Month	Inflow (Mm^3)	Cum. Inflow (Mm^3)
Jun	1.31	13.38
Jul	1.23	14.53
Aug	1.22	15.62
Sep	1.30	16.79

6.1.4 *Water Quality Assessment*

During the field visit to the dam sites, water analysis was done on site or in several laboratories depending on proximity of the laboratory and these included the Water Laboratory at the department of Water Resources Engineering of the University of Dar es Salaam and at the University of Burundi where water samples collected in April 2012 were analyzed. The analyses were aimed at giving a quick assessment of the present status of the water quality at the dam sites.

The water samples taken to the laboratory were analyzed for the following parameters: pH, Electrical Conductivity (EC), Colour, Turbidity, Total Dissolved Solids (TDS), Total Hardness (TH), Total Alkalinity (TA), Nitrate (NO_2), Nitrite (NO), Ortho-Phosphorus, Total Phosphorus (TP), Total Nitrogen (TN), Ammonia (NH4) and Iron. The results of the analysis are presented in ***Table 6-2.***

Table 6-2: Results of Water Quality Analysis

S/NO	PARAMETERS	Mwongo River		WHO Guidelines
		(a)	(b)	
1	pH	7.24	8.9-9.3	6.50 – 8.50
2	Electrical Conductivity (uS/cm)	160	47-49	2000
3	Colour (mg PtCo/l)	105	565-1012	15
4	Turbidity (FTU)	72	72.3-119	5
5	Total Dissolved Solids (mg/l)	94.60	31-31	1000
6	Total Hardness (mg/l as $CaCO_3$)	56.50	25-30	500
7	Total Alkalinity (mg/l as $CaCO_3$)	90	10.8-10.8	Not Specified
8	Nitrate (mg/l)	0.08	----------	10
9	Nitrite (mg/l)	0.02	----------	10
10	Ortho-Phosphate	0.25		Not Specified

S/NO	PARAMETERS	Mwongo River		WHO Guidelines
	(mg/l)			
11	Total Phosphorus (mg/l)	0.09	0.25-0.37	Not Specified
12	Total Nitrogen (mg/l)	1.08	10.92-11.71	Not Specified
13	Ammonia (mg/l)	0.34	---------	Not Specified
14	Iron (mg/l)	0.12	---------	0.3
15	Temperature °c	22	19-22	---
16	Dissolved Oxygen mg O_2 /l	-------	8.74	---

a) Water sample collected in January 2012 and analyzed by the Water Laboratory at the Department of Water Resources Engineering of the University of Dar es Salaam, Tanzania

(b) Water samples collected in April 2012 and analyzed at the University of Burundi

The results of the water quality analysis were compared with the WHO guidelines for drinking water. The results of water quality analysis are discussed below:

The values for pH at 7.24 are close to neutral which is within the acceptable value for natural waters. The pH values obtained by the Laboratory in Bujumbura (pH 8.9-9.3) were on the high side and could be suspicious. The parameter EC indicates the extent of dissolved solids in the water and hence the intensity of non-point sources of pollution. The observed values of ECat 47-160 μS/cm is well below the WHO acceptable range for drinking water. These values are relatively on the lower side indicating that the impact of human activities on water quality within the basin is still low. Colour was at 105 mg PtCo/l in March (dry eason) but this was greatly raised in April at 565-1012 (mg PtCo/l) due to flooding at the beginning of the rainy seaon. This figure is well beyond WHO acceptable levels ((15 mg PtCo/l). Turbidity showed similar rise although relatively at a smaller value. However the figure of FTU 72-119 is still high compared to the WHO limits 5 FTU respectively). The turbidity of water sample is a measure of the ability of suspended and colloidal materials to diminish the penetration of light through the sample. The values of turbidity are expected to vary with season. Turbidity values are expected to be at a higher level during the rainy season when surface runoff carries considerable amounts of suspended sediment. The high turbidity value observed at the sampling points at 72 FTU is a sign of heavy soil load in the river water. The relatively high values of turbidity determined at the sampled points are likely attributed to sediments resulting from erosion taking place in the upper reaches of the dam catchments. Phosphorus as well as Nitrogen are considered to be the nutrients in water bodies and responsible for aquatic plant growth. These nutrients normally originate from non-point source of pollution. The values for TP are below 0.2 indicating they are on a lower side. The value for Total Nitrogen is relatively low indicating that the river is not eutrophied.. The findings presented in the above show that the Mwogo River water is much more turbid than the Buyongwe River water. This is caused by soil erosion in the hills and by widespread sand mining along the river. The river water is well oxygenated at super saturation.

Water quality characteristics in natural waters are a function of many variables which would include season and time of day the sample is collected; and place or location of sampling site. Hence, many factors affect the chemical composition of waters and these include factors such as temperature, photosynthesis, composition of rocks and others. Higher temperature would reduce solubility of gases in water. Limestone rocks would tend to dissolve into bicarbonates and provide more sources of CO^2 and this would make the water acidic. During daytime temperature tends to rise whilst at night it is reduced. The effect of rains on all the water parameters in the rivers is very clear. It causes flooding and siltation. Water colour and Turbidity rise very significantly. There is great dilution and consequently there is significant drop in Electrical Conductivity, Total Dissolved Solids, Transparency, Total Hardness, and Total Alkalinity. Nitrates, Phosphates tend to rise due to import of large quantities of organic matter through the flood. The large amounts of solid and dissolved organic matter will tend to reduce dissolved oxygen due to biological decomposition. Photosynthesis consumes CO^2 and parameters like pH are reduced in the water. Hence the measurement of parameters like pH, Temperature and Dissolved Oxygen would give varying readings. The situation in rivers is perhaps even more complicated due to turbulence, mixing, high content of silt and organic matter and the large absence of phytoplankton. In all the rivers being studied in this project, these readings were seen to be within the normal for example the pH of most natural waters in lakes and rivers would lie between 6.0-9.0 (Gerald A. Cole 1975).

6.1.5 *Reservoir Sedimentation*

As mentioned in Section 2.4 above, the Revised Universal Soil Loss Equation (RUSLE) one of the commonly used empirical methods was used to estimate the sediment yield from the dam catchments. The Revised Universal Soil Loss Equation was developed by United States Department of Agriculture (Renard, et al., 1997). According to RUSLE, the annual soil loss is expressed as:

$$\boldsymbol{A = R \cdot K \cdot L \cdot S \cdot C \cdot P} \quad (\text{tons/km}^2\text{/year}) \qquad (4)$$

Where A = computed spatial soil loss per unit area

R = rainfall-runoff erosivity factor

K = soil erodibility factor

L = slope length factor

S = slope steepness factor

C = cover-management factor

P = Supporting practices factor

The factors R, K, L, S, C and P are estimated on an empirical basis as illustrated hereafter. The estimation of such parameters was performed, on a cell-by-cell basis, using GIS techniques.

6.1.6 *Environmental Flow Assessment*

The 'Montana Method' proposed by Tennant (1976) was used to estimate the magnitude of flows required to be released downstream of the dams for the purpose of maintaining the health of the ecosystem downstream of the dams. The values of 10% of the Mean Annual Flow (MAF) for the

Taba Gakomeye sites have been determined from available flow records. Further more the Q_{95} values have been determined for comparison with the value of 10% of the MAF at the two sites. The 10% of MAF and Q_{95} indices are proposed to be the levels of flow required to be released downstream of the dams for purposes of maintaining the ecosystem. Computed 10% of MAF values are presented in table ***6-2.*** The Q_{95} values obtained from the flow duration curves are also presented. The constructed flow duration curves for Taba Gakomeye sites are presented in ***Fig. 6-4.***

From table ***6-3*** it can be observed that the 10% MAF values that were determined at the dam sites where observed flow records are available are much lower by 25% compared to the estimated Q_{95} (the flow that is exceeded 95% of the time) at the same sites. In view of the low yield flow values determined for Mwongo stream, **the 10% of MAF values are recommended to be adopted as flow values to be released downstream of the embankment** to be constructed at the proposed dam site for purposes of maintaining the ecosystem downstream.

Table 6-3: Indices values proposed for release downstream of the dam embankments proposed to be constructed

S/No.	Dam site	Mean Annual Flow (MAF)	10% of MAF (m^3/sec)	Q_{95} from flow duration curve (m^3/sec)
1	Taba Gakomeye (upstream)	0.51	0.05	0.18
2	Taba Gakomeye (downstream)	0.56	0.06	0.24

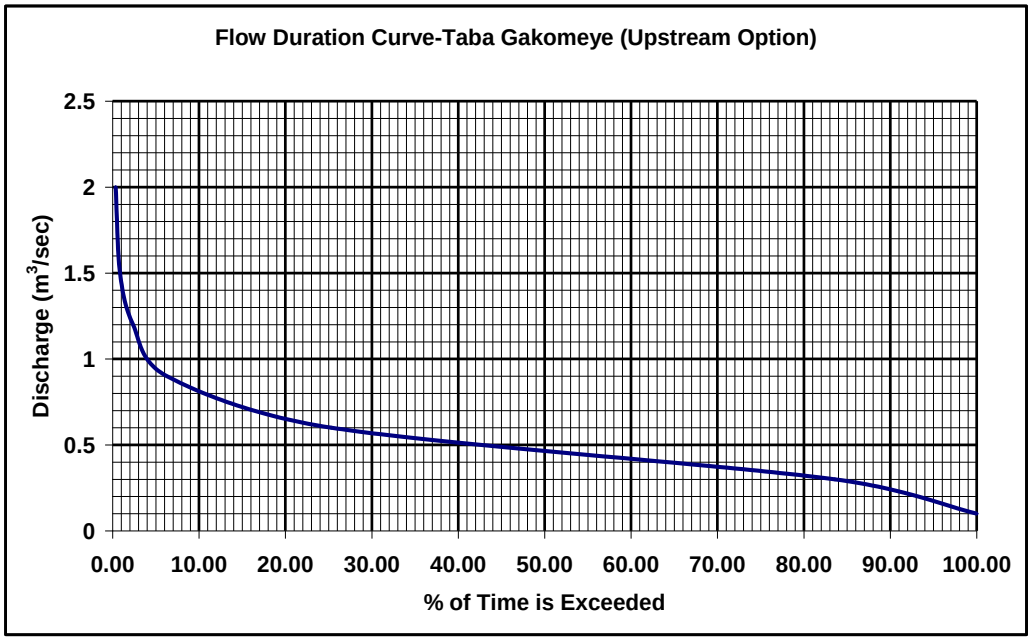

Figure 6-4: Flow Duration Curve for Taba-Gakomeye Dam site

The environmental flow recommended to be adopted as a flow value to be released downstream of the dam embankment to be constructed at Taba Gakomeye for purposes of maintaining the

ecosystem downstream 0.06 m3/sec. which is 10% of MAF value estimated from observed records. The environmental flow requirement is considered as one of the water demands in planning the water use from the multi-purpose dam to be constructed. During releases of water for irrigation and water supply from the dam, the environmental water requirement will be released in addition to those requirements for the water uses indicated above.

6.1.7 *Air quality and Noise*

Taba Gakomeye dam site is generally undisturbed natural environment with rich biodiversity. The area may be zoned as a rural setting. Major activities found at the proposed dam site were cultivation of rice, irish potato, vegetables, maize, banana, coffee and other crops with small scale livestock farming. These activities per say have no impact on air quality at the project site and its surrounding environment. Air quality is therefore considered good as there are no industries and there has not been any recent reported volcanic activity. Even human settlements are sparse and are limited to upper areas and downstream in the valley. Further, main inter- district road is tarred and does not produce dust to rise into the atmosphere, which would modify air quality. In this regard the air quality at the project site is generally good. Regarding noise levels, it was observed during the ESIA study that there are no sources of noise pollution close to the project site. The Taba Gakomeye dam site area is therefore pristine, with LAdn ≤ 55 dB noise levels or less. The area is undisturbed by any human development and portrays a clean fresh environment in terms of air quality and no noise from human activity. Therefore, the area may be categorized as quiet and serene.

6.2 **BIOLOGICAL ENVIRONMENT**

6.2.1 *Vegetation*

Different points were sampled in the project and species list was compiled to show the diversity to lesser extent with abundances using the encounter rate. Plants of any conservation status or importance were identified and pointed out.

