conditions.

125villages were selected within the districts concerning in Lake Kyoga Basin exclude nine districts in the northern part of the Study area for security reason. Criteria for the selection were as follows; 1) village number for the surveying was determined by number of sub-counties in each district, 2) villages were distributed in whole survey area, and 3) village was as close as possible to Rural Growth Center (RGC). The district-wise distribution of villages and name of the sub-counties are presented in Table 6-3. The locations of the selected villages are presented in Figure 6-2.

Because the number of sub-counties in the area is 310, survey number 125 is recognized as significant number.

The survey was consisted “Village survey” which would be clear the general village condition, and “Household survey” selected three households in the village which would be investigated villagers condition.

Table 6-3 Targeted Villages of the Socio-Economic Survey

Region	District	Number of Village	Sub-county
Central	Kayunga	5	Bbaale, Galiraya, Kitimbwa, Kayonza, Nazigo
	Luweero	4	Bamunanika, Kikyusa (2 villages), Zirobwe
	Mukono	6	Kawolo, Ngogwe, Nakisunga, Nabaale, Ntunda, Ngoma
	Nakasongla	5	Nabiswere (2 villages), Lwampanga, Wabinyony, Ngoma
	Wakiso	3	Kira, Nangabo, Busukuma
	Sub total	**23**	
Eastern	Amuria	5	Kapelbyong, Obalanga (2 villages), Orungo, Wera
	Budaka	4	Iki-Iki, Lyama, Buseta, Kadama
	Baduda	3	Bublita, Bududa,, Bukigai
	Bugiri	5	Nabukalu, Buluguyi, Kapanyanga, Buwwunga, Nankoma
	Bukedea	4	Kachumbala, Kidongole, Koir, Malera
	Bukwa	1	Kabei
	Busia	3	Bulumbi, Butebi, Masaba
	Butaleja	4	Budumba, Butaleja, Busaba, Kachonga
	Iganga	6	Bukooma, Ikumbya, Nabitende, Nakigo, Buyanga, Bulamagi,
	Jinja	3	Busedde, Kakira, Buyengo
	Kaliro	4	Gadumire, Namugongo, Namwiwa, Nawaikoke
	Kapchorwa	5	Kaproron, Ngenge,(2 villages), Unknown(2 villages)
	Kamuli	6	Kidera, Kagulu, Blawoli, Nabwigulu, Buyaza, Kizisi
	Kaberamaido	5	Ochero, Alwa, Anyara, Bululu, Kalaki
	Kumi	5	Mukongoro, Nyero, Ongino, Kapir, Kobwin
	Katakwi	6	Usuk(2 villages), Katakwi, Toroma, Magoro, Unknown(2 villages)
	Mayuge	2	Buwaya(2 villages)
	Mbale	3	Busiu, Busoba, Nakaloke
	Manafwa	3	Butiru, Bupoto, Buwagogo
	Namutumba	4	Bulange, Ivukuta, Kibale, Namutumba
	Pallisa	5	Butebo, Kibale, Agule, Kasodo, Puti-puti

Table 6-3 Targeted Villages of the Socio-Economic Survey

Region	District	Number of Village	Sub-county
	Soroti	6	Bugondo, Pingire, Katate, Asuret, Gweri, Katine
	Sironko	5	Bunambutye,(2 villages), Oyembe, Buhugu, Bunasifwa, Unknown
	Tororo	5	Kwapa, Molo, Lyolwa, Bulanda, Paya
	Sub total	**102**	
Grand Total		**125**	

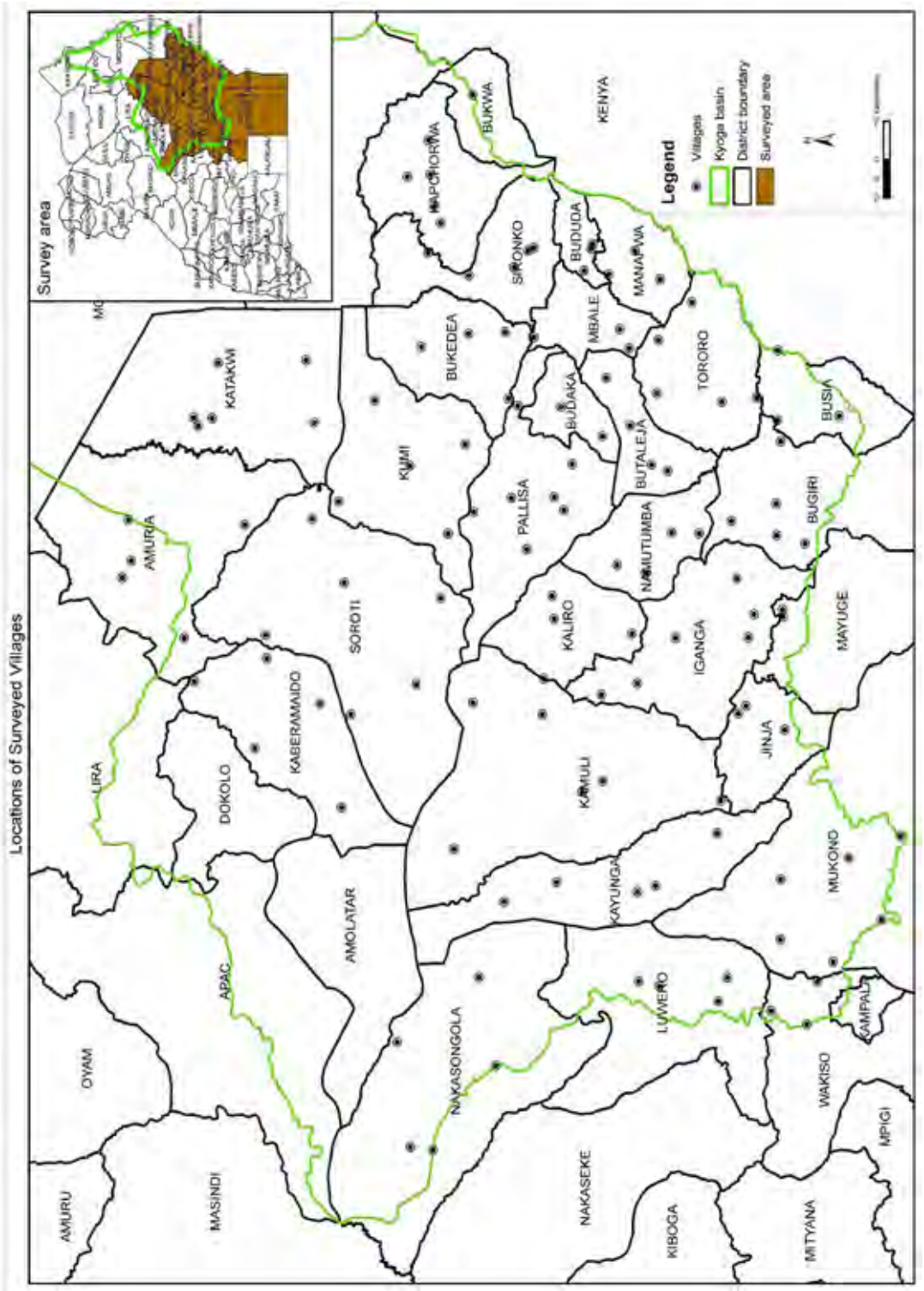

Figure 6-2 Location of Target Villages for Socio-Economic Survey

6.5.2 Survey Results

"Village Survey" is conducted as interview survey using by questionnaires against the representative of the village, namely village leader, chairperson or vice chairperson, in the selected 125 villages. As "Household Survey", a total of 375 household questionnaires were filled in 125 villages spread out over the survey area, and where possible households in different wealth classes were interviewed within a village. The wealth status is a relative status within the village; the village leaders assisted in selecting the households per wealth class. The results are described below.

(1) Feature of Surveyed Village

i) Demographic and Ethnic Information

Based on estimated figures from the respondents, the total population of the 125 villages interviewed is 182,254 people, with an average village size of 1,458 people, and varying between a size of 200 to a size of 6,500 people per village. On the other hand, the total household number is 40,183. Therefore, the household size is calculated as 4.5 people, this is the same range of the result of the Census 2002 (UBoS). The respondents estimated more women than men in their villages (105,030 as compared to 77,224, respectively).