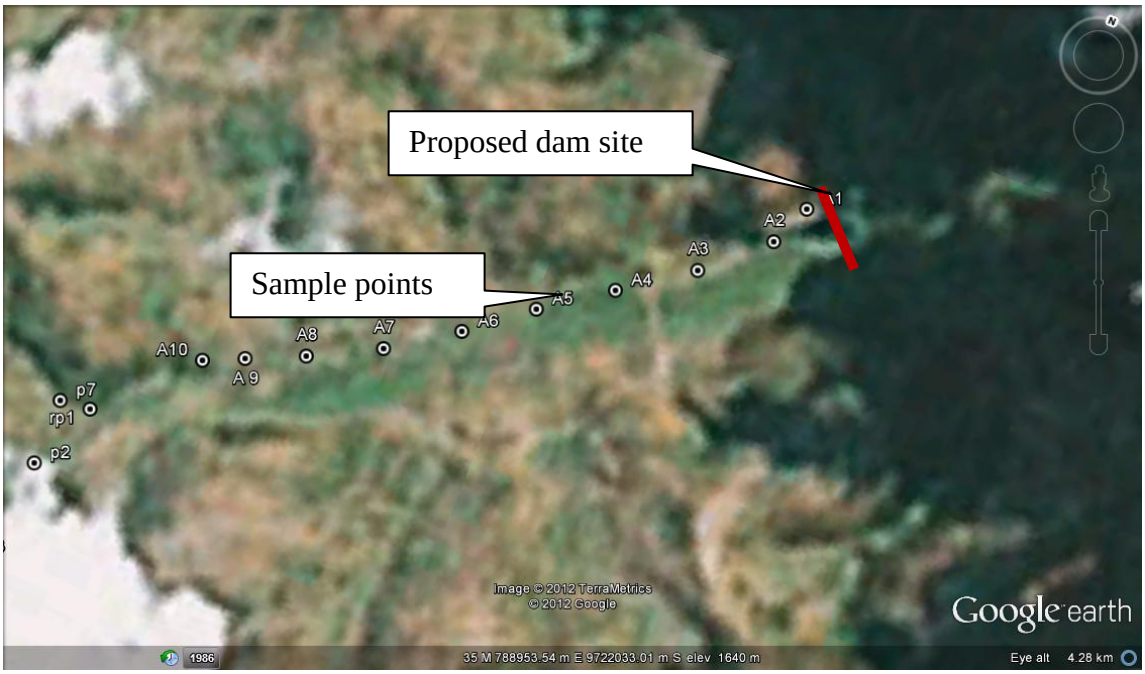

Figure 6-5: Google map showing project area

The Taba-Gakomeye project lies within an agro-ecosystem area where food crops like Sorghum, Phaseolus vulgaris, Eulisine corocan, Colocasia antigonum, Zea mays, Oryza sativa, Triticum sp., Hordeum vulgare, Pisum sativum, Soja hispada, Arachis hypogea (Ground Nuts), Ipomoea durcis, Irish potatoes, Manihot esculenta (Cassava) and bananas are grown. Wild plant species found included *Eragrostis* sp., *Bidens pilosa, Digitaria* sp., *Conyza* sumatrensis, Cyperus sp. There are also plant forage crops like *Tripsacum laxum,* Setaria sp, Desmodeum sp. *Pennisetum purpureum, Mucuna pruriensis, Cajanus cajan Calliandra calothyris, Leucaena diverifolia,* and *Sesbania sesbhan*. Some of the common tree species found in the project area included *Ficus thoningii*, *Euphorbia tirucalli*, *Erythrina abyssinica*, *Verminia amygdalena*, *Dracaena fragrans*. This area also benefited from the first afforestation efforts that took place between 1920 and 1948 during which period plant species like *Eucalyptus* were introduced. Other species introduced later included *Pinus* sp, *Callistris* sp, *Grevillea robusta, Cedrella* sp, and *Cupressus lustanica.* A total of 160 plant species from 59 families were recorded from the project area and are shown in **Appendix 5.**

Because of the intensive cultivation and the high population density in the project area, there were hardly any native tree species. Although there are endemic plants recorded within the project area, these species are abundant in Nyungwe National park which is fully protected. Common vegetation especially after heavy cultivation is shown in **figure 6-6 & 6-7.**
The project implementation will affect only species within the valley while most of the woody plants are on the hills or on sloping ground. There were no plant species of conservation importance recorded as threatened or endangered in the study area according to the IUCN (2007) red list.

Figure 6-6: Transformed vegetation after heavy culti

Figure 6-7: The rolling landcape with eucalyptus tree

Figure 6-8: Tristemma mauritianum from the Albertine rift

Figure 6-9 Dirty water in the river an indication that most of the vegetation has been depleted

6.2.2 *Fauna*

6.2.2.1 *Mammals*

The Taba-Gakomeye project lies within an agro-ecosystem area that has food crop plant species. So the mammals that live in this habitat are those that are adapted to habitat disturbance especially the rodents which are also crop pests although only the black rat (*Rattus rattus*) was trapped. There are 189 mammal species in Rwanda, of which 2 are critically endangered, 4 are endangered, 11 are vulnerable, and 5 are near-threatened. No threatened or near-threatened species were recorded in the project area. Further more, no protected animals in Rwanda (Ministerial Order N 007/2008-15/08/2008).

6.2.2.2 *Birds*

A total of 31 species of birds were recorded at the downstream site (near the tarmac road) including **two species that are Near-threatened** (GREY HERON *Ardea cinerea &* GIANT KINGFISHER *Megaceryle maxima*) and **one regionally restricted in the East African region** (SPOT-FLANKED BARBET *Tricholaema lachrymose)* (List of Bird species recorded are included in **Appendix 5*).*** 30 species were recorded upstream of the dam including one species that is regionally restricted in the East African region. These are mainly non-forest species, water bird specialists and non specialists. None of the species recorded is globally threatened. 666 species are known to occur in Rwanda of which 12 are globally threatened.

6.2.2.3 *Amphibians*

A total of seven species of frogs were recorded with Common river frog *Amietia angolensis* being the most common in both sites (**Figure 6-10**). The Albertine Rift reed frog *Hyperolius discodactylus* recorded in the proposed site downstream is globally vulnerable species. Table 6-4 shows frog species recorded in the project area.

Figure 6-10 Amietia angolensis, common spcies of frog in Taba Gakomeye

Table 6-4: Species of frogs recorded in Taba- Gakomeye Dam site

	Proposed site (Upstream)	Alternative site (down stream)
Species	No. of indiv	No. of indiv
Mascarene Grass Frog *Ptychadena mascareniensis*	10	5
Senegal Running Frog *Kassina senegalensis*	0	8
Natal Puddle Frog *Phrynobatrachus natalensis*;	13	0
Common river frog *Amietia angolensis*	65	19
African Common Toad *Amietophrynus gutturalis*	2	0
Lake Victoria Clawed Frog *Xenopus victorianus*	2	6
Ptychadena chrysogaster	7	0

	Proposed site (Upstream)	Alternative site (down stream)
Species	No. of indiv	No. of indiv
Bufo sp	0	1
Hyperolius nasutus	0	1
Hyperolius discodactylus (VU)	0	3

6.2.2.4 *Dragonflies and Butterflies*

A total of 4 dragonfly species were recorded and these are shown in the table below. None of the recorded species is globally threatened according to the list provided Clausnitzer *et al* (2011). A total of 9 Butterflies species were recorded as shown the table below. None of the species is globally threatened or near-threatened.

Table 6-5: Dragonflies recorded in the project area

species	Proposed site	Alternative site	Habitat preferences
Elatteoneura glauca	0	1	Widespread, usually riverinne, prefers damp, shady spots, bush, woodland
Palpopleura lucia	0	1	Reedy sluggish streams and pools in woodland and forest
Pseudagrion melanicterum	0	1	Forest streams, thick bush and litus
Pseudagrion sp ?sjoestedti	0	1	Pools, streams, rivers

6.2.2.5 *Fish and aquatic Invertebrates*

There is intensive human activity in the Mwogo River including sand mining and agriculture. It was therefore not expected to find many fish in this section of the Mwogo River. It was therefore not surprising that, after 9 hours of gillnetting, only a single small fish, *Barbus apleurogramma* (Cyprinidae), was caught. Analysis of water from the Mwogo River showed very high Turbidity of between 69.5-119 NTU. These conditions would make it difficult for fish to breed and survive. It is possible that if the habitats were restored, species, especially the cyprinids which like fast flowing water in rivers, would most probably return to the river. River Mwogo flows through the Taba-Gakomeye dam site. River Mwogo is the source of water for River Nyabarongo, which is itself thought to be the origin of River Kagera. The fish species known from the Nyabarongo River can therefore reach River Mwogo.

Invertebrates from River Mwogo; The bottom substrate of the sampled site was sandy. After sieving and examination of the samples, only *Potamonautes niloticus*, a widely distributed crab in the

Kagera basin, the Gastropod Mollusc, *Melanoides tuberculatus* and Lumbricus annelids were found. It was surprising to find these invertebrates in a place so much disturbed by sand diggers.

6.2.2.6 *Protected Areas*

Rwanda belongs to a zone of global ecological importance called Albertine Rift Eco-region. Approximately 10% of the national territory is dedicated to the protection of natural ecosystems and their biodiversity.
The dense mountain forests of the Volcanoes National Park (12 000 ha) are home to an important population of mountain gorillas. Furthermore, the Nyungwe National Park (924 000 ha), hosts 13 species of primates and 275 bird species. In addition, the Akagera National Park (90 000 hectares) is home to a great diversity of wild species, such as zebras, baboons, elephants, and crocodiles. The Rugezi ecosystem and the Bulera and Ruhondo lakes have been declared as Ramsar sites. The major threats to Rwanda's biodiversity include erosion, floods and droughts, disease and pests, as well as population pressure and resettlement, overexploitation, poaching, and bush fires. The 1994 genocide also had a big impact on Rwanda's biodiversity.

The nearest protected area to the Taba-Gakomeye project is the Nyungwe National Park (924 000 hectares) (RW007) (29^0 14.00' East 2^0 30'. Nyungwe forest is situated in south-west Rwanda between Lake Kivu and the international border with Burundi, where it is contiguous with Kibira National Park (BI002). The Nyungwe ecosystem harbours forest biodiversity of very high conservation significance which even if they found their way to the Taba-Gakomeye project area they would not survive because the latter is a cultivated area.

6.3 SOCIO-ECONOMIC ENVIRONMENT

6.3.1 *General Information and Methodology*

The study area is located between two districts of the Southern province of Rwanda namely Nyamagabe and Huye. There are two sub-sites named site A and site B, with the former being the main catchment area and the latter being the alternative one. Villages of direct impacts are: Gakomeye, Cyinyana, Kagarama of Nyamagabe District and Taba, Gitwa and Kinombe of Huye District while the zone of indirect impact is Karambi, downstream side neighboring site A. The survey was conducted in 2 districts of Southern Rwanda that is, Nyamagabe and Huye. The methodology used in this work was especially guided by the terms of reference and available documentation in the above districts of survey consideration. A multistage purposive sampling procedure was employed in the selection of the survey population. The main sampling unit of the survey was the household. Purposive sampling of the study areas was used (from district up to village level). The purposive sampling method employed in this survey was based on the understanding that communities are not homogenous particularly in terms of levels of socio-economic values, development concerns and threats and impacts. Thus, the sample population comprises three strata: (1) population directly affected by the Kagera project or within the project area, (2) the population moderately affected, and (3) population indirectly or less likely to be affected by the above project.

Key results were obtained from discussions with informants, stakeholders, and opinion leaders from the Nyamagabe and Huye Districts, representatives of the local administrative government at cell and village level, representatives of youth and women. These are presented in the next sections of this report including their opinions about the proposal to construct the dams in Kizi and Gasumba cells. Focus Group discussions, public meetings were organized and held at cell level. In total 3 public meetings were organized: 2 for 6 villages (one for Taba, Gitwa, Kinombe of Gasumba cell within Maraba sector, and the other for Gakomeye, Cyinyana, Kagarama of Kizi cell within Kamegeri sector) and 1 for the downstream part with Karambi cell villagers. This allowed members of the communities that are likely to be directly or indirectly affected by the project to express their issues and concerns with respect to the construction of dams in the region, implementation of the project and also their overall opinion regarding the same project. Issues that require special attention were also outlined. Standardized questionnaires enabled acquisition of household data and information among households in the project area. Information generated is used as a basis to assess potential socioeconomic impacts of the Kagera project. Key information drawn from the questionnaires include socioeconomic characteristics of the population, access to services like health, education, water and sanitation, energy, etc. From these discussions good insights were obtained and contributed to the understanding of the overall expected impacts of the project.

The identified villages were, Taba, Gitwa, Kinombe of Gasumba cell within Maraba sector, Huye District and Gakomeye, Cyinyana, Kagarama of Kizi cell within Kamegeri sector, Nyamagabe District. Subsequently, a random sampling was done in the purposively-identified villages to select household respondents. The survey sample size for each village was calculated considering the %age proportion of the total village population (total number of households in each village) over the total population (total number of households) of the 3 villages in each of the concerned cells. 119 households in Huye District and 83 households in Nyamagabe District were surveyed making a total of 202 households included in the survey. **Table 6-6** below gives a summary of the number of households in the villages in the project area whilst **Table 4-84** shows the number of sampled households included in the study.

Table 6-6: Village sizes in terms of Numbers House holds

District	Sector	Cell	Village	Estimated population (estimated number of households)
Nyamagabe	Kamegeli	Kizi	Cyinyana	123
			Gakomeye	159
			Kagarama	108
Huye	Maraba	Gasumba	Gitwa	215
			Kinombe	168
			Taba	171

Note: It is of note that only 2 villages (Kinombe and Kagarama) touch the demarcation line between site A (first dam) and B (alternative dam). So site B is partly in KinombeandKagarama.

Table 6-7: Count for sample households by Administrative unit

					District		
Sector	Cell	village			Huye	Nyamagabe	Total
Kamegeli	Kizi	Cyinyana	Site	A		25	25
			Total			25	25
		Gakomeye	Site	A		33	33
			Total			33	33
		Kagarama	Site	A		12	12
				B		13	13
			Total			25	25
Maraba	Gasumba	Gitwa	Site	A	47		47
			Total		47		47
		Kinombe	Site	A	25		25
				B	10		10
			Total		35		35
		Taba	Site	A	37		37
			Total		37		37

6.3.2 *Administrative Structure*

Situated South-West of the Southern Province, the new District of Nyamagabe is one of the 8 Districts comprising the Southern Province. It is surrounded by the Districts of Karongi and Ruhango in the North, Nyanza and Huye in the East, Nyaruguru in the South, Rusizi and Nyamasheke on the West. Nyamagabe District is composed of the former Districts of Kaduha, Mushubi, Mudasomwa, GikongoroTown and eleven Sectors of the former Karaba District. It is subdivided into 17 administrative Sectors, 92 Cells and 536 Villages (Imidugudu).

Huye District is one of the eight Districts comprising the Southern Province. It is composed of 14 Sectors namely: Mbazi, Kinazi, Simbi, Maraba, Rwaniro, Rusatira, Huye, Gishamvu, Mukura, Ruhashya, Tumba, Kigoma, Ngoma and Karama. The neighboring districts are placed as follows: Nyanza in the North, Gisagara in the East, Nyaruguru in the South and Nyamagabe in the West**.** **Fig. 6-11** below depicts Nyamagabe and Huye Districts whilst **Table 6-8** shows Some socio-economic indicators as per Vision 2020 and the MDGs.

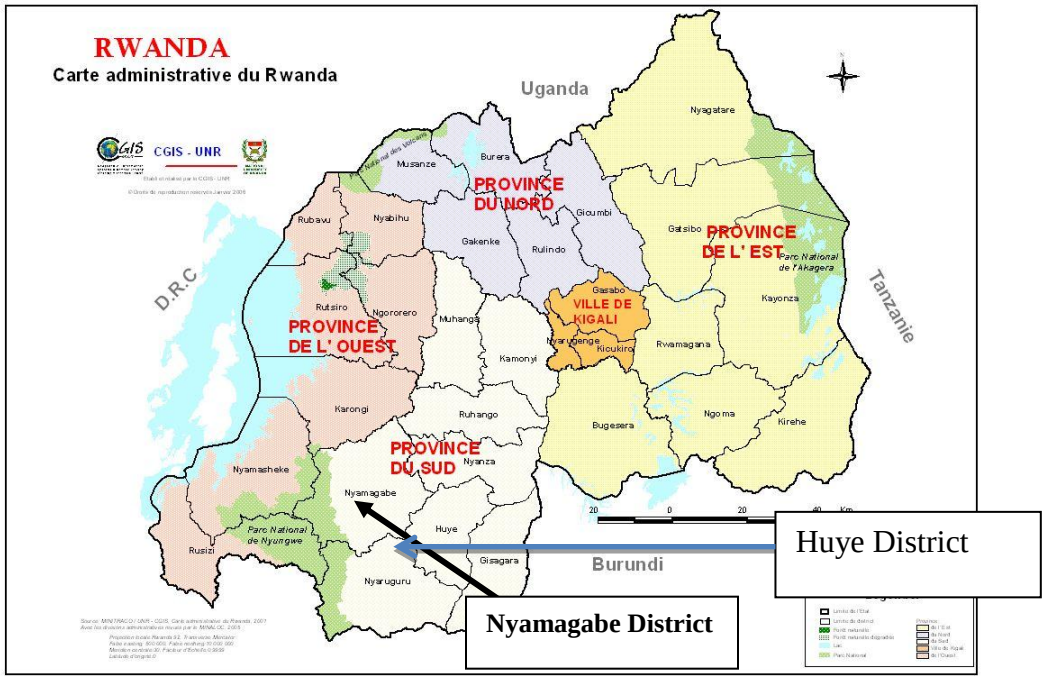

Figure 6-11: Current Administrative Map of Rwanda

Source: CGIS-NUR

Table 6-8: Some of the socio-economic indicators (Vision 2020 & MDGs)

MDGs area	Vision 2020 and MDG indicators	Baseline 2000	Baseline 2006/2007	Vision 2020 target
Eradicate extreme poverty and hunger	GDP per capita in US dollar	200	272	900
	Average real GDP growth rate (%)	8.1	6.5	8
	National Investment (% of GDP)	13.6	15	30
	Poverty (% below National poverty line)	60.4	56.9	30
	Availability of proteins /person /day (% of needs)	44	NA	65
	Gini Coefficient of consumption disparity	0.47	0.51	0.35
	Access to electricity (% of population)	2	4.3	35
	Agricultural population (% of active population)	90	80	50
Achieve universal primary education	Literacy level (%)	71	74	100
	Primary school net enrolment (%)	72	90	100
	Vocational training centres (number)	7	54	106
	Admission in tertiary education (gross enrolment in %)	3.2	3.2	6
Promote gender equality	Gender gap in literacy (%)	10	0.2	0
	Females in tertiary education (%)	20	39	50
	Females in decision making positions (%)	10	47.5	40
Reduce Child	Life expectancy	49	51	55

MDGs area	Vision 2020 and MDG indicators	Baseline 2000	Baseline 2006/2007	Vision 2020 target
mortality				
	Under 5 mortality rate (/1000 births)	196	152	50
	Infant mortality rate (/1000 births)	107	86	50
Ensure environmental sustainability	Access to safe/ clear water (%)	64	64	100
	Rwandan population (million)	7.7	9.1	13
	Population growth rate (%)	2.9	2.6	2
	Total fertility rate (children/woman)	5.8	6.1	3.9
	Urban population (% of total population)	10	17	30

Source: MINECOFIN (2007): Economic Development and Poverty Reduction Strategy

6.3.3 *The population and demographic data*

(i) Total population

The total population of Rwanda is predicted to be 13 million in year 2020 with a population growth of 2 %. The forecasted family size is going to reduce from 6.1 in 2007 to 3.9 in year 2020 with 55 years of life expectancy. Given that the overall economy is agricultural oriented, efforts need to be made in developing the service sector to release the agriculture sector by providing off-farm opportunities. The construction of the dams is part of measures that are likely to create new jobs in the targeted area.

Nyamagabe District has a population of 317,766 persons 55 % of whom are women. In six sectors the percentage of women far surpasses the national average which is attributed partly to the consequences of genocide. By considering an average of five persons per family, it can be estimated there are 66,000 homes in the District. Nyamagabe District population is unevenly distributed in the Sectors. The total population of Huye district is estimated 290,677 inhabitants who are distributed in 14 sectors. Women represent the majority of the population, and they are 54.9 % of the total population.

(ii) Population structure

When described the population in Nyamagabe District according to age strata, the following were observed. The population under the age of 15 years old represents about 35 % of all the population. The youth between 15 to 34 years represent 35.6% of all the population. Nyamagabe District population is very young since people aged 34 years and below represent 71 % of the entire District population.

The review of the statistics of Huye District shows that people below 25 years of age represent 48.2% of the total District population, whereas the active population i.e. between 18 and 65 years of age has risen to 59%. These two factors constitute a development opportunity for Huye District.

(iii) Classification of household members by age in the project area

As a matter of inference from the statistics as in ***Fig. 6-12***, the majority of the population in the project area (47 %) is composed of children (those under 18 years old) compared to the active population which is in total 44 % of the entire population in this area. The implication is that to whatever activity is to be undertaken in the region, there`s enough active labour. It was highly requested by local people during the FGD to employ them during the project activities, and this is highly recommended to hire them as a matter of making them feel part of the project and on-going activities. The low %age of retired people (9 %) indicates low dependence compared to high dependence of low age people, i.e. children, on the active population.

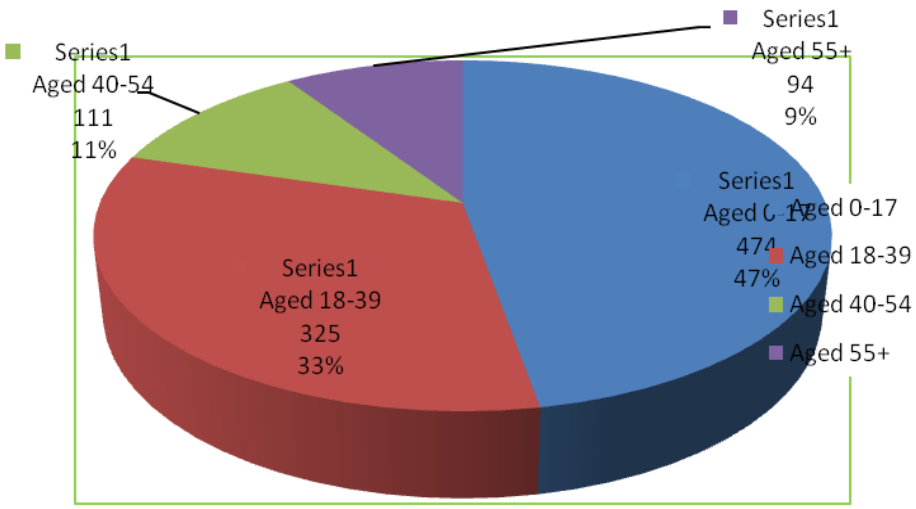

Figure 6-12: Age group of the population in the project area

ii) Average household size

It was found out that most of the average household size is 5. This shows that majority of the households are large, implying high demand for food and other household sustenance needs. Again, this implies increasing pressure on the wetland resources to satisfy basic needs. For households already involved in wetland utilization, this may translate into further wetland overexploitation. The fact that cultivation is the major economic and social activity for the majority of the communities adjacent to wetlands is a confirmation that pressure on the natural resource base is high. Other indication is that, given the limited average land size, it is critical to closely ensure that people in the concerned area obtain adequate compensation, in case their belongings are taken over. Furthermore, similar to FGD, most of villagers mentioned that a very big number of the households were supported by wetland-based agriculture, this being emphasized by the fact that irrigation is the most welcomed use of dams to be constructed in the region. There is therefore need to ensure effective, efficient and sustainable exploitation of wetlands in the region which supports in the end the implementation of Kagera project to build multipurpose dams in the area

iii) Presentation of heads of households by gender

In terms of gender perspective, 23.3 % of sample households are female headed compared to 76.3% headed by males. There are just slight differences in the percentages of women and men as far as household headship is concerned for both sites (**Table 6-9).** From what was observed at the field

level, this number of women taking the headship is highly linked with their marital status – being mostly widows; in case the husband dies, the wife takes over the headship of the household.

Table 6-9: Household heads headship by Gender

			Sex of household head		
			Male	Female	Total
Site	A	Count	138	41	179
		% within Site	(77.1)	(22.9)	(100.0)
	B	Count	17	6	23
		% within Site	(73.9)	(26.1)	(100.0)
Total		Count	155	47	202
		% within Site	(76.7)	(23.3)	(100.0)

Source: Own survey

iv) Religious affiliations

The majority of household heads, in site A (62.6 %) and in site B (82.6%) are Catholic while only 34.1 % in site A and 17.4 % in site B are Protestant. As a matter of inference with regard to the percentages presented in the following ***Table 6-10,*** Muslims are quite few in this region. These results are not very different from the national statistics where Roman Catholics are 56 %, Protestants 26 %, Adventists 11.1%, none 1.7 %. A big difference is in regard to Muslims. This may be explained by the fact that this area is rural. There is a high concentration of Muslims mostly in cities and town centres, given that they mostly build their mosques in these areas. We have presented the religious affiliation of heads of households because they are the ones who most of the time influence the adherence to religions of the rest of family members in most cases.

Table 6-10: Religious Affiliations of household heads

			Religion of household head						
Site			Protestant	Catholic	Seventh Day Adventist	Muslim	No belief	Other	Total
A	Male	Count	48	85	1	0	2	2	138
		% of Total	26.8	47.5	.6	.0	1.1	1.1	77.1
	Female	Count	13	27	0	1	0	0	41
		% of Total	7.3	15.1	.0	.6	.0	.0	22.9
Total		Count	61	112	1	1	2	2	179
		% of Total	34.1	62.6	.6	.6	1.1%	1.1	100.0
B	Male	Count	4	13					17
		% of Total	17.4	56.5					73.9
	Female	Count	0	6					6
		% of Total	.0	26.1					26.1
Total		Count	4	19					23
		% of Total	17.4	82.6					100.0

Source: Own Survey

v) Marital status

Most of the male heads of households surveyed in site A (68.5 %) are monogamously married as compared to 17.4% of female heads of household who are widows. The same applies for site B but with slight differences in terms of %age as in the ***Table 6-11*** The results herein presented are in accordance with Rwandan tradition and belief where it is well known that in a household with a husband and wife, the one who takes the lead is the husband, hereby expressed as head of household. In some cases women are heads of households, but in this case, the majority are widows. It is also noted that the dominant percentage of marriages are monogamous which can be explained by the fact that the Rwandan Civil Law encourages a man to be married to only one woman as long as both are still alive.