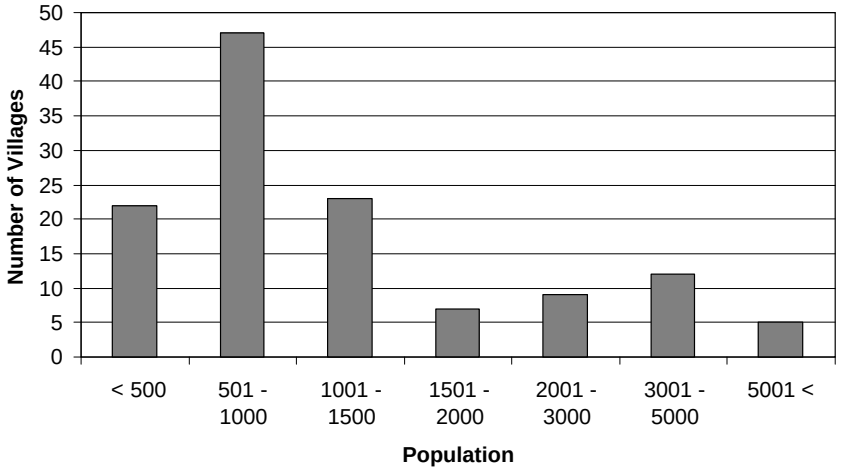

Figure 6-3 Population Distribution in the Surveyed Villages

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 as shown in Figure 6-4.

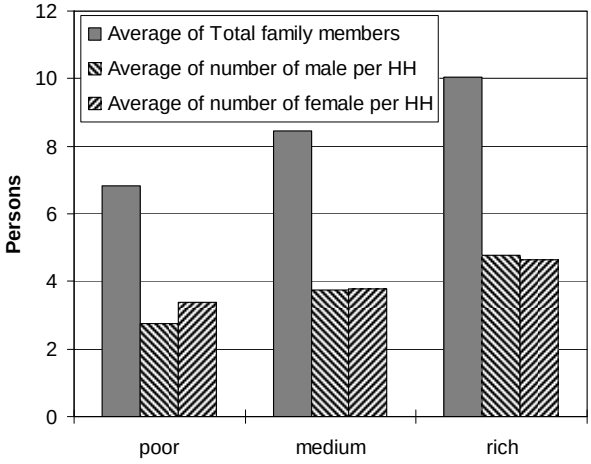

Figure 6-4 Average Household Size

Twenty-three villages are situated in the Central Region, and 102 villages in the Eastern Region of Uganda. The study area is ethnically very heterogeneous: nineteen different ethnical main identities were recorded during the village survey, as shown in **Figure 6-5.**

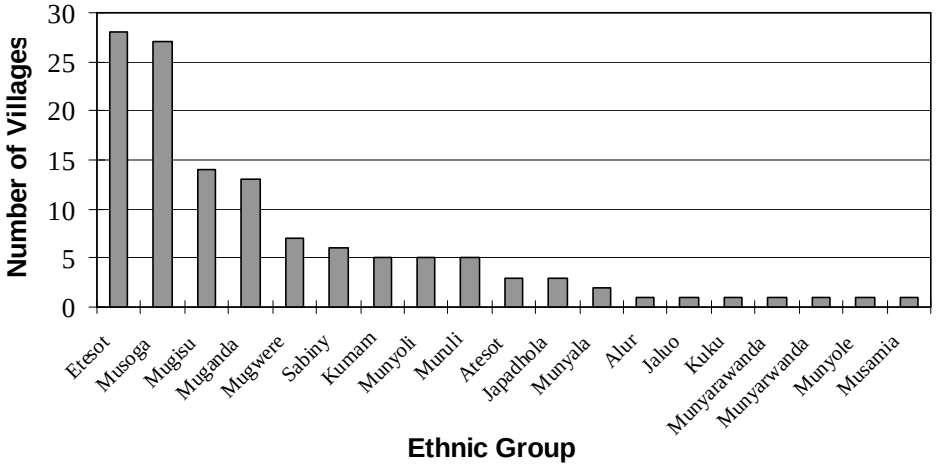

Figure 6-5 Ethnic Variations of the Village Leaders

ii) 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.

Table 6-4 Engagement in Economic Activities

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

Income and wealth information is listed in Table 6-5. 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. It should be noted that respondents in many cases had difficulties in establishing their yearly income, especially respondents running poor households, and the figures should be regarded as estimates only.

The people in the study area largely depend on agriculture, as reflected by the percentage income derived from agriculture, which is on average half of their total income, and even slightly more for the poor and medium households (72 %, and 66%, respectively). Poultry provides about 5% of the average income. Fishery is hardly done as an economic activity. Most fishing, when done, is carried out for own consumption only. Other income, including for instance salary as a teacher or daily labourer, constitutes the other main part of the income.

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.

Households on average own 3.6 cattle and 6.5 poultry (local chicken). The number of cattle and poultry is directly related to wealth, with poor households owning 2 cows/goats and 4 local chickens, and rich households having 9 cows/goats plus chickens.

Table 6-5 Average Wealth Indicators per Household

Wealth Indicators		Wealth Class of Household			
		Poor	Medium	Rich	Overall Average
Av. Annual Income	(UGX)	**403,278**	**1,352,132**	**4,871,464**	**1,661,400**
Av. Income from Agriculture	(UGX)	291,571	895,316	1,795,072	845,819
	/Income	72%	66%	37%	51%
Av. Income from Poultry/dairy	(UGX)	11,971	79,464	279,206	91,301
	/Income	3%	6%	6%	5%
Av. Income from Fishery	(UGX)	-	2,426	1,449	1,367
	/Income	0.00%	0.18%	0.03%	0.08%
Av. of other Income	(UGX)	106,948	390,442	2,818,897	761,258
	/Income	27%	29%	58%	46%
Av. Monthly Expenditure	(UGX)	48,178	106,213	401,251	138,365
Av. Annual Expenditure	(UGX)	**578,136**	**1,274,556**	**4,815,012**	**1,660,380**
	/Income	143%	94%	99%	100%
Av. Loan	(UGX)	21,795	585	720,000	247,283
Av. Monthly Expenditure for Water Related	(UGX)	4,525	4,773	22,296	9,452
	/Monthly Expenditure	9%	4%	6%	7%
Av. Number of Cattle		1.7	2.9	9	3.6
Av. Number of Poultry		3.6	6.2	12.7	6.5

iii) 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

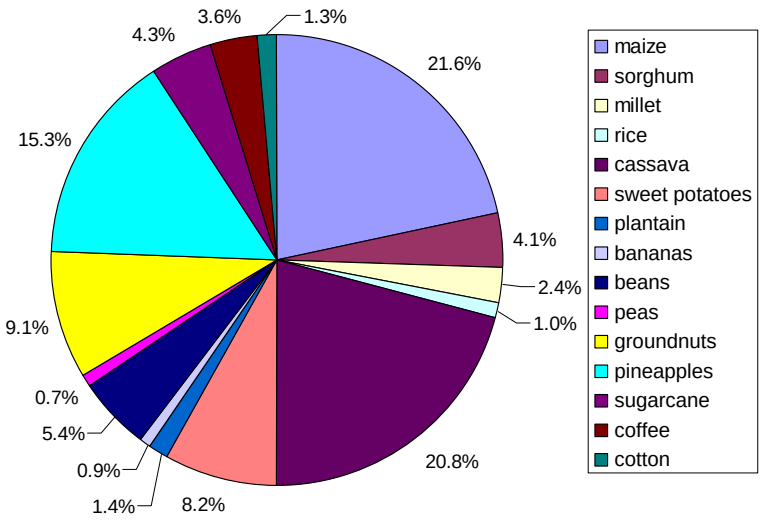

Figure 6-6 Ratio of Cultivated Area by Crops

establish the amount of acres for a specific crop. The Figure 6-6 shows the kinds of cultivated crops. Maize field constitute 22% of the total stated cultivated area, with cassava and pineapple cultivation using 21% and 12% of the cultivated area, respectively. The growing of pine trees constitutes the largest percentage of cultivated land (20%); this is commercial farming on 250 acres carried out by the owner of just one household, and this was excluded from the Figure 6-6.

iv) Existing facilities and infrastructure

The visited villages have in total 157 primary schools, corresponding to 1,160 people per primary school. The villages have a total of 41 secondary schools. A total of 93 health centres were registered in the visited villages, which means that one health centre covers on average 1,960 people, or less than one health centre per village. The villages have in total 258 churches of different denominations, which gives an average of 706 people per church, or 2 churches per village. Only 19 banks were present in the 125 villages, or 9592 people per bank.

There is no electricity available in the majority (78%) of the villages. The mobile telephone network is however good, with network in 120 out of the 125 villages.

(2) Water supply and Sanitation

i) Drinking Water Sources

The ratio of main drinking water sources is shown in Figure 6-7.

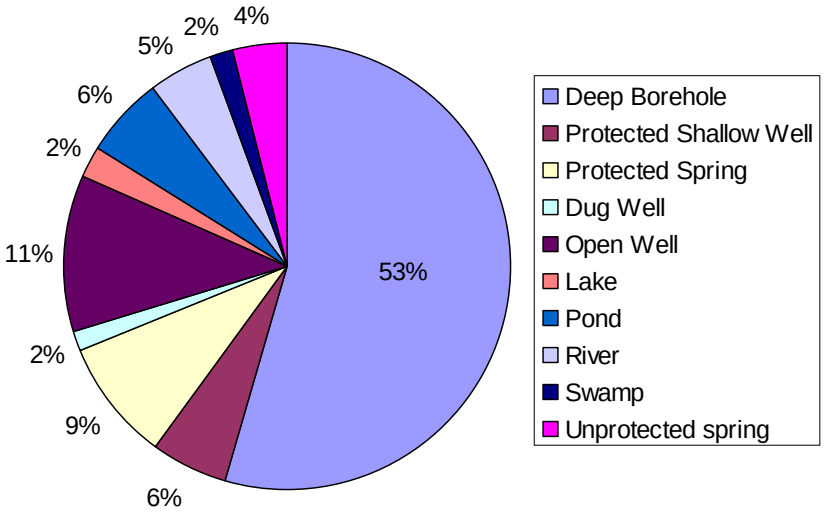

Figure 6-7 Ratio of Main Water Source in Surveyed Villages

The majority of the main water sources consist of deep boreholes (68 villages). Total of deep borehole, protected shallow well and protected spring as safe water source becomes 68% out of whole water source. On the other hand, 32% of whole surveyed villages are using unsafe water source. The type of point sources can be subdivided in safe water supplies providing non-polluted drinking water, and unsafe water supplies. Safe water supply types include deep boreholes, shallow boreholes equipped with a hand pump, protected springs, and shallow wells equipped with a hand pump. Unsafe sources include swamps, lakes, ponds, unprotected springs and open wells. The safety of water supply from dug wells depends on the withdrawal mechanism and the protection of the surrounding area. Piped water is available in 4 of the 125 visited villages.

ii) Water Supply Facilities Which Villagers Are Using

Water supply facilities which they are using were interviewed up to three kinds in the "Household Survey". The overall larger part of the population, which is overall a rural population, is supplied by point sources rather than a piped water supply.

The majority of the households interviewed, 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). Nine households (2%) 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.

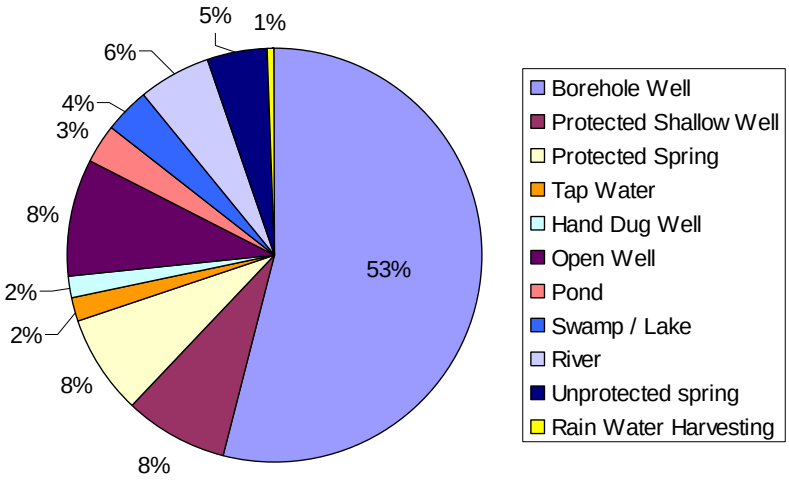

Figure 6-8 Ratio of Water Supply Facilities Which Villagers Are Using

The water quality of the sources is described as good by 60% of the respondents, and 40% as bad. The main reason for bad quality stated is turbidity (described as muddy, brownish colour); other reasons are hardness and saltiness of the water, and bad odour. Part of these reasons can be attributed to high iron content.

iii) Time Spent on Collecting Water

The average time required to fetch water, i.e. the total time required to fetch water including waiting time, is 95 minutes, varying from 10 minutes to 6 hours daily. The interviewed people revealed that most of the time is taken by waiting at the source, which means that it is the yields of water sources rather than the distribution of sources that forms the problem.

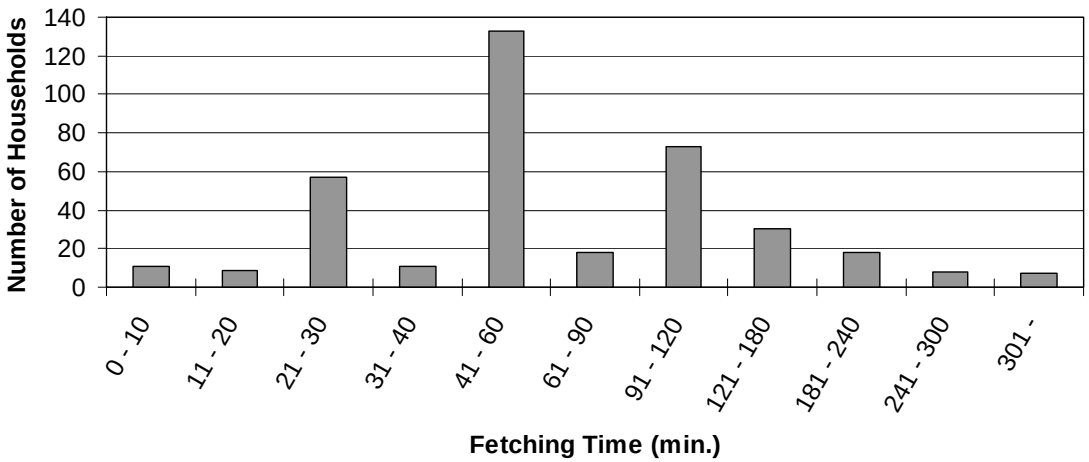

Figure 6-9 Time Spent on Collecting Water

iv) Water Consumption and Fee

People use on average 18 litres per person per day for domestic purposes, including drinking, cooking and washing. Although someone pay the water fee monthly and others pay by jerrycan, etc., they are paying 1.47 UGX per one liter in whole average. However, poor class people are paying less than 1 UGX per 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.

Table 6-6 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	6.8	8.4	10.1	8.2
Average of water price per litter	0.98	1.21	2.26	1.47
Water Used (person/day/litters)	15.7	17.5	19.9	17.5
Willingness to pay for improved water system (% of yes)	94.7	88.9	98.6	93.1

v) Willingness to pay and Operation & Maintenance

Water supply is a big issue for the population, and people spend a lot of time collecting it. Therefore, most people indicate they would be willing to meet the operation and maintenance cost of a tap water delivery system. Also, if the existing system is improved and an extra fee is charged, the people are willing to pay for it. The whole population is in favor of applying strict rules for water fee collection.

vi) 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 (see also **Figure 6-10**).

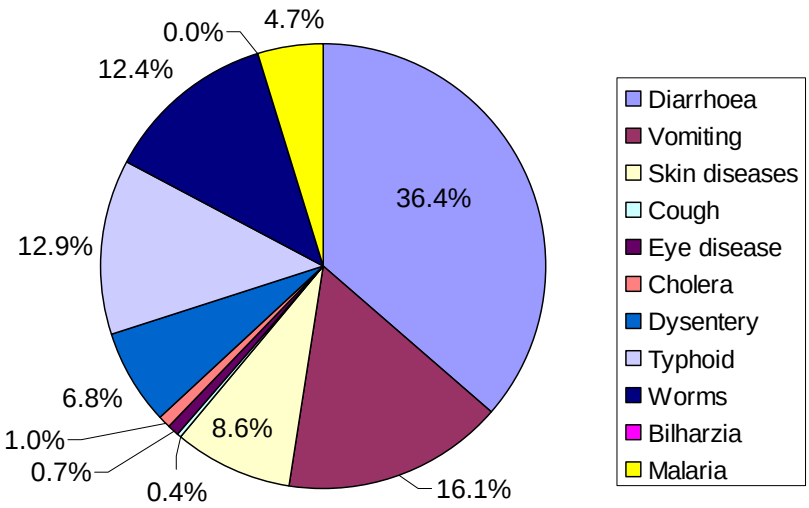

Figure 6-10 Occurrences of Reported Cases of Waterborne Diseases

According to the result of "Household survey", thirty-three percent 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.