Table 6-11: Marital Status of House hold head by Gender

			Marital status household head						
Site			Married monogamous	Married polygamous	Single	Widowed	Divorced	Cohabiting	Total
A	Male	Count	122	1	2	2	0	10	137
		% of Total	68.5	.6	1.1	1.1	.0	5.6	77.0
	Female	Count	0	0	1	31	6	3	41
		% of Total	.0	.0	.6	17.4	3.4	1.7	23.0
Total		Count	122	1	3	33	6	13	178
		% of Total	68.5	.6	1.7	18.5	3.4	7.3%	100.0
B	Male	Count	14			1		2	17
		% of Total	60.9			4.3		8.7%	73.9
	Female	Count	0			5		1	6
		% of Total	.0			21.7		4.3%	26.1
Total		Count	14			6		3	23
		% of Total	60.9			26.1		13.0%	100.0

Source: Own survey

6.3.4 *Education*

vi) Literacy

In Rwanda, education is seen as the cornerstone towards economic transformation. Different initiatives are undertaken to enhance access to quality education through various initiatives like the 9 Year Basic Education and 12 Year Basic Education (YBE) policies that are playing a substantial role in raising the literacy levels mostly for young scholars. It is now compulsory throughout the country that students complete 9 years of basic education. Under these education programs, no school fees are paid by the students. Therefore primary and secondary education is free and open to all children. The literacy rate in Nyamagabe district and Huye district for people aged 15 years and above is at 68% and 57.7% respectively. *(Nyamagabe District Education Officer and Huye District Development Plan – 2007).*

In Huye and Nyamagabe as well as in the rest of the country, the language of instruction is English as there has been a shift from French. To support this change, teachers are given English language training each year during holidays. The government has put efforts in recruiting teachers from English speaking countries to support this initiative; because of this, some teachers from Kenya are expected to be in Rwanda from April 2012 to support the above-stated initiative in Nyamagabe. All

in all, there is a remarkable commitment from the government of Rwanda to support education for all. In regard to enrollment, the enrollment rates in Huye District are as follows: 65,019 students are enrolled in primary schools, 18,492 in secondary schools, 684 in vocational training education and 5958 in nursery schools while in Nyamagabe District there currently 85,000 students in primary schools, 15,000 students in secondary schools.

vii) Level of education of household heads in the project area

The literacy level of members of households is measured either by years of formal schooling or by informal education like training. The level of education is used to capture the quality of the human capital endowment of the household (Bewket, 2009; Huffman, 2001).

From this survey, it is clear that a big number of the population interviewed are illiterate (41 % in site A and 56.5 % in site B) compared to 27 % in site A who completed the primary school and 26.1 % in site B who attended but not completed primary school. A number of reasons explain this illiteracy rate such as little awareness about the value of education; dropping out of school to help parents with farm work and early marriages among others. It should be noted that the genocide that rocked the country in the 1990s also greatly affected the education levels in the area. This has also implication on options of their professional carriers. The low education levels in the project area imply that the people will mainly be considered for unskilled jobs in the project. In terms of gender, the results show that out of the female heads of households, majority of them did not attain any education. The project should also consider women for employment opportunities especially as unskilled labour. ***Table 6-12*** below shows the education levels of household heads by gender in the project area.

Table 6-12: Level of Education of Household head by Gender

				Education of household head						
Site				None	Completed primary	Not completed primary	Completed Secondary	Not completed Secondary	Completed Tertiary	Total
A		Male	Count	53	39	38	1	5	2	138
			% of Total	29.8	21.9	21.3	.6	2.8	1.1	77.5
		Female	Count	20	9	7	2	1	1	40
			% of Total	11.2	5.1	3.9	1.1	.6	.6	22.5
	Total		Count	73	48	45	3	6	3	178
			% of Total	41.0	27.0	25.3	1.7	3.4	1.7	100.0
B		Male	Count	8	4	5				17
			% of Total	34.8	17.4	21.7				73.9
		Female	Count	5	0	1				6
			% of Total	21.7	.0	4.3				26.1
	Total		Count	13	4	6				23
			% of Total	56.5	17.4	26.1				100.0

As regards dropout rates, in Nyamagabe District the drop rate was to 3-5% in 2011 while in Huye district it was 8% for primary students and 3% for secondary students. The reasons for the dropout cases are: Parents who are generally other requirements; Children lack any form of counseling from their parents; vagrancy of children and repeated failure which discourages children who repeat

certain classes. It was reported that the dropout rate for girls also reduced tremendously due the government efforts to support the girl child pursue education. Some of these include provision of separate toilets, counseling by a senior teacher, provision of sanitary towels to every female student, provision of incentives and gifts to girls who attend school regularly for example 5 litres of cooking oil are given to girls who attend school regularly every term.

6.3.5 *Housing and Settlements*

Settlements in the project area are scattered and are found on the mountain slopes. There are a few settlements in the valleys. This was attributed to the government policy which does not allow people to settle in the valleys but on the hills. In trading centres, the settlements are close to each other and concentrated. Structures in the trading centres are mainly used for both residential and commercial uses while those on the slopes of the mountains were mainly used for residential purposes. Most of the residential houses are made of semi-permanent materials while those in the trading centres were made of permanent materials **Plate 6-1** and **Plate 6-2.** There was no grass roofed structure observed in the area. In the proposed area for the project, several households were observed and it is likely that these will be submerged by the reservoir.

Plate 6-1: A structure in the Project Area

Plate 6-2: Another Structure in the project area

Downstream of the reservoir, there is a trading centre known as Karambi Trading Centre and a number of settlements that are concentrated. Settlements downstream are mainly of permanent and non-permanent materials and they are used for both commercial and residential purposes. Consultations with the downstream communities revealed that during heavy rains there is a lot of flooding and most of the settlements there are affected by the floods.

6.3.6 *Economic Activities*

i) Agriculture

Like in other parts of the country more than 90% of the population of Huye and Nyamagabe Districts relies on agriculture. Agricultural production is characterized by a diversity of food crops including Irish potatoes, sorghum, beans, soya beans, cassava, bananas and vegetables such as tomatoes, cabbages, and eggplants among others **(Plate *6-3*** and ***Plate 6-4)***. Fruits grown in the area include plum fruits, avocados and pawpaw among others. These different crops are often intercropped on the same piece of land. Rice growing is mainly noticed in swampy areas and along river banks.

The main cash crops grown include tea and coffee for Nyamagabe District. Tea is grown mainly in the eastern part of the District close to NyungweNational Park whereas coffee is grown almost throughout the entire District. The western part of the District is particularly favourable for tea production. MIG, a Community Based Organization, has currently embarked on tea extension programme. Another crop which has attracted the attention of farmers in the District is passion fruits, which have good prices on the market. Progress made by passion fruit farmers in the District gives light that this crop shall constitute one of the cash crops in the nearest future. Agricultural production is mainly subsistence oriented with minimal levels of monetisation

Coffee is the major cash crop in Huye District. It is in fact a specialty of Maraba Sector whose coffee has relative advantage in the District due to its superior quality.

In the project area, majority of the households are engaged in crop farming. Crop farming is mainly done in cooperatives. Consultations revealed that most of women are registered as cooperative members and they actively participate by taking the lead. Most cooperatives are headed by women and comprised of mainly (80%) women as compared to men. The participation of women in these cooperatives highly contribute to the improvement of their own and family`s livelihoods.

Plate 6-3: Maize growing at Taba -Gakomeye

Plate 6-4: Bananas grown in the project area

In terms of production, serious problems are facing food production in both districts. These include poor soil fertility due to soil acidity, extreme land fragmentation, small sizes of farmland available to each family due to demographic pressure, poverty among farmers which has hampered the capacity of families to invest in the improvement of their land capital; lack of sufficient agricultural inputs such as quality seeds and fertilizers, over exploitation of existing land due to scarcity of land, unpredicted climatic conditions and insufficient systems against soil erosion.

All these factors make agricultural production poor and hence a large portion of the population remains underfed. In addition, a large proportion of the population in these districts lives below the poverty line and constantly faces food insecurity. Although, some initiatives from different development officials have contributed to the betterment of the population in this District especially the period after the 1994 Genocide as compared to the prior period the situation still needs attention.

ii) Animal husbandry

According to the Nyamagabe District Development Plan (2008-2012), animal production in the district has declined over the years and animals are still insufficient in the district both in quantity, quality and performance. There are currently 31,146 livestock of which 831 are of genetically improved race **(*Plate 6-5*),** 60,653 goats, 27,387 sheep, 44,445 pigs, 40,587 poultry and 26,875 rabbits.

In Huye District, like other parts of the country livestock was decimated during the genocide of 1994. Despite the effort by certain intervening parties to restock, there is still insufficient livestock in the district in general. ***Table 6-13 shows*** the number of livestock in Huye District.

Table 6-13: Animals in Huye District

Cattle	Number
Improved cattle	1,650
Traditional cattle	25,788
Improved goats	0
Sheep	2,260
Pigs	17,840
Rabbits	15,005
Poultry	34,415
Beehives	2,663
Fish ponds with fish	103

Source: Huye District Development Plan - 2007

In the project area, there were a few animals that were observed. These include cows, goats and pigs.

Plate 6-5: Animals in the prject area

iii) Fish farming

Fish farming in both districts is still at a very low scale. In Nyamagabe district there were 103 fish ponds in 2008, while in Huye District, there were about 20 fish ponds in 2007. Fish farming is essentially practiced at a personal level or by associations. In the project area, fish farming is not practiced. There were fish ponds that were observed in the project but which were not functional and had been abandoned for some time **(*Plate. 6-6).*** Consultations revealed that these fish ponds had been dug by the government but their management and maintenance failed.

Plate 6-6: Fish ponds that have been abandoned

iv) Sand mining

In the project area, sand mining is practiced by a number of people. Consultations with some of the sand miners showed that the sand miners worked under a registered person who had a license from

the Sector and the District. The registered sand miners are expected to pay taxes per month to the District or Sector. The consultations further revealed that profits were shared equally between the registered sand miner and his workers. It was estimated that about 10 people work for each registered sand miner and that there are several registered sand miners. In terms of production, it was reported that at least each person can sell about one 3-tonne truck per day and each truck costs about 8,000-15,000 Rwandan Francs. Construction of the dam in this area will greatly affect incomes of a big number of people in the area.

Plate 6-7: Sand mining in the project Area

a) Occupation of respondents

It is well documented that the majority of the Rwanda population are farmers by occupation. This is supported by our statistics from the survey that 91.7 % of surveyed respondents in site A maintain farming as their main occupation while 100 % of surveyed households in site B are also farmers. Moreover, the analysis revealed that the minimum yearly income earned by a household is FRw 4.000 while the maximum is FRw 3.030.000; the average being FRw 166.957 (about 300 USD) with agriculture as the main source of income and hence their principal occupation. Most of the farmers are peasant farmers and very few engage in commercial farming. Other occupations the households heads engaged in include casual labour, trading, service provision (taxi driving, salon, restaurant etc.), while a sizeable number have no occupation at all. Even though there is an expected direct effect of the project on agriculture, its implementation (construction and operation) will generate short and long term job opportunities. Consequently, people will gain wage or casual labourer salaries that may complement what they are currently earning from the agriculture sector and /or compensate what was lost during the construction phase. ***Table 6-14*** shows the different occupations of household heads in the project area.

Table 6-14: Main occupation of the household heads

				Main source of livelihood household member2								
Village	Site			Peasant farmer	Commercial farmer	Salaried worker	Trader	Service provision	Casual laborer	Technician	No occupation	Total
Cyinyana	A	Household head	Count	21	1				1		1	24
			% of Total	87.5	4.2				4.2		4.2	100.0
Gakomeye	A	Household head	Count	23	1			1	2		4	31
			% of Total	74.2	3.2			3.2	6.5		12.9	100.0
Gitwa	A	Household head	Count	37		1	1		3	1	4	47
			% of Total	78.7		2.1	2.1		6.4	2.1	8.5	100.0
Kagarama	A	Household head	Count	11							1	12
			% of Total	91.7							8.3	100.0
		Household head	Count	10							2	12
			% of Total	83.3							16.7	100.0
Kinombe	A	Household head	Count	19					2		4	25
			% of Total	76.0					8.0		16.0	100.0
	B	Household head	Count	10								0
			% of Total	100.0								100.0
Taba	A	Household head	Count	25	1	1	2	3	2		3	37
			% of Total	67.6	2.7	2.7	5.4	8.1	5.4		8.1	100.0

Source: Own Survey

Downstream of the reservoir, the people similarly practice farming and crops grown are similar to those grown upstream. However, because downstream there was a trading centre, trading is done through sale of basic goods, restaurants and bars were also noticed. Fish farming is highly practiced downstream of the reservoir.

6.3.7 *Land Tenure, Ownership and Use*

i) Land tenure

The majority of land in Rwanda has been registered by the National Land Centre. This has added more value to land properties. The prices went higher than ever and speculations regarding land are quite profitable nowadays.

In the project area, 92.5% of the land owners had registered land and owned title deeds, 2.5% owned land customarily, 5% had leasehold titles, 3% had freehold titles and 0.5% owned the land communally. ***Table 6-15*** below shows the different land tenure systems in the project area.

Table 6-15: Counts for land tenure systems

		Land tenure systems					
		Registered land (Title deed)	Customary land	Leasehold	Freehold	Communal land	Total
Site	Site A	166	4	9	3	0	178
	Site B	19	1	1	0	1	22
Total		185	5	10	3	1	200

Source: Own Survey

ii) Land ownership

As regards ownership of land, the household surveys revealed that 95.5% of the respondents in the project area own land and only 0.5% did not own land. Consultations however revealed that land near the river banks is owned by the government and not by individuals. This implies that the people cultivating near the river banks may be eligible for compensation for crops and not land. Consultations revealed that people are highly attached to land to the point that any activity requiring privately-owned land needs first to start with consultations with people involved to assess their opinions. This is mainly attributed to the scarcity of land in the country in general and the project area in particular. The project planners should further ensure that special consideration is given to the people who do not own land but are utilizing the land either communally or using other people's land that will be affected.

iii) Land use

It was relevant during this study to ask the question about land use so as to reveal any activity that may be affected during the construction of the proposed dams. It is clear from the majority of households that the predominant land use is the crop farming in site **(*Table 6-16*)** the second major land us is tree planting and settlements.

Table 6-16: Land use in the Taba-Gakomeye valley

		LAND USE						
		Crop farming	Buildings	Tree planting	Sand retention	Other (Not specified)	Livestock rearing	Total
Site A	Count	174	12	52	2	1	36	177
Site B	Count	22	11	2	0	0	9	22
Total	Count	196	23	54	2	1	45	199

Source: Own Survey

Downstream of the reservoir the land is used for crop farming, tree cropping on the slopes and settlements for residential and commercial purposes.
The land downstream is also used for fish farming.

6.3.8 *Infrastructure*

i) Education *Infrastructure*

There are quite a number of educational institutions in the two districts of Nyamagabe and Huye ***Table 6-17*** shows the distribution of schools among the two districts.

Table 6-17: Number of Schools by District

District	Nursery Schools	Primary Schools	Secondary Schools	Vocational TainingCentres	Literacy Centres	Higher Institutions of Learning
Nyamagabe	72	102	48	6	184	
Huye	92	87	27	4	91	5

Source: Huye District Development Plan (2007), Nyamagabe District Education Department

Consultations revealed that in NyamagabeDistict there were at least 2 secondary schools in each Sector and 2 literacy centres per cell. As regards the nature of structures of educational structures, it was observed that most them are constructed using permanent materials and most of them are fairly in good condition in both districts. This was attributed to the fact that the classrooms are currently constructed by local people with support of the government by providing cement and sheet roofs. The local people have a sense of ownership over these structures and therefore ensure that materials are utilized efficiently. However, in Huye District, although the structures are of permanent materials, most of the classrooms are old and about 40% of them need rehabilitation. It was observed that there is vocational institution **(*Plate. 6-8*)** in the proposed area for the reservoir that is likely to be affected. This institution provides carpentry and building training to about 200 students.

Plate 6-8: Vocational Institute in the Project area

It was observed that downstream of the reservoir, there was a field that was being used by pupils for their recreation like football playing.

ii) Education Service delivery

Quality of education and education service delivery in Rwanda has greatly improved as compared to the previous years. This is attributed to a number of factors. The system of double shifting is applied in both districts. This is where one group attends the class in the morning and another in the afternoon. As aresult of this the teacher: student ratio is 1 teacher per 46 students in primary school and 1:26 in secondary school in Nyamagabe and 1 teacher per 62 students in primary and 1 teacher per 56 students in Nyamagabe. Another factor that has contributed to good education

service delivery in the two districts is the deployment of qualified teachers. Consultations revealed that 100% of the primary teachers are well qualified from Teacher Training Centers (TTC). However, in secondary schools, some teachers still have low qualifications but there is an upward trend towards required qualification. However, despite the efforts to improve the quality of education in both districts, the schools still face a number of challenges like lack of well-equipped laboratories, lack of enough books, lack of electricity and lack of enough computers. For example, according to the Nyamagabe District Education Officer, only 2 of all secondary schools have got well-equipped laboratories basically for science. This is a big challenge for both teachers and students; this constitutes a gap in the teaching of science in the study area.

6.3.9 *Health*

i) Health Infrastructure

Nyamagabe District has 15 health establishments (2 hospitals, 12 health centres and 1 dispensary). Those establishments are Kigeme District hospital, Kaduha District hospital, Mubuga health ventre, Kaduha health centre, Jenda health centre, Cyanika health centre, Ngara health centre, Nyamagabe health centre, Kigeme health centre, Nyarusiza health centre, Mushubi health centre and Nyarwungo dispensary. The 2 hospitals (Kaduha and Kigeme) are electrified and with fiber optic internet communication facilities. Nine of the health centres have got EWSA electricity and 7 others have power generators. Kigeme is a very old referral hospital with very limited space making it difficult for possible expansion. Consultations with the District Health and Monitoring Officer revealed that 5 of the health centres need to be rehabilitated. There is one district pharmacy which provides medical drugs used in hospitals and health centres. The pharmacy is led by the Administration Council. The operating costs are provided by the District and they are deposited to the pharmacy`s account. Beds are provided by the Ministry of Health to the health centres and hospitals and these are given money for maintenance of these beds. Huye District has 12 health centres serving a total population of about 290,677 inhabitants **(**an estimation of 23,500 inhabitants per health centre) whereas the WHO recommended norm ought to be 20,000 inhabitants per health centre. There is 1 national referral hospital, 1 first stage referral hospital and 1 health centre specializing in mental health.

ii) Health service delivery

In Nyamagabe District, there are 14 doctors compared to 33 that are required, which makes a %age of 44%, 267 nurses compared to 330, hence 72% of the requirement.

In Huye District, there are 7 Doctors and 108 Nurses which is way much lower than the required 33 doctors. It is very clear that the health personnel are not enough compared to the number of people in need of medical attention. The laboratories are also not enough and lack adequate equipment. In addition, the health centres are not equitably distributed in the two Districts such that patients often walk over 10 km to access a health centre or hospital.

iii) Diseases

The principal cause of morbidity and mortality by decreasing order are malaria, respiratory diseases, AIDS, diarrhea diseases and diseases linked to malnutrition. These principal causes of morbidity and mortality can be linked mainly to lack of hygiene, ignorance, lack of material and financial means and long distances to health centres in certain Sectors. Chronic malnutrition was reported to be a major

problem in both districts due to lack of sufficient basic foodstuffs. Relative prevalence of these diseases is depicted in (***Fig 6-13***).

In the project area, results from the household survey showed that malaria is the most common disease in the area followed by intestine infections, cough, water related diseases (diarrhea, typhoid), HIV/AIDS, skin diseases, respiratory infections and ulcers. The category (others) not specified consists of diseases experienced but unknown to the villagers; most of these were even not treated at health centres or hospitals.

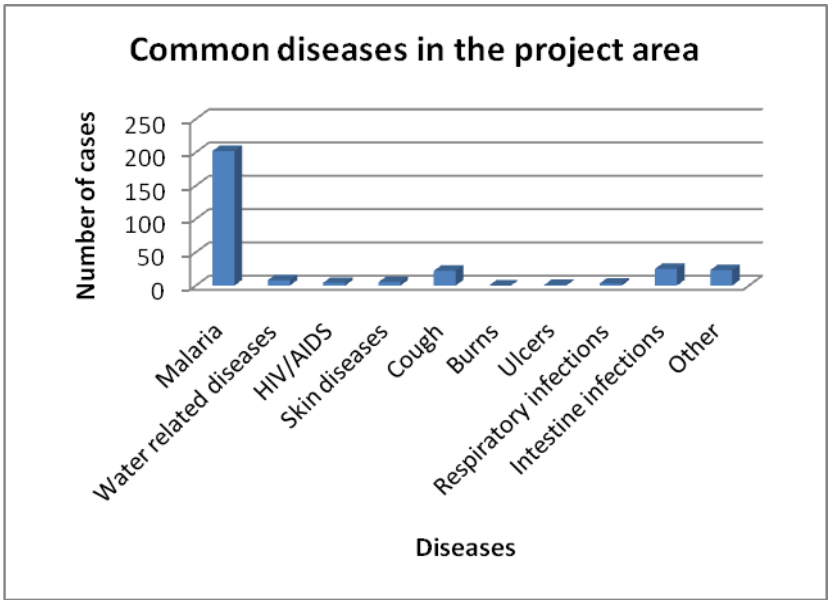

Figure 6-13: Common Diseases in the project area

iv) HIV/AIDS prevalence and awareness

Like in other African countries, HIV/AIDS remains a challenge in Rwanda. The HIV/AIDS prevalence is reported at 2.9%. In Nyamagabe District, in 2006 out of 23,922 persons tested, 1,299 (5.4%) tested sero-positive. The rate of voluntary screening for HIV/AIDS remains low. People who have gone for voluntary testing in VCT/PMTCT during the year 2006 were only 7.6 % of the District population. HIV/AIDS has affected women more than men. Out of the Persons undergoing ARVs treatment during the year 2006 63% of them were women. (Nyamagabe District Development Plan – 2008-2012). In Huye District in 2007, the HIV/AIDS prevalence rate was at 3%. In the project area, only 4 respondents reported that they had been suffering from HIV/AIDS. This is a small %age. During the construction phase, the project should put measures in place to ensure that HIV/AIDS awareness levels are increased so as to ensure that there is no increase in the disease.

6.3.10 *Transport and communication*

Transport

Nyamagabe District is crossed by a single tarmacked road Huye-Nyamagabe-Rusizi. The District possesses a dense road network but most of it is inaccessible due to the poor state of roads rarely maintained or rehabilitated. During the rainy season transport often comes to a standstill due to seasonal rivers which overflow, bridges which collapse and landslides which make roads impassable.

According to the Huye District Development Plan (2007), the district has four distinct categories of roads namely Roads of international importance, Inter-District roads, Inter-Sector and roads Urban roads. Most of these roads are in very bad state and most of the bridges are also in very poor state.

The road to the project area is in also in a very poor state and is crossing several temporary wooden bridges. The road is impassable especially during the rainy season. Before construction of the project, there might be need to rehabilitate the road so as to enable big trucks carrying materials to the project site pass. ***Plate 6-9*** and ***Plate 6-9*** below show the current state of the roads to the project dam site.

Plate 6-9: Temporary Bridge to the project area

Plate 6-10: Section of the road to the project area

There are 2 access roads, several footpaths and bridges in the project area that cross the area where reservoir will be located eg that one shown in ***Plate 6-11*)**. According to consultations with the community members, two of the roads expected to be affected by the project are called Nkungu-Kazana road and Kiizi-Ibisi-Byahuye road.

Plate 6-11: Bridge in the Project Area and might be submerged

Downstream of the reservoir, there is a highway tarmack road.

Communication

In regard to communication, Nyamagabe and Huye districts have a very big number of MTN and Tigo subscribers. These two telephone communication networks are the most used in the two Districts as well as in the country.

The proportion of population in both districts which uses telephones is still very small even though some remarkable progress in this domain has been made. The number of people using mobile telephones is generally on the increase. Information and Communication Technology (ICT) has enormously contributed to the progress of the country in general and the districts in particular and has improved service delivery like education through long distance learning. Cybercafés are concentrated principally in the District towns.

In the project area people access information mainly through village public speakers, then community meetings, radio and through geographically-close households **(*Fig. 6-14).*** The fact of zero count for television may be understood in a sense that first of all purchasing power of local people is low; secondly, there is no electricity. Furthermore, the zero count of responses for newspaper information has twofold explanations: A number of the surveyed people are illiterate, then newspapers may not be affordable for them given their relatively low income in comparison to the national statistics. Furthermore, the culture of reading is at its infant stage. Telephone communication represents only 5.5% of all means of information access. The project planners and implementers should take note of the most effective ways of disseminating information to the local people..

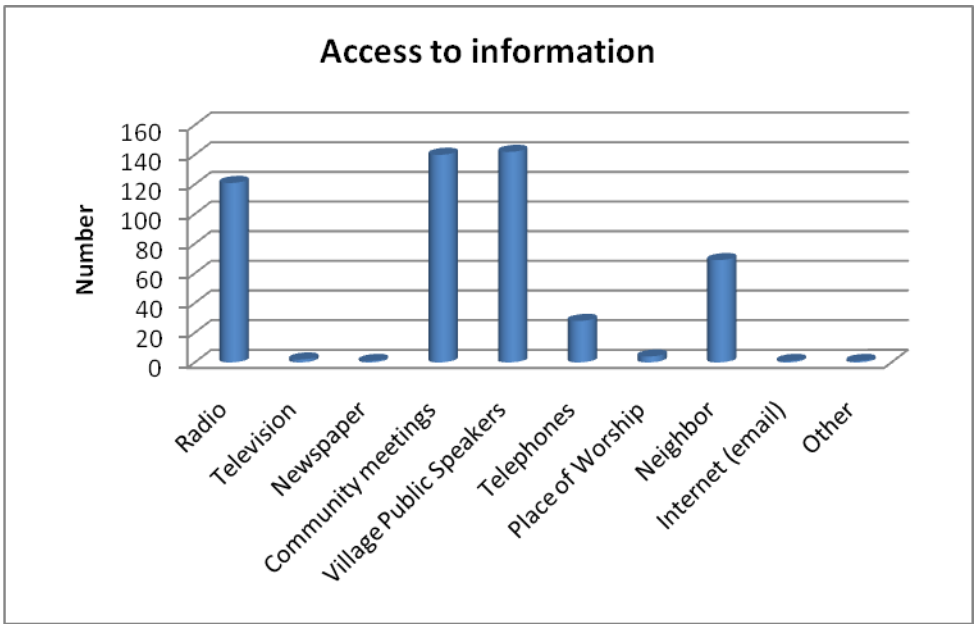

Figure 6-14: Access to Information

6.3.11 *Water supply*

Accessibility

Nyamagabe District is among several zones in the country with sufficient water sources which can potentially satisfy the demand of the population if tapped. However, the majority of the population uses dirty water from streams, dams, valleys or swamps. The population travels an average distance of 3.5 km to access clean drinking water whereas the standard norm determined by MINITERE is 250 m. (Nyamagabe District Development Plan–2008-2012)

In Huye District, the principal sources of water used most in the District are free public fountains used by about 53.7% of the population. A high %age of the population (7%) use poor quality water and only 19.3% have access to clean drinking water. (Huye District Development Plan – 2007)

In the project area, despite the considerable amount of water running off in the Gasumba and Kizi mountains and draining into the Mwogo River, facilities for access to water for the majority of respondents are still very basic, and usually rely on the village government facilities, here expressed as public boreholes indicated by a high number of responses (**Table 6-18**). Very few people own private boreholes due to high costs involved, and none have private pumps plumbing within their homes. For households who use the river as their main water source of water, consultations revealed that they are given water purifiers from World Vision to help purify the water for drinking purposes.