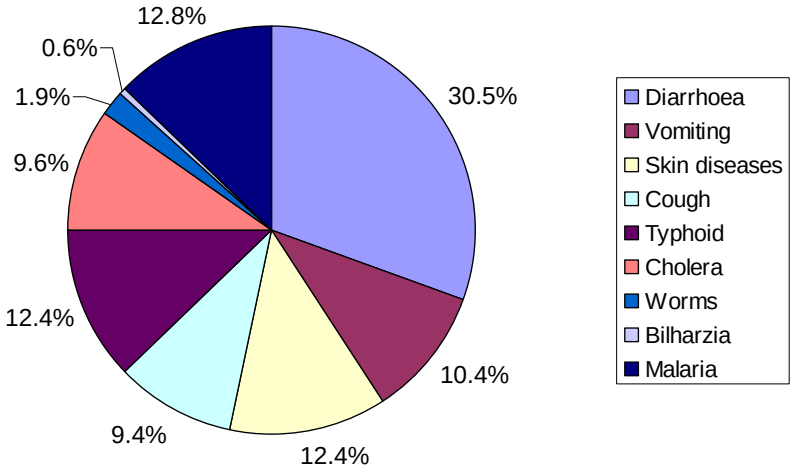

Figure 6-11 Reported Waterborne Diseases by Respondents

Generally speaking, drinking unsafe water leads to a higher incidence of water borne diseases. Safe water supplies include mainly deep boreholes, and to a lesser extent, protected springs and protected shallow wells. A closer look at the village database with regard to the possible link between use of unsafe water supplies and records of waterborne diseases reveals that there is no clear relationship. Water borne diseases were reported in 31 villages out of 60 villages having a deep borehole as their main source, all five villages using a protected shallow well reported water borne diseases, and five of the 13 villages with protected springs as main water supply recorded water borne diseases. On the contrary, the five villages using mainly unsafe stream water did not experience water borne diseases over the last year.

On average, the villages report that improved latrine coverage is 63%. The 60 villages that report to have had water borne diseases over the last year have a slightly lower reported latrine coverage of 61%, as compared to 66% latrine coverage in villages without reported water-borne diseases. There may be many parameters impacting on the prevalence of water-borne diseases, including hand washing practices and other sanitary improvements other than water source or latrine coverage.

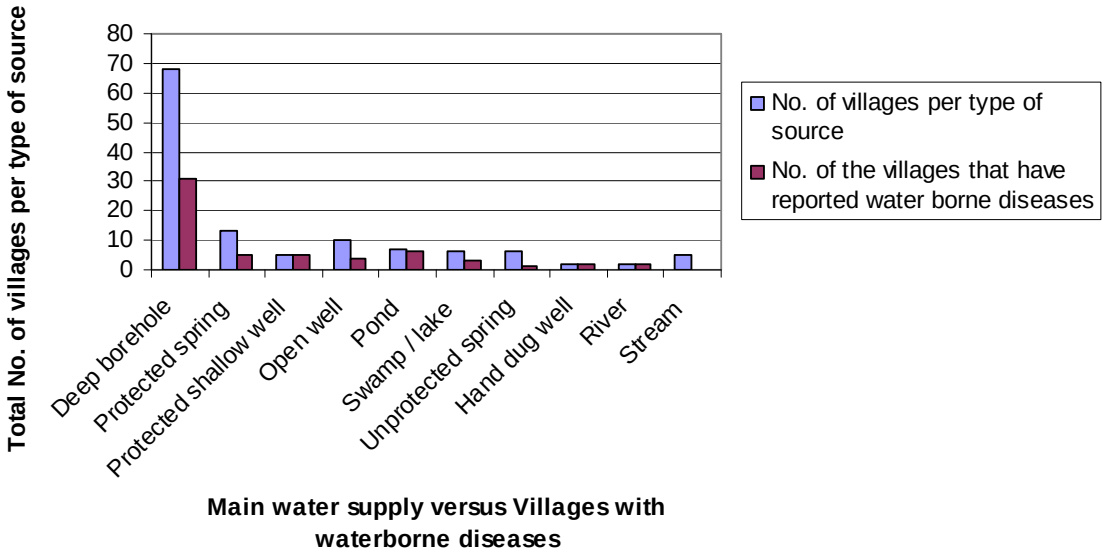

Figure 6-12 Water Sources and Occurrence of Water Borne Diseases

(3) Needs of Villages

i) 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 (see also Figure 6-13).

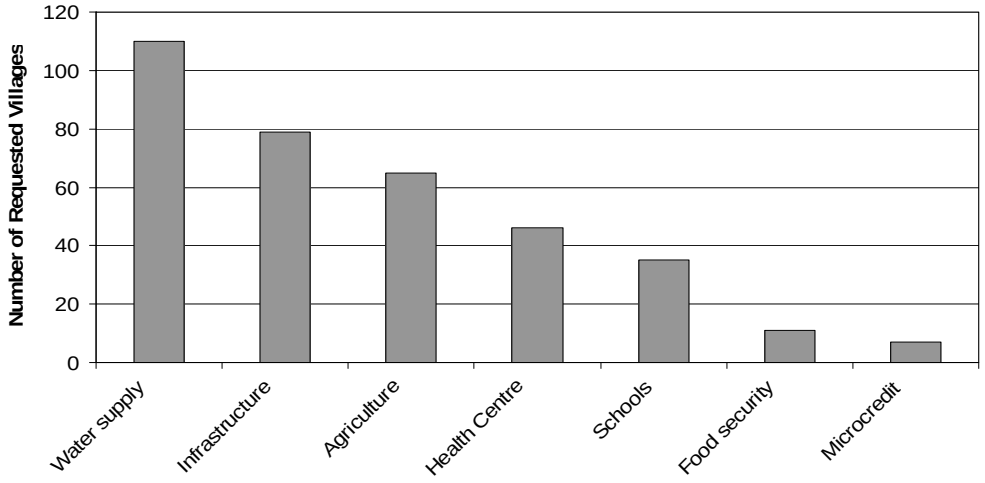

Figure 6-13 Needs for Development in the Surveyed Villages

The respondents indicated a great number of needs for their community. These needs have been grouped in categories as indicated in Figure 6-14. Most often, 23 % of the indicated needs, relate to drinking water supply, followed by agricultural support (22%), education as well as roads (both 12%), and health (11%). Agricultural support covers mainly needs for improved seeds, fertilizers, and agricultural machinery (especially ox ploughs).

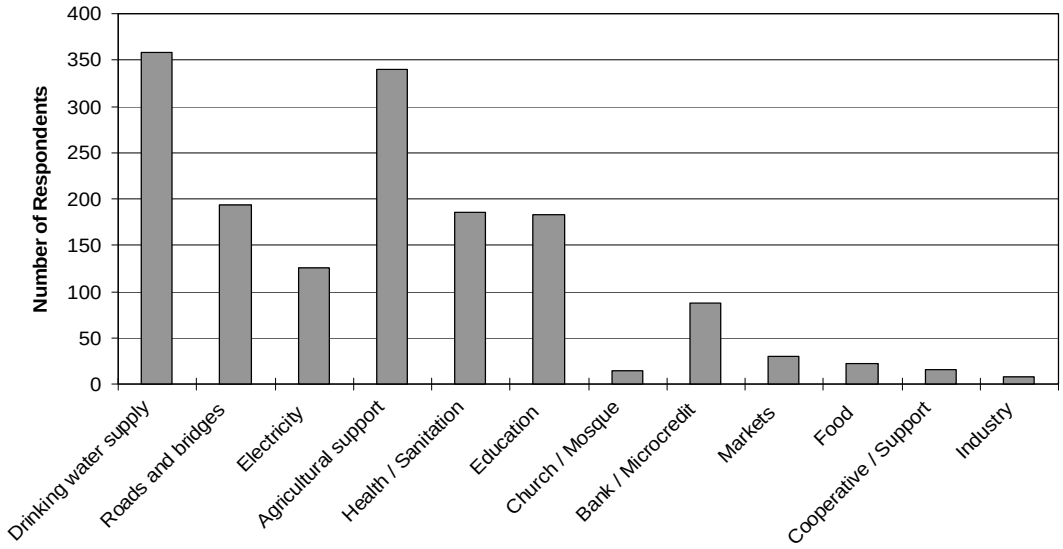

Figure 6-14 Needs of the Communities

ii) Active Organizations in the Surveyed Villages

Surveyed villages have various ongoing development activities under the lead of Government of Uganda. A total of 44 development organizations were mentioned during the Village Survey. The major activity is in the field of agriculture. NAADS (National Agricultural Advisory Services) is involved in many of these agricultural activities. NAADS is a semi-autonomous body, which was established June 2001 under the NAADS Act. The purpose of the agricultural activities is to improve rural livelihood with the increase of agricultural productivity, and poor farmers, women, youth and disabled people in the rural areas are specifically targeted. International Donors and NGOs have overall little participation in those activities. The second-largest organization is made up of all governmental structures, at national and local government level; twenty-two percent of the development organizations are part of government.

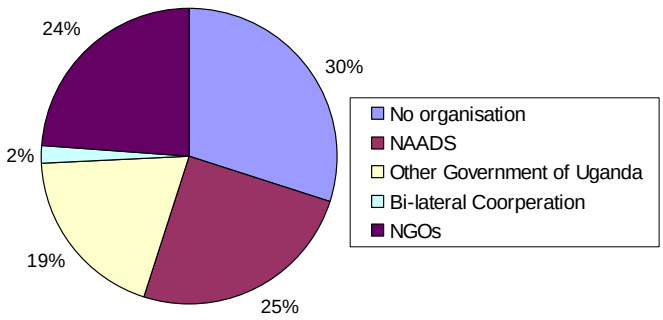

Figure 6-15 Main Development Organizations in the Surveyed Villages

Ongoing development activities in the surveyed villages are mostly in the field of agriculture (47%), followed by activities in the fileds of education and health, with 33%, and 32%, respectively, of the villages engaged in related development activities. Development activities in the field of infrastructure include road construction, and the building of schools and churches; these developments take place in 19% of the surveyed villages, whereas savings and credit groups and microcredit facilities are mentioned to be present in 11% of the surveyed villages. Thirty-two percent of the surveyed villages are not involved in any development activity (see also **Figure 6-16**).

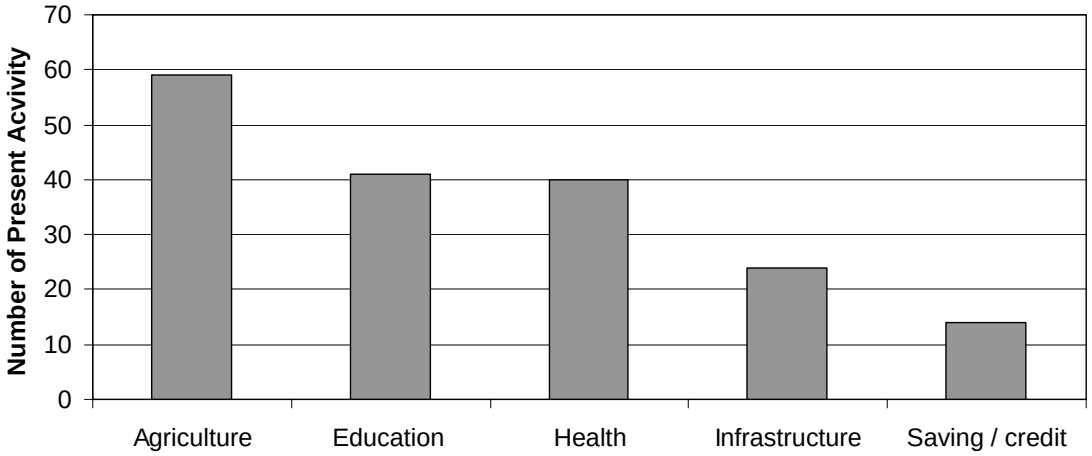

Figure 6-16 Major Activities in the Surveyed Villages

CHAPTER 7 POLICY, INSTITUTIONAL FRAMEWORK AND ORGANIZATION

The policies, regulatory and institutional framework for the water and sanitation sector development in Uganda are described below.

7.1 Framework for Sector Development

The Government of Uganda put in place the Poverty Eradication Action Plan (PEAP) as a national framework for poverty eradication. The PEAP, which was first prepared in 1997 and revised in 2000 and 2004 (MoFPED, 2004), has adopted a multi-sectoral approach. The PEAP objectives are being addressed through various programs including water and sanitation. In PEAP 2004 the water and sanitation sector falls under the following two (2) pillars:

- Pillar 2: Enhancing production, competitiveness and incomes (includes water for production and water resources management) and
- Pillar 5: Human Development (includes rural and urban water supply and sanitation).

The PEAP 2004 was originally set to expire at the end of June 2008, but was extended for one (1) year. The PEAP has been evaluated and results are currently being fed into the revised PEAP, which will be called the National Development Plan (NDP). The overall objective of the NDP is wealth creation - prosperity for all.

In 1997, Cabinet directed the ministry responsible for water to reform the sector with a view to ensuring that (1) services are provided and managed with increased efficiency and cost effectiveness; (2) government's burden, especially in relation to operation and maintenance of water supply and sanitation systems, is decreased; and (3) services are increasingly more accessible by, and affordable to, the poor. The reforms, in line with government's policy of decentralization, also sought to limit central government's involvement in the sector to policy making, setting priorities, standards development, resource mobilization, monitoring and evaluation, capacity building and managing water resources. Four subsector reform studies were accordingly carried out as follows:

(i) Rural Water Supply and Sanitation Reform Study (1999-2000);
(ii) Urban Water Supply and Sanitation Reform Study (1999-2000);
(iii) Water for Production Reform Study (2002-2004); and
(iv) Water Resources Management Reform Study (2004-2005).

The main output from these studies was a strategy for each sub-sector to guide investment planning, resource mobilization, establishment of management and implementation frameworks and policy for capacity building.

These reform studies were undertaken between 1999 and 2005 and completed at different times. Consequently, the respective sub-sector investment plans were not coordinated. This led to fragmentation of sector investments. The sector has continued to evolve since the sub-sector investment plans were completed, including the creation of many more District Local Governments (from 36 in 2001 to 80 in 2008), changes to the MoWE structure and a new policy of bulk water transfer for multi-purpose use.

7.2 Policy Objectives

The overall policy objectives of the Government for water resources management, domestic water supply and sanitation and water for production respectively are as follows (National Water Policy, 1999, and Uganda Water and Sanitation Sector Performance Measurement Framework. 2004):

i) To manage and develop the water resources of Uganda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations with the full participation of all stakeholders.

ii) To provide sustainable provision of safe water within easy reach and hygienic sanitation facilities, based on management responsibility and ownership by the users, to 77% of the population in rural areas and 100% of the urban population by the year 2015 with an 80% - 90% effective use and functionality of facilities.

iii) To promote development of water supply for agricultural production in order to modernize agriculture and mitigate effects of climatic variations on rain fed agriculture.

7.3 Policy and Regulatory Framework

The key policies and the legal framework in the field of Water and Sanitation sector are shown in the Table 7-1.

Table7-1 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.

7.4 Sub-Sectors

The water and sanitation sector consists of the four (4) sub-sectors: Rural Water Supply and Sanitation (RWSS), Urban Water Supply and Sanitation (UWSS), Water for Production (WfP), and Water

Resources Management (WRM).

7.4.1 Water Resources Management

The Water Resources Management (WRM) sub-sector is responsible for the integrated and sustainable management of water resources in Uganda so as to secure and provide water of adequate quantity and quality for all social and economic needs for the present and future generations. It does this through monitoring and assessment of the quantity and quality of water resources; storing, processing and disseminating water resources data and information to users; providing advice on management of transboundary water resources; regulating water use and discharge of wastewater into water bodies through issuing of water permits and providing analytical services for water quality analysis. WRM functions have been implemented at the central government level. Decentralisation of these functions to catchments has been initiated.

7.4.2 Rural Water Supply and Sanitation

The Rural Water Supply and Sanitation (RWSS) sub-sector covers all rural communities with populations up to 5000. The 2002 population census estimated the rural population at 21.04 million rising to 26.2 million by 2006 and 32.75 million by 2015. The sub-sector considers two divisions of communities, villages with populations up to 1500 and Rural Growth Centres (RGC) with populations between 1500 and 5000, which number approximately 850.