Table 6-18: Source of Water

Source of water	Frequency	%
Public boreholes	118	58.4
Privately owned boreholes	10	5.0
Protected spring/well	37	18.3
Unprotected spring	9	4.5
River, lake, stream, swamp	25	12.4
Total	199	98.5
No responses	3	1.5
Total	202	100.0

Consultations revealed that most of the water sources like the springs are not reliable throughout the year as some of them dry up during the dry season making it difficult for the people to access water. Given the current poor situation of water in the area, the construction of the proposed multipurpose dam will improve on the accessibility to clean water by the local people. Consequently, River Mwogo remains the main reliable source of water ***(Plate6-12).***

Plate 6-12: River Mwogo, one of the water sources in the area

Water use

In regard to water uses, apart from domestic use which is common for all people in this region, as in the rest of world, the surveyed households revealed other uses of water among which watering animals is the most prominent, followed by beer brewing or making juice, brickmaking, agricultural use, and fishing.

Distance to the water source

The results from the household interviews show that people in this region are not very far from water sources as the majority of them have to travel just less than 500m to reach them. Another high %age travel between 500m and 1000m to reach the water sources **(*Fig. 4-15*).** From the EDPRS document, the average distance from home to the water source was of 500m in 2005 and much effort has been made to ensure easy access to clean water. Comparing the current situation of this region with the national trends, more efforts have to be made in this regard in this particular study area. Maybe this can be one of the intervention areas to be addressed by this project.

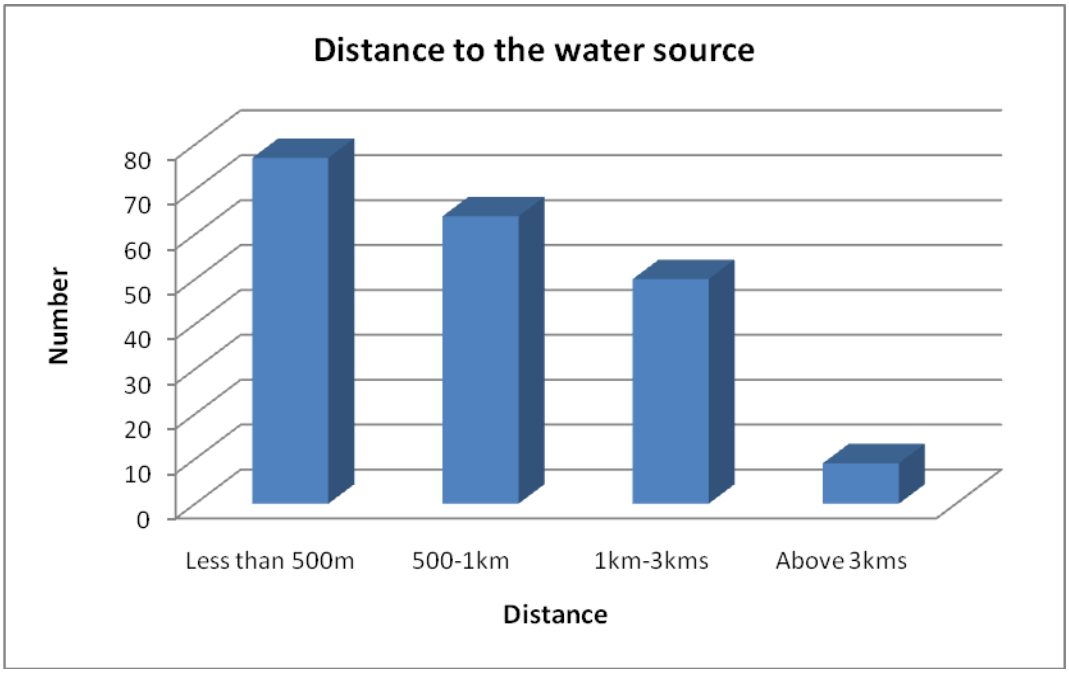

Figure 6-15: Distance to the Water Source

As regards time spent fetching water majority of the respondents (44.5%) spend less than 30 minutes fetching water on a single trip, 41.5% spend 30 minutes to 1 hour, 13.5% spend 1 to 2 hours and only 0.5% spend more than 2 hours fetching water on a single trip. The little time spent fetching water is attributed to the short distance to the water sources.

Quality of water

The Figure below shows the opinions on the quality of water with respect to some of the key attributes of water: taste, smell and colour. The majority of responses (50.9 %), a cross-view of all the 3 attributes, reveal that the available water is relatively of good quality (***Fig. 4-16***). Consultations revealed that World Vision an NGO supplies the local community with water purifiers so as to make the water from the river consumable. The project should ensure that water quality tests are undertaken prior the project construction to measure the actual quality of the water against measurement and monitoring of levels of contamination will be measured.

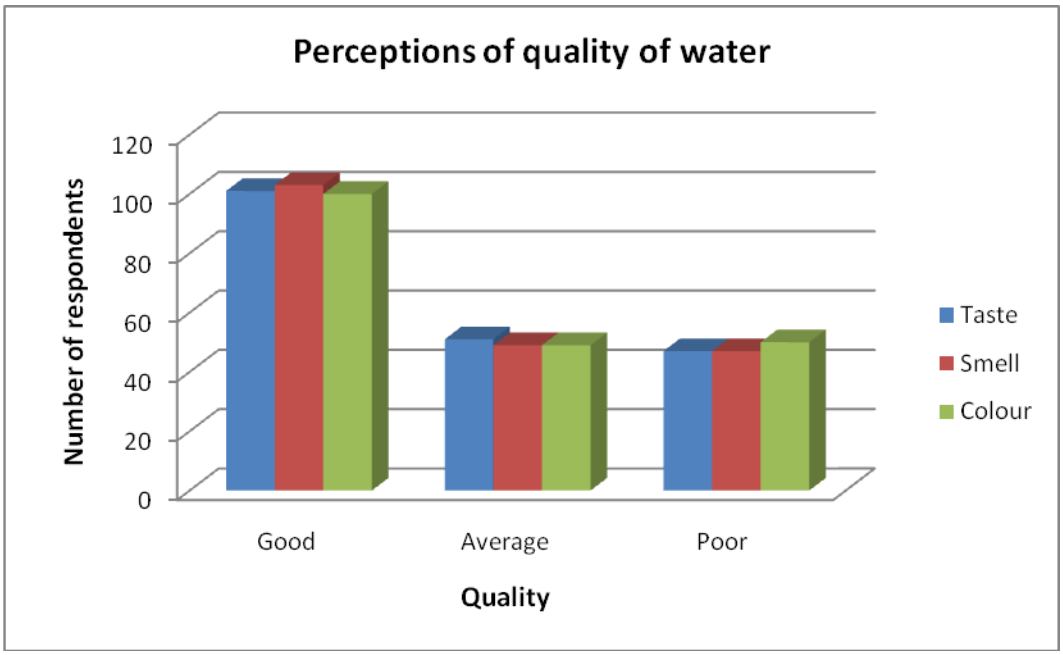

Figure 6-16: Perception of quality of Water

6.3.12 *Sanitation and Waste Disposal*

In Nyamagabe and Huye Districts, 87% and 88.2% of the homes own pit latrines respectively. However, in Huye District out of the 88.2% 32.1% use unprotected latrines. (*Nyamagabe District Development Plan - 2008-2012 and Huye District Development Plan – 2007).*In the project area, the household survey showed that majority of the households (93%) owned toilets and most of the households (65.3 % in site A and 81 % in site B) used pit latrines. The results, with a high %age (93%) of people having latrines compared to only 7 % who don`t have them, are coherent with the efforts of local government to sensitize people to have toilets, at least pit latrine. Only about 5.6 % of the households in site A don`t have latrines, and 70 % of these indicated that they share the latrines with their neighbors and 30 % go to the bush because they don`t have their own latrine compared to 17.4 % of households in site B and all of these use their neighbors' toilets.

In regard to waste disposal options, the household survey results indicate that 98.5 % of the sample households have got waste disposal facilities. Majority of households scatter the wastes in gardens, others use open dumps and shallow pits.
Consultations with the Nyamagabe District Health and Monitoring Officer revealed that government had put in more efforts to ensure that the levels of hygiene are improved by putting in place health clubs/committees in each village to sensitize the local community about ownership of toilets and proper garbage disposal places. These work hand in hand with the community health workers. These efforts may explain why majority of the households in the area own latrines.
Still, more efforts by the local administration in general and the households in particular are needed to ensure that there is 100% latrine coverage so as to minimize the chances of water contamination of the reservoir.

6.3.13 *Other water infrastructure*

In the area where the reservoir will be constructed, a dilapidated dam was observed **(*Plate. 4-13*).** Consultations with the local people showed that this dam had been constructed by the government to control floods but it did not meet its objectives as floods instead just increased. Consequently, this structure was abandoned and the river was diverted.

Plate 6-13: Water Infrastructure in the Project Area

6.3.14 *Sources of energy*

It is hoped that by the year 2020, Rwanda shall be able to produce sufficient energy to satisfy all social and economic activities without damaging the environment, by combining hydro and methane gas potential. It is hoped that 35% of the population shall be able to access electricity instead of the current 6%. In Nyamagabe District, only Nyamagabe town and Gasarenda trading centre are connected to the national electricity grid. A small %age of people has electricity in their homes. More than 90 % of homesteads use firewood or charcoal as a source of energy to cook their food. Nyamagabe District is currently in the process of promoting alternative energy sources with focus to biogas and solar energy.

Firewood is the principal source of energy in 92% of homes in Huye District as most homesteads use it for domestic cooking. Kerosene lamps are the principal source of lighting for about 54% of the population in the district. Use of electricity in homes is very limited especially in rural and semi-urban zones. Huye District has a single site (Sumo situated North-East at the frontier with GisagaraDistrict) which is earmarked for development of a micro electric station. Supply of electricity shall initially target communities to support economic activities other than local consumption only. In the project area, the household survey results indicate that the far dominant source of energy used for cooking is firewood (***Table 6-19***) which represents 88.3 % of the responses while kerosene represents 54.5 % of all responses for source of energy for lighting at home (***Table 6-20***.)

Table 6-19: Counts for source of Energy for Cooking

	Site		
Source of energy for cooking	Site A	Site B	Total
Firewood	175	23	198
Charcoal	9	0	9
Kerosene	10	3	13
Solar	3	1	4
Total	197	27	224

Source: Own Survey

Table 6-20: Counts for Source of Energy for lighting

	Site		
Source of energy for lighting	Site A	Site B	Total
Firewood	32	13	45
Charcoal	1	0	1
Kerosene	112	3	115
Electricity	7	0	7
Gas	1	0	1
Solar	5	6	11
Locally made torch	25	6	31
Total	183	28	211

In the project area, there is an electricity transmission line from the vocational institution to the Gasumba town that will be affected by the project. This transmission line **(*Plate 6-14*)** supplies electricity to the vocational school and a nearby local factory that produces animal feeds.

Plate 6-14: Electricity Transmission Line in the project area

Given the low electricity supply in the area, the project if possible could also harness the option of hydropower generation so as to contribute to the people's economic wellbeing and improvement of their lives through small scale industries, using the generated power to pump water to people living on the hills among others. In addition, measures should be in place to relocate the transmission line.

6.3.15 *Security*

Insecurity is not a problem in Nyamagabe and Huye districts, the majority of the population carry out patrols called « Irondo » and the Police give their support to activities which require exhaustive investigations. However, there are a few isolated cases of insecurity. This structure supports the population in keeping their own security so that regular security organs are not overstretched. However, they need training to discharge their responsibilities. In Kiizi, security issues are handled by security committees at village level. These committees are supported by the Gasaka-Kamegeli police station. Apart from the assistance Gasumba villagers get from Simbi-Maraba police station, they have "Inkeragutabara" which is a group of people assigned by the community to ensure their security. INKERAGUTABARA is a security cooperative and most of the persons are former soldiers and volunteers who have training in security matters. The citizens pay money according to what they agreed with that cooperative on a monthly basis. Furthermore, security issues are managed by Karambi police station and "Inkeregutabara".

As regards conflicts, the most common conflicts in Kiizi are husband-wife conflicts. These conflicts are handled by local authorities, Abunzi (local institution), family members, CNF at village level and at the higher level by police. The majority of people in Gasumba agree that, land conflicts and family conflicts are the most common ones, but they explained that resolution mechanisms have been put in place in this regard. In addition to conflict resolution mechanism mentioned above, Karambi villagers explained during the focus group discussion that they first try to handle the conflicts themselves, i.e. between conflicting parties or ask for assistance from their neighbors before taking it to the next level.