7.4.3 Urban Water Supply and Sanitation

The urban water supply and sanitation sub-sector is made up of large towns managed by the National Water and Sewerage Corporation (NWSC) and small towns as defined below.

- Large Towns are classified as those gazetted for operation by NWSC, which provides water and sewerage services in the 23 urban water centres in Uganda. Large towns in the Lake Kyoga Basin are Jinja/Njeru, Tororo, Mbale, Soroti, Mukono, Lugazi, Iganga, and Kaberamaido.
- Small Towns are gazetted Municipalities, Town Councils and Town Boards outside the jurisdiction of NWSC. In 2007/8, there were a total of 160 small towns 印 Uganda. There are 72 small towns in the Lake Kyoga Basin.

7.4.4 Water for Production

Water for Production refers to development of water resources for; productive use in agricultural (crop irrigation, livestock and aquaculture), rural industries, wildlife, recreation, hydropower generation, transport and commercial uses. With respect to Water for Agricultural Production, MoWE is the lead agency for water for production and development off-farm. MoAAIF is the lead agency for water use and management for agricultural development on-farm. The MoTTI's mandate covers water use and management of industries, commerce, wildlife and tourism. The mandate of MoEMD is water use and management for hydropower generation.

7.5 Institutional 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 7-1.

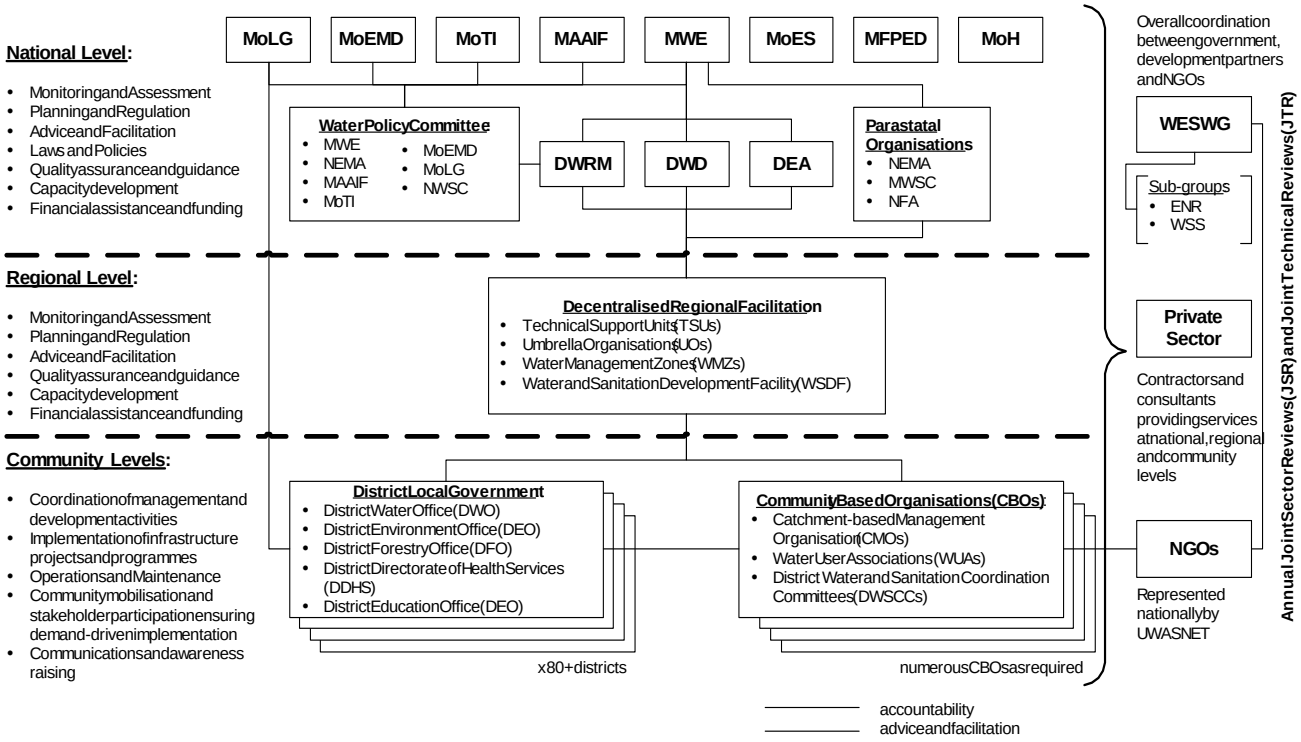

Figure 7-1 Institutional Setting for Water and Environment Sector in Uganda

7.5.1 National Level

(1) Ministry of Water and Environment (MoWE)

The Ministry of Water and Environment (MoWE) has the overall mission: "To promote and ensure the rational and sustainable utilization, development and effective management of water and environment resources for socio-economic development of the country". The ministry has three directorates: Directorate of Water Resources Management (DWRM), Directorate of Water Development (DWD) and the Directorate of Environmental Affairs (DEA).

MoWE has the responsibility for setting national policies and standards, managing and regulating water resources and determining priorities for water development and management. It also monitors and evaluates sector development programs to keep track of their performance, efficiency and effectiveness in service delivery.

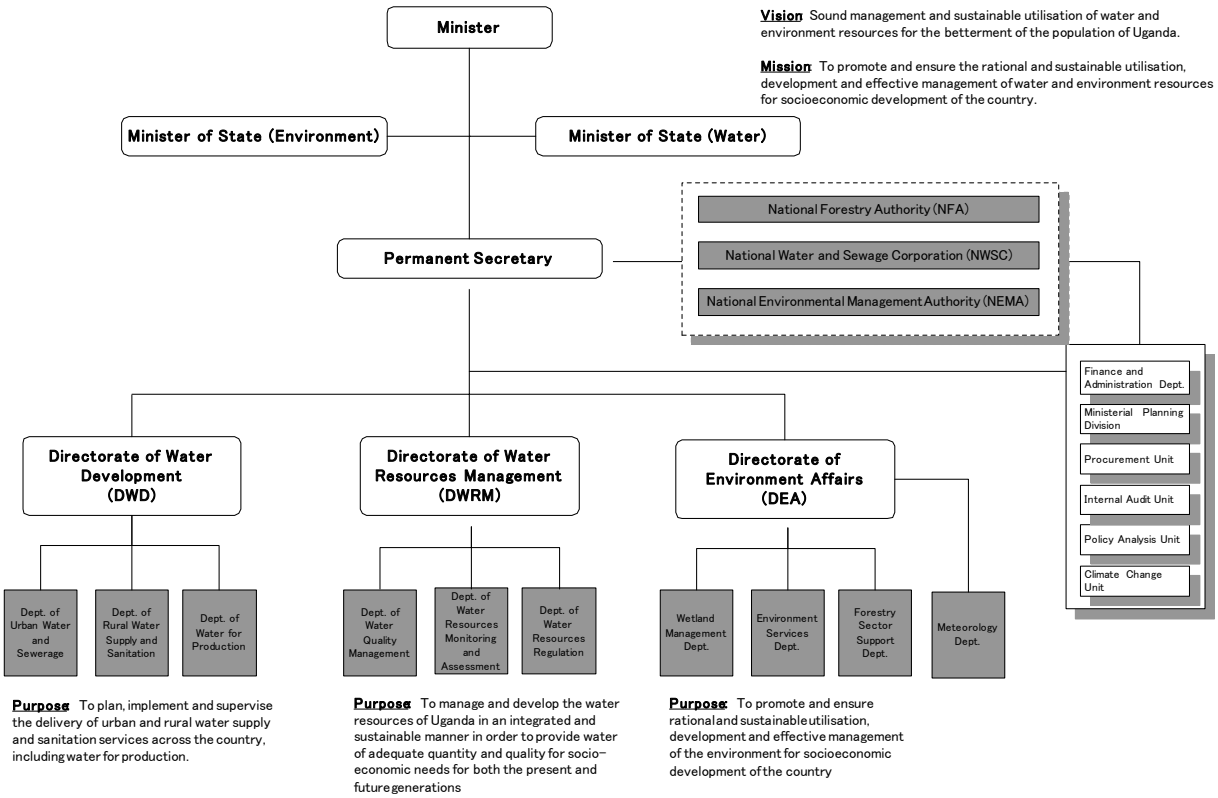

Figure 7-2 Organization of Ministry of Water and Environment

1) Directorate of Water Resources Management (DWRM)

The Directorate of Water Resources Management (DWRM) has a mandate "To promote and ensure rational and sustainable utilization, effective management and safeguard of water resources so that there is water of adequate quantity and quality to meet the social welfare and economic development needs of Uganda". The Directorate is responsible for monitoring, assessing, allocating and regulating water resources through the issuance of water abstraction and wastewater discharge permits. It also coordinates Uganda's participation in joint management of trans-boundary waters resources and peaceful cooperation with Nile Basin riparian countries.