6.3.16 *Vulnerable groups*

There are several vulnerable groups in the project area as revealed by focus group discussions and household interviews. These include female headed households majority of whom are widows, the elderly, households with People with Disabilities, households with orphaned children and households with HIV/AIDS people. Most of these became vulnerable as a result of the genocide and diseases. From the household surveys, fifteen cases of disability were reported where the majority of them had physical lameness caused by accidentS. With physical disability being the most frequent in this region, it may hinder the livelihoods of people given that most of activities in such a rural area require physical strength. However this depends also on the magnitude of disability.

These groups face a number of problems which include; heavy workload on women, gender based violence, discrimination against and marginalization of people with disabilities, low education levels, low incomes and thus high levels of poverty, landlessness and lack of shelter. Consultations with the women revealed that gender based violence was still a big problem to them and the main causes of this included alcohol abuse and poverty related stress. Special consideration should be given to vulnerable households in all stages of the project by the project planners and implementers.

6.3.17 *Gender considerations*

Ownership of and access to resources

During the focus group discussions with women, when asked about access to resources and assets, participants expressed that nowadays both women and men have equal rights to access and ownership of resources and assets in a home. When asked whether it was possible for a man to sell land without his partner`s consent, they replied that this was a traditional practice which doesn't exist anymore. They added that the only case where land is legally owned singly by a woman is for widows. As regards land use, the consultations revealed that land use was decided upon mutually by both the man and the woman. They added that this has been enforced by gender policies, laws and regulations put in place by the government.

Gainful employment

Most people in the project area are farmers including the women. Very few especially women are employed and earn a monthly salary. This is attributed to the low levels of education and besides, the job opportunities are hard to come by. According to District Development Plan of Huye District (2007) women organise themselves in mutually beneficial associations which engage in income generating activities such as commerce, breeding of small animals, crafts particularly basket and mat weaving, brick making and agriculture.

Division of labour

In Gasumba and Kizi cells, women are involved in daily domestic activities, but also they participate in income generating activities for their family. For this, women participate in cooperatives and most of the time they take the lead; the cooperative membership rate is estimated at 80% of women compared to 20% of men. Although it is the responsibility of the men to look after the family's financial needs, the women contribute greatly to this responsibility. The children help their parents in daily domestic activities like sweeping, fetching water and, catering for domestic animals. The project should ensure that women are given a fair chance to compete for the available jobs especially during the construction and operation phases.

6.3.18 *Tourism*

Tourism is one of the activity sectors which generate revenue in areas frequented by tourists. In Nyamagabe District, Nyungwe National Park is a tourist attraction with its fauna and flora rich in different animal and plant species. Apart from the park, other activities attracting tourists include organised handcrafts trade and cultural troupes which must be developed to attract and retain tourists in the region. Huye District has 4 medium class hotels (Ibis, Faucon, Credo, Petit Prince) and motels. The presence of the National University in the District is an opportunity for tourism development since it can attract conference organizers, professors and other intellectuals. The National Museum of Rwanda can also attract tourists. Nevertheless, the focus group discussions, consultations and observations reported no tourism attractions in this area of study. The dam with its recreational potential may attract tourists to the area. In addition, birds may also be attracted to the water and thus may act as tourist attractions in the area.

6.3.19 *Development organizations operating in the area*

The main organizations operating in the region are World Vision, Compassion International and Care. Most of them intervene in supporting students by paying school fees and farmers. ***Table 4-98*** below presents major development organizations and their areas of intervention in both Nyamagabe and Huye Districts.

Table 6-21: Development Organization operating in the project area.

District	Name of organization	Area of intervention
Nyamagabe	World Vision	- Payingschoolfees, - Support to farmers by providing them with improved seeds and fertilizers, - Live stock provision (mostly cattle), - Building schools
	Care International	- Training of heads of households about saving and credit and linking them with banks
	DUHAMIC-ADRI, Association for integrated rural development	- Provision of fertilizers and improved seeds
	SDA (Services for the Development of Associations) Iriba	- Construction of animal feed plant
	Red Cross Rwanda	- Disasterriskalleviation, - Capacitydevelopment, - Helping the poor
Huye	World vision	- Payingschoolfees - Helping the vulnerable
	Compassion International	- Payingschoolfees
	Global Fund	- HIV prevention - Fightagainst Malaria

6.4 ARCHAEOLOGICAL AND CULTURAL RESOURCES

Following the baseline survey conducted in the Taba-Gakomeye dam site, some finds were collected during the foot survey and most of the finds were briefly analyzed and photographed. These finds

included a pottery piece located at Gps; 35m 0787848, 9721437 belonging to Late Iron Age period and characterized by curved wood roulette decoration found isolated in a newly cultivated garden; an archaeological site recorded was characterized by plain pottery shards recovered at Gps; 35 m 0788023, 9721946; a stone tool in form of a stone core in a small pine forest. The stone was isolated and no other Stone Age archaeology was recorded in the project area. There were no features recovered or seen by the assessment team indicating the existence of paleontological sites in project area, however this does not mean nonexistent of palaeontology in the area.This indicates that there was not much archaeological or cultural resources in the project area but this would need to be further verified by deeper investigations and excavations.

6.5 QUARRY FOR FOR SOURCING STONES AND GRAVEL

The proposed area for camp site, aggregate stones and gravel as well as clay and suitable soils is provided in **Figure 6-17**. The source of stones and aggregates for the Taba-Gakomeye dam site is located on a hill in Rebo Omudugudu, Kigoma Sector, Huye District. It is located about 500m from the main Huye-Nyamagabe road (plate **6-16.).** The whole hill was once planted with Pine, Cypress and some Eucalyptus trees. However, some trees have been cut on the side of the hill leaving large white patches of hard granite rocks. . Information at the site was that the trees were planted by the Government and therefore belong to the state. Similarly, the hill belongs to the Government. The trees were mature and ready for cutting to be used for timber. No wildlife was seen on the site. No plant species of conservation importance were recorded on the site and no animals were seen

In regard to settlements there were no settlements and no cultivation observed at the site. The nearest settlements were located on another side of the hill. However, there was a temporary structure in the vicinity of the site (at the roadside) currently used as camp site for a Srilankan Company. There is an existing road to the site which is narrow and in bad condition (**Plate 6-15).** The nearest trading centre from the proposed site is Karambi which is about 1 km away. In terms of land ownership, consultations revealed that the proposed site is owned by the government under the district leadership and all the trees therein are owned by the government. The figures below show the temporary structure near the proposed site for sourcing stones and aggregates and the access road to the site.

Temporary structure in the vicinity of the

Existing access road to the proposed site for

proposed material source. stones and gravel

Plate 6-15: Temporary structure in the vicinity of quarry and access road

Plate 6-16: The main Huye-Nyamagabe road 500m from Rebo Hill
Far left the site for stones and gravel

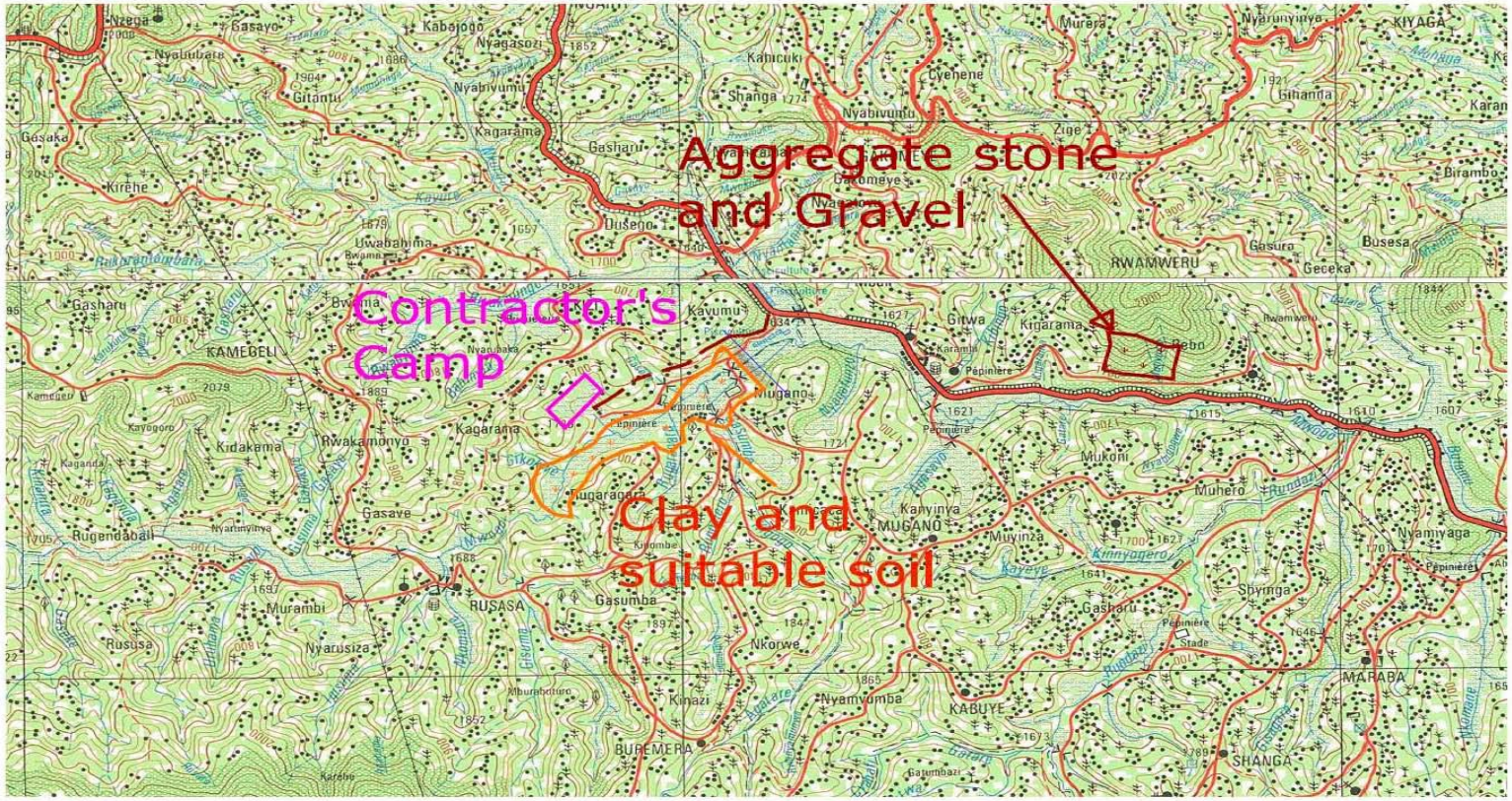

Figure 6-17: Figure showing location of Camp site, source of aggregates stone and gravel, clay and suitable soil

6.6 CAMP SITE

The Feasibility Consultant identified the camp site at about 1.6 km from the main road and is located in Cyinyana village, Kamegeri Sector, Kizi Cell Nyamagabe district. The area is about 200x250 meters and about 20 meters from the side road. The vegetation in the site is made up of planted Eucalyptus trees (**Plate 6-16**) which have been cut and many are sprouting again. Originally the area was covered by wooded grassland vegetation whose dominant trees were *Acacia* sp. The grasses are short and over grazed types (**Plate 6-17).**

There were no crops cultivated at the proposed site however, there were bananas planted at the periphery of the area. In regard to settlements, at the actual site there are no settlements, however there are 2 residential structures that were observed in its vicinity. One of the structures was immediately adjacent to the site while another one was about 300m from the site (**Plate 6-19 to 6-20).** Few goats were observed grazing at the proposed site. The figures below show the proposed camp site, the banana plantations at the periphery of the proposed site and the residential houses nearest to the proposed site.

Plate 6-17: Proposed area for camp with goat grazing

Plate 6-18: Bananas at the periphery of the proposed camp site

Plate 6-19: Residential structure adjacent to the camp site

. Plate 6-20: Residential structure near the site

6.7 SOURCE OF CLAY AND SOIL

Ecological Environment

The proposed area for sourcing clay and suitable soil for construction was estimated to be about 1.6 km from the main Huye-Nyamagabe road. It is located in Gitwa village, Maraba Sector, Gasumba Cell, Huye District. The site is degraded and heavily cultivated with crops like sweet potatoes, cassava, irish potatoes, bananas, beans and some yams. There is no natural vegetation left and no wildlife. The top soil is covered by a sprinkling of grasses but half a meter or so down, there is a thick layer of clay covering very large areas of more than two square kilometers *(**Plate 6-21**)*.. This layer of clay must be several meters thick ***(Plate 6-22)*** but no digging was done to ascertain its depth.

Human environment

The area is currently used for cultivation of beans, maize, sweet potatoes, yams, cassava and irish potatoes. On the hilly side of the area, a number of residential structures and a church were observed. The Church is made of permanent materials while the residential structures were made of semi-permanent building material. In terms of infrastructure, several electric poles were observed and there is an access road which is narrow and supported by weak temporary bridges in some sections **(*Plate 6-25 to 6-26).***

Plate 6-21: Source of clay and soils in small valley cultivated with crops in Gitwa village, Maraba Sector

Plate 6-22: Small road going through the clay site in Gitwa

Plate 6-23: Strip of Clay lying below top layer of soil and grass in Gitwa village

Plate 6-24: Heavy clay layer lying below top soil

Plate 6-25: Clay /soil source area with path and houses.