The DWRM is to provide water abstraction permits to the Water Authorities, and waste discharge permits for those towns with sewerage as well as monitoring compliance with the permit conditions. DWRM also provides on demand services related to water quality as the case may be. DWRM may also move in to provide emergency water quality surveillance to guide the operations of water systems during periods of emergency e.g. algal bloom as in Lake Victoria, water hyacinth invasions, epidemics and floods. The DWRM does not link with districts directly but is in the process of decentralising the WRM functions to Water Management Zones (WMZs) and catchment level.

2) Directorate of Water Development (DWD)

The Directorate of Water Development (DWD) is responsible for regulation of water services and for providing the overall technical oversight for the planning, implementation and supervision of the

delivery of urban and rural water and sanitation services across the country, including water for production. It provides capacity development and other support services to Local Governments, Private Operators and other service providers.

DWD fulfils its responsibilities through three departments: Urban Water and Sewerage Department; Rural Water Supply and Sanitation Department and the Water for Production (WfP) Department. The WfP Department is responsible for regulation, quality assurance and monitoring of off-farm activities related to WfP as well as planning and implementation of bulk water/ multi-purpose water infrastructure. The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is responsible for the on-farm activities related to water for production.

DWD is still to some extent involved in designing, construction and operation and maintenance of water infrastructure mainly due to lack of capacity at the districts. As capacity is developed in the districts and more flexible mode of infrastructure financing such as the Water and Sanitation Development Facility (WSDF) is becoming operational, DWD will be limited to design, construction and support to operation of major multipurpose multi-district water infrastructure (dams for water supply and WfP, strategic reservoirs and bulk transfer systems); and planning and regulation of urban and rural water services within the overall assessment and planning framework provided by DWRM.

In relation to sanitation, DWD is responsible for planning and investment in sewerage services and public sanitation facilities in towns and Rural Growth Centers (RGCs), as well as technical capacity building and development for sanitation service delivery. NWSC and the local authorities are mandated (by DWD) to manage and support the use of adequate standards for the onsite sanitation and the sewerage systems in urban centers.

3) Directorate of Environment Affairs

The Directorate of Environment Affairs is responsible for promoting and ensuring rational and sustainable utilization, development and effective management of the environment for socio – economic development of the country. Of special relevance for the water sector is the Meteorology Department responsible for collecting, analysing and disseminating meteorological data. Mechanisms for real time data exchange between the Meteorology Department and DWRM should be established to facilitate the latter in its role, particularly on interventions for flood and drought forecasting and early warning systems.

4) National Water and Sewerage Corporation (NWSC)

The National Water and Sewerage Corporation (NWSC) is a parastatal under MoWE that operates and provides water and sewerage services for 22 large urban centres across the country including Kampala City. It is essentially a Water Authority for providing water and sewerage services in accordance with the Water Act Cap 152 and the subsequent regulations governing water supply and waste disposal.

NWSC’s activities are aimed at expanding service coverage, improving efficiency in service

delivery and increasing labour productivity. Key among its objectives is to invest generated surpluses towards infrastructure improvements and extensions.

5) National Environment Management Authority (NEMA)

The National Environment Management Authority (NEMA) is a parastatal under MoWE responsible for management of the environment in accordance with the National Environment Management Act Cap 153 and its subsidiary regulations. NEMA compliments the efforts of DWRM in ensuring compliance with discharges into public waters and the maintenance of environment flow through limitation of excess abstraction of water.

(2) Other Line Ministries

A number of other line ministries have important roles in the sector.

- **The Ministry of Health (MoH)**, in particular the Environmental Health Division (EHD) is the lead agency in hygiene and sanitation promotion and is responsible for providing overall policy and technical oversight for planning, implementation, and supervision of hygiene and sanitation promotion in the country. It is also responsible for planning, implementation, management, and monitoring of household hygiene and sanitation improvement through the management of the Public Health Care Conditional Grants (PHCCG). It develops guidelines, standards, and Information, Education and Communication (IEC) materials for the promotion of hygiene and sanitation by local governments and other service providers. Through the area support teams, it assists local authorities in the development of adequate work plans and budgets and also capacity building in hygiene promotion.
- **The Ministry of Education and Sports (MoES)** is responsible for hygiene education and provision of sanitation facilities in primary schools. It also promotes hand washing after latrine use in the schools.
- **The Ministry of Local Government (MoLG)** is responsible for capacity building in local governance and policy supervision of local authorities. MoLG is responsible for establishing, developing and facilitation of management of effective decentralised local government systems. It also oversees the implementation of Local Government Development Plans that also includes water supplies and improvement of hygiene and sanitation in institutions and public places.
- **The Ministry of Gender, Labour and Social Development (MGLSD)** is responsible for gender responsiveness and community development/mobilization. It assists the sector in gender responsive policy development, and supports districts to build staff capacity to implement sector programs.
- **The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)** spearheads agricultural development. This includes the on-farm use and management of water for production (irrigation, animal production and aquaculture).
- **The Ministry of Trade, Tourism and Industries (MoTTI)** is responsible for in house water facilities for rural industries, wildlife and recreation with the MoWE/ WfP Department

responsible for the bulk water supply infrastructure.

- **The Ministry of Energy and Mineral Development (MoEMD)** is responsible for hydropower generation. It plans for the implementation of hydropower infrastructure in collaboration with DWRM. Its water use is largely non-consumptive.
- **The Ministry of Works and Transport (MoWT)** and the Uganda National Roads Authority (UNRA). MoWT is responsible for policies and regulation of water transport as well as development and maintenance of non-national roads. UNRA is responsible for development and maintenance of national roads, as well as the provision of large passenger water vessels. The latter offers technical advice on specifications, procurement and operation and maintenance of mechanical equipment for maintenance of open waters and water ways. Their functions ensure that water ways remain clear and that no pollution/contamination is occasioned by the vessels.
- **The Ministry of Finance, Planning and Economic Development (MFPED)**, mobilises funds, allocates them to sectors and coordinates development partner inputs. MFPED reviews sector plans as a basis for allocation and release of funds, and reports on compliance with sector and national objectives.
- **The Ministry of Foreign Affairs (MoFA)** plays a lead role in negotiations over international waters, in particular the use of the Nile waters; in development of trans-boundary projects on Lake Victoria and the Nile with neighbouring countries and in development of institutional frameworks for cooperative frameworks for management trans-boundary waters. The MoFA also plays a lead role in the communication and negotiation with international Development Partners in the water sector.

The country has considerable Development Partner support for the development budget. These include ADB, Austria, BADEA, DANIDA, EU, France, Germany, JICA, UNICEF and SIDA.

The NGOs working in the sector are coordinated at the national level through Uganda Water and Sanitation NGO Network (UWASNET) an umbrella organization, which has been largely funded by sector development partners through MoWE.

7.5.2 District Level

Local Governments (Districts, Town Councils, Sub-Counties) are empowered by the Local Governments Act (2000) to provide water services. They receive funding from the center in the form of a conditional grant and can also mobilize additional local resources for water and sanitation programs. Local Governments, in consultation with MoWE appoint and manage private operators for urban piped water schemes that are outside the jurisdiction of NWSC.

The restructuring of Districts recommended that established posts in the District Water Office are the District Water Officer; Assistant District Water Officer; County Water Officers and Borehole Technician. This led to problems in implementation and follow up of community management and sanitation activities as District Water Officers were overwhelmed with activities. The District Community Development Department and Health Directorate were supposed to fill the human resource gap but the high demand for their services by the agriculture and health sector further complicated the situation. In a bid to address the gap, MoWE advised Districts to recruit staff on contract basis. Some Districts

seconded staff from the other Departments. However there are still staffing gaps in many Districts, which undermine the capacity to effectively implement and coordinate software and sanitation activities.

The current drive by MoWE to make it possible for Districts to engage NGOs in mobilization for Water and Sanitation activities is intended to address this challenge. A framework which spells out the guidelines to be followed by districts when procuring services of NGOs has been finalized and approved by PPDU. Districts are being encouraged to engage NGOs that have the expertise to carry out community mobilization, training, hygiene and sanitation promotion activities.

7.5.3 Private Sector

Private Sector firms undertake design and construction in the sector under contract to local and central government. Private hand pump mechanics and scheme attendants provide maintenance services to water users in rural and peri-urban areas. Private operators manage piped water services in small towns and rural growth centers.

7.5.4 Community Level

Communities are responsible for demanding, planning, contributing a cash contribution to capital cost, and operating and maintaining rural water supply and sanitation facilities. A water user committee (WUC), which is sometimes referred to as a Water and Sanitation Committee (WSC) should ideally be established at each water point.

7.5.5 Catchment Management Organizations

At the catchment or watershed-level within Uganda, Catchment Management Organisations usually encompass water management and development activities involving two or more Districts. Examples where such management is presently taking place include the Ruizi Catchment Management Organisation, the Lake George Basin Organisation, and the Lake Albert IWRM Project. Trans-boundary catchments organisations are also evolving for the Kagera River basin (shared with Burundi, Rwanda, Tanzania and Uganda) and the Sio-Malaba-Malakisi River basins (shared between Kenya and Uganda).

7.5.6 Capacity Building and Support Institutions

(1) Technical Support Units (TSUs)

Since 2002, Technical Support Units (TSUs) have been set up as temporary structures funded via the Joint Partnership Fund (JPF) to support the capacity building of district based structures. With the rapid increase in the number of districts this task is likely to be required for longer than originally foreseen. The TSUs have focussed on capacitating Districts for their role in the rural sub-sector however their mandate also covers water for production. The TSUs have not so far played any major role in the urban sub-sector. There are considerations being made about consolidating the TSUs and where relevant harmonising their functions with other emerging organisations with a regional presence such as the Umbrella Organisations (UOs), the Water and Sanitation Development Facility (WSDF) and the Water Management Zones (WMZs) in order to create synergies and promote IWRM.

(2) Umbrella Organisations (UOs)

Umbrella Organisations (UOs) are regional organisations constituted as associations of the local Water Supply and Sanitation Boards (WSSBs) with the principal objective of providing Operation and Maintenance (O&M) back-up support. The organisations provide training, technical, legal and organisational support to their member boards, including specific services such as the supervision of rehabilitation and extension works and water quality monitoring. Further, the organisations support and supervise monitoring and reporting procedures and hereby provide services to administrative bodies e.g. MoWE/ DWD and donors. The concept has been successful in the South West, where functionality of water systems is well above 90%. Two additional UOs have been set up to support the Eastern Region (Mbale) and the Mid-Western region (Kyenjojo).

(3) Water and Sanitation Development Facility (WSDF)

The Water and Sanitation Development Facility (WSDF) is a mechanism for supporting water supply and sanitation facilities for rural growth centres, small towns and large gravity flow schemes intended to promote a demand responsive approach where Water Authorities/Town Councils or Town Boards apply for funding. The successful applicant Water Authorities are assisted by the WSDF to develop piped water supply systems. The WSDF concept has been piloted in the South West (WSDF-South Western Branch) and has been rolled out to the Northern Uganda with the establishment of the WSDF-North in Lira in early October 2008. The WSDF is expected to be rolled out to the rest of the country within the next five years.

The WSDF will replace the present implementation support through a number of different projects for small town water and sanitation under DWD and will contribute to operationalising the Sector Wide Approach to Planning (SWAP) in the implementation of piped water supplies.

(4) Water Management Zone

As one of decentralization on Water Resources Management, Water Management Zone is planned. The purposes are; (i) the separation of regulatory functions from service provision; (ii) raising the profile of the government department responsible for Water Resources Management and attaching greater importance to this subsector; changing from centralized to catchment-based water resources management; (iii) using hydrological boundaries as opposed to political/administrative boundaries for catchment delineation; further consolidation of IWRM (Integrated Water Resources Management) approaches; (iv) integrating transboundary concerns in national planning; and (v) increasing

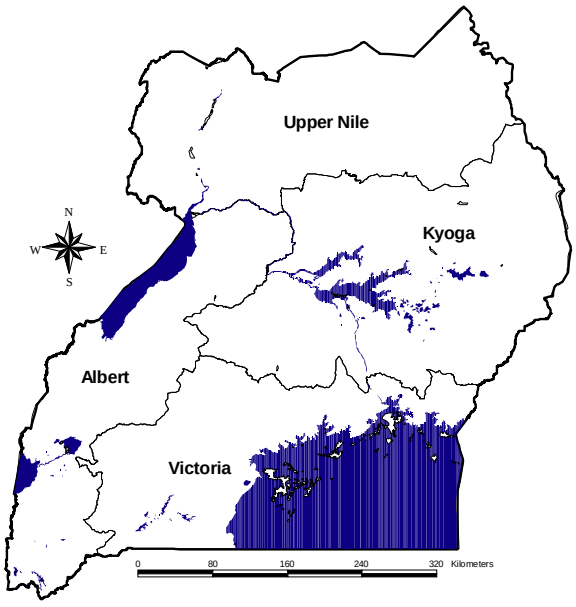

Figure 7-3 Water Management Zones

cross-sectoral coordination. The reform study proposed to subdivide the country into four water management zones whose boundaries closely follow the natural boundaries of river/lake catchments with adjustments to avoid districts belonging to more than one management zone. The four zones are Victoria, Albert, Kyoga and Upper Nile. The reform study also recommended a follow-on study to look into the possibility of establishing a National Water Institute to conduct water resources research, build capacity for IWRM and enhance outreach and communication to stakeholders.

7.5.7 Organization for Sector Coordination

The legal and institutional frameworks provide for organs that coordinate the activities of the sector. These are the Water Policy Committee (WPC), Water and Environment Sector Working Group (WESWG) and Annual GoU/Donor Joint Sector Reviews (JSR). These were established at national level to formulate policies and provide technical guidance to facilitate development of the water and sanitation sector and are central in managing the Sector Wide Approach to Planning.

At district level coordination takes place through the District Water and Sanitation Coordination Committees (DWSCCs).

(1) Water Policy Committee (WPC)

The Water Policy Committee (WPC) is established by the Water Act Cap 152. The WPC advises on water policy, standards for service delivery, and priorities for water resources management. The WPC also advises on revisions to legislation and regulations for water resources and also coordinates formulation of international water resources policy. The membership includes government ministries, and representatives from district local governments, private sector and NGOs.

(2) Water and Environment Sector Working Group (WESWG)

The Water and Environment Sector Working Group (WESWG) formerly the Water and Sanitation Sector Working Group (WSSWG) provides policy and technical guidance for the sector. The WESWG is made up of representatives from MoWE, NWSC, MoH, MoES, MoLG, MFPED, Development Partners, NGOs (represented by UWASNET) and Local Governments represented by the Uganda Local Governments Association (ULGA).

The National Sanitation Working Group (NSWG) was established in 2003 as a co-ordinating body to operationalise the sanitation MoU, integrate sanitation and hygiene promotion in sector operations and improve cross-sectoral co-ordination. It was tasked with establishing clear budget mechanisms for sanitation at all levels and test models in selected districts and urban councils to guide their strategy, work plans, budgets, implementation mechanisms and coordination at local government level.

(3) Annual GoU/Donor Joint Sector Reviews (JSR)

Annual GoU/Donor Joint Sector Reviews (JSR) are held and have the following objectives: i) Progress and performance of the sector is assessed in relation to 10 key sector performance golden indicators, ii) Agreement is reached on key strategic policy issues, and iii) Guidance is provided for resource allocation and use with particular emphasis on accountability and transparency. JSRs will continue to been held annually with annual Joint Technical Reviews (JTRs) held midway.

(4) District Water and Sanitation Coordination Committees (DWSCCs)

District Water and Sanitation Coordination Committees (DWSCCs) have been established in the districts. The DWSCC membership consists of administrative and political leaders, technocrats and NGO/ CBO representatives at district level. The role of the DWSCC is to oversee the implementation of WSS programmes, strengthen collaboration and coordination with other sectors (health, education, social development and agriculture) and other players (private sector, NGO and CBOs and civil society). Its mandate will need to be reviewed and streamlined with WRM decentralisation.