Plate 6-26: Maize and other crops grown at site with electric poles in site.

6.8 **IRRIGATION COMMAND AREA**

Ecological environment of the area

The irrigation command area in the Mwogo River is quite narrow with very step hills on both sides of the river ban as the river flows from west to east. Close to the dam axis, the valley is only about 100 m wide **(plate 6-27**.). However a few kilometers downstream the valley widens to 200 for about 3 km downstream.

The river receives a number of in lets as streams joining the main Mwogo River. Ten km downstream the Mwogo River becomes quite wide and swampy. The soils in the valley are coarse and loamy and are noted to have low natural fertility.

The valley is currently heavily cultivated with maize (sown in September/October and harvested in February/March) **plate 6-27& 6-28**. Maize yields reach about 4 tons / ha. For early varieties, sown in February/March and harvested in June, a lower yield of 3 tons/ha is often obtained. Rice is not grown in Nyabagabe because of cold temperatures. But upstream of the dam site, maize, soy beans, beans, irish potatoes, sweet potatoes are grown. There is an old weir on the Mwogo River some 2000 meters upstream from the dam site which was used for irrigation but this weir was submerged some ten years ago and the project was abandoned.

The irrigation command area has been heavily cultivated with crops (**plate 6-28 to 6-29**). A few areas downstream remain marshy with grassland patches of short grass typically of wetland vegetation within the valley. Because of the intensive cultivation and the high population density in the project area, there were no native tree species. Wild plant species found included *Eragrostis* sp., *Bidens pilosa, Digitaria* sp., *Conyza* sumatrensis, Cyperus sp. There are also plant forage crops like *Tripsacum laxum,* Setaria sp, Desmodeum sp. *Pennisetum purpureum, Mucuna pruriensis, Cajanus cajan Calliandra calothyris, Leucaena diverifolia,* and *Sesbania sesbhan*.

The proposed irrigation command area which is downstream of the dam axis lies within Nyamagabe and Huye districts. The area is currently under cultivation and the main crops grown include maize, beans, sweet potatoes and cassava. Sand mining is also a major activity carried out in the area. There are also several (about 9) abandoned fish ponds and other aquaculture structures. Several electricity lines were observed crossing the area and a footpath that was used by the people to cross from one side of the river to the other. The nearest trading centre is Karambi trading centre. In terms of land ownership, most of the land is owned by the government.

Plate 6-27: Mwogo valley widens downstream

Plate 6-28: Irrigation Command Area 1-heavily cultivated valley of Mwogo River near Kakambi Township

Plate 6-29: Soya Beans grown in Mwogo Valley Area

Plate 6-30: Fish ponds, some structures and sand mining in proposed irrigation command area

Plate 6-31: Beans cultivated in the proposed irrigation command area

Area 1 is of about 60 ha along side Karambi Township some 2.5 km downstream from the dam axis;
Area 2 is of about 36 ha of swampy marsh land some 7 km downstream of the dam axis after the long narrow gorge;
Area 3 is of about 57 ha after the river flows though a second gorge upstream of the KFW project where there is a weir and a dam supplying 178 ha of irrigation land ***Plate6-32***. A second weir is being built a few kilometers upstream and this one is almost complete ***Plate 6-33):***
Area 4 is about 40 km downstream of the dam axis. This site has several critical issues to be resolved before it can be fully utilized.

If all the three potential irrigation command areas are developed, it is expected to realize net controlled area and gross controlled areas of between 20-40%. The potential net irrigated area in the project could be 122 ha at maximum and 92 ha at minimum.

Plate 6-32: KFW project; dam and weir supplying 178Ha downstream of river Mwogo

Plate 6-33: Second weir being built by KfFW afew kms upstream of dam

Potential crops to be grown when the project is fully implemented are maize, beans, potatoes and vegetables. Fruit tees like plums, oranges and lemons could be grown on the edges of the perimeter. Rice is not recommended for Areas 1, 2 and 3 due to low temperatures. Due to slightly higher temperatures, rice could be grown in Area 4. Due to irrigation, farmers will be able to grow 3 crops annually

Aquaculture Development

In Nyamagabe District there were 103 fish ponds in 2008, while in Huye District, there were about 20 fish ponds in 2007. Fish farming is essentially practiced at a personal level or by associations. There are about 9 fish ponds in the project area that were built some ten years ago but which are not functional and had been abandoned for some time **(*Plate 6-34 to 6-36).*** Consultations revealed that these fish ponds had been dug by the government but their management and maintenance failed. These fish ponds together with fish fry aeration chambers and channels are intact and are in very good condition and could be rehabilitated for aquaculture in the new project ***(Plates…6-34-6-35).*** Already there is an aquaculture project some 100 meters across the Huye/ Nyabagabe Road which has over 6 fish ponds in excellent working condition coupled with rabbit cages **(*Plate 6-36).***

Potential demand for fish and Impacts of fish farming in the project area

The Feasibility Consultant has estimated density of the population in the project area as high at about 364 persons/km². This is projected to increase to 727 persons /km² by 2037. The Table below gives the projected fish consumption levels and demand for fish ponds in the subsistence and commercial level.

	2012		2037	
	Subsistence 2 km radius 2t/ha/yr size 0.04 ha	Commercial 4 km radius 3t/ha/yr size 0.04 ha	Subsistence 2 km radius 2t/ha/yr size 0.04 ha	Commercial 4 km radius 3t/ha/yr size 0.04 ha
Population density	364	364	727	727
Population	4,575	18,299	9,137	36,548
Fish consumption kg2 1kg/person/year	4,575	18,299	9,137	36,548
Pond area ha	2.29	6.10	4.57	12.18
Number of ponds	57	15	114	30

The conclusion that can be drawn from this table is that the required the project area will require 57 fish ponds currently of 2.29 ha each to supply 4,575 kg of fish to a population of 4,575 people per year. This fish demand would rise to 18,299 kg of fish from 15 fish ponds annually by 2037. Hence, there is potential sizable demand for fish in the project area and this fish demand will continue to grow.

In order to meet the expected fish demand in the project area, the existing fish ponds should be rehabilitated simply by clearing grass, repair of channels and gates.

Plate 6-34: Fish ponds of the old Aquaculture Project & Fish fry aeration and preparation chambers

Plate 6-35: Existing aqualture project across the main Huye/Nyamagabe

Plate 6-36: Rabbits' houses in the old fish ponds area

Water Supply

Although both Nyabagabe and Huye districts are well supplied with drinking water, many people still use water from streams, dams, valleys and swamp water direct. In the project area, 3-37% of the people have clean water from stand pipes; 33-66% obtain water from protected springs and 22-50% get their water from rivers, lakes, or un protected springs (Source: Feasibility Report-Tractebel Engineering, 2012). The fetching distance for water is 2-5 km. This is exacerbated by the fact that the majority of the households are located on top of hills. National water demand has been estimated at 20 l/person/day. The present water demand in Nyabagabe, Huye and Nyaruguru districts has been estimated as follows:
Total for urban for 2012 is 1,441 m^3/day for; total for peri-urban is 1,005 m^3/day; total for rural is 6,724 m^3/day. This gives a total water demand at 9,170 m^3/day for 2012. This figure is expected to jump to 39,077 m^3/day for 2037. It is expected hat with the Taba-Gakomeye dam in place, it will be possible to achieve the above water demand including feeding stand pipes, water abstraction, transmission, distribution, storage, pumping and treatment components. Further, environmental flow has been approximated at 3.94 Mm^3 taking into account the fact that the annual mean flow in the Mwogo River is 39.40 Mm^3 and the river has a guaranteed discharge of 0.79m^3/s.

7 EVALUATION OF POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

7.1 Positive Impacts of the action

7.1.1 Preparation phase/planning

7.1.1 *Preparation phase/planning*

7.1.1.1 Employment opportunities

The positive impacts that may arise during this stage are employment opportunities among the community members. Most of the people in Taba-Gakomeye are involved in agricultural activities. However due to land scarcity, most families have small pieces of land such that the community members are not fully engaged thus the need for employment in other sectors. The jobs are in form of translators, casual labourers, guides and data enumerators who are hired during the study phase of the project. Some community members were engaged for about two weeks during socio-economic surveys as enumerators, interpreters etc. However the magnitude of impact is **low positive** due to the small number of people that will be employed as compared to the many who would need the opportunity.

7.1.2 Construction Phase

7.1.2.1. Improved access road

Currently, the access road to project site is in very bad condition and is impassable during the rainy season. It is also characterized by temporary bridges. During the construction of the dam, heavy vehicles carrying raw materials and other equipment will constant use the road. It is therefore likely that this road will be improved before project construction as to enable the transportation of the materials, equipment and project workers. Improvement of this access will help the local community in easier transportation of their commodities to the nearby trading centres and markets. Although the impact will be long term and will benefit a number of people the section of the road to be improved may not be very long thus the impact is expected to be **medium positive**.

Enhancement of positive impacts

- Periodic maintenance of the access road.

7.1.2.1. Skills development

Those who will have the opportunity to work with the project during the construction phase, particularly the unskilled and semi-skilled, will get an opportunity for skills development. The unskilled are likely to be upgraded to semi-skilled while the semi-skilled will be exposed to better techniques and work methodologies. Improved skills are always beneficial as they result into more income opportunities for the holder. This impact is therefore **low positive.** This is because although its benefits go on even after the construction phase, only a few people will benefit as compared to the many people who would need this opportunity.

Enhancement of positive impacts

- On job training for the unskilled and semi-skilled workers

7.1.2.2. Employment opportunities and increased incomes

During the construction phase, workers including both skilled and unskilled are expected to be employed directly by the project which will in turn contribute to an increase in their incomes. The baseline findings indicated that the literacy rates of the Nyamagabe and Huye district sites were at 63.9% and 52.5% respectively. The local people will thus be employed mainly as casual workers. The number of workers recruited to work at the project will be small as compared to the job seekers and the opportunity will only last for the construction phase. The magnitude of the impact is therefore expected to be **medium positive**.

In addition, the local communities will benefit indirectly from the increased spending of the workforce. Local people will gain through sale of items like food stuffs, milk and other basic goods to the workers. The increase in demand of products will lead to increased supply and creating market for products thereby improving the incomes and general welfare of the local communities and their families. In addition, the community members with rental houses will further benefit from the project by renting out houses for accommodation to the project workers. The magnitude of this impact is expected to be **medium positive** as not everyone will benefit from this opportunity and the impact will be short term.

Enhancement of positive impacts

- Sensitization of communities and information dissemination on the existing job opportunities on the project.
- Priority should be given to sourcing local labour from the project area.

7.1.3 Operation and maintenance /Post construction stage

7.1.3.1 Impact on Floods down steam

During heavy rains in the rainy seasons the Mwogo River down stream tends to flood and this destroys mainly crops and infrastrure and upsets the farming regime. The flow of water down stream of the dam will be regulated. This will stop uncontrolled flow of water downstream and allow farming and other activity to procede uninterrupted. This will have huge positive impacts on agriculture and other economic activities of the communities downstream.

7.2.4.1 Irrigation Command Area

A large number of impacts that are likely to result from establishment of the irrigation scheme are highlited below

Positive impacts of irrigation

- Availability of water during both rainy season and the dry season;
- Availability of water for irrigation;
- Availability of water for growing two-three crops annually;

- Potential for better food supply;
- Guaranty in food security;
- Reduction in poverty levels;
- Increased income for the communities;
- Improved drainage in the irrigation command area;
- Improved access roads;

- **Enhancement of positive impacts**
- Proper planning, construction and maintenance of irrigation dykes and canals;
- Adequate funding of maintenance of irrigation dykes and canals;
- Training of farmers in modern agricultural practices and in irrigation technology;
- Training of technicians in maintenance of irrigation equipment;
- Establishment of practical management structure to oversee the maintenance of the irrigation dykes and canals;
- Formulation of bye-laws and regulations for the management of the irrigation dykes and canals;
- Good enforcement mechanisms for the management of the irrigation dykes and canals;
- Establishment of good law and order, security and public health strategies in the irrigation command area;
- Separation of cattle watering areas;
- Provision of safe points for accessing domestic water supply.

7.1.3.2Improved agriculture through irrigation

As is the case with the majority of Rwandese, most of the people in the project area live on agriculture. According to the baseline findings there are several factors that have contributed to the low agricultural production in the two districts and these include unpredicted climatic conditions, poor soil fertility and land fragmentation among others and all this has contributed to food insecurity and low incomes for the people.. According to the feasibility report, about 60ha (more than 2.7km) downstream the dam site (downstream Karambi village) is possible for irrigation. In addition, an additional 36ha downstream the 60ha could also be irrigated. This therefore implies that with irrigation cultivation shall be carried throughout the year with 3 seasons. The proposed crops to be grown under the irrigation scheme include maize, beans potatoes and vegetables. It is expected that 5 tons of maize, 1.6 tons of beans, 15 tons of potatoes and 2-6 tons of vegetables per hectare will be produced per season. This further implies that small pieces of irrigated land will be fully and properly utilized thereby leading increased production. Increased crop production will in turn translate into food security, increased incomes for the people and therefore improvement of their general welfare. The impact is thus estimated to be **high positive** as it is long term and will improve many people's lives and their household members**.**

Enhancement of positive impacts

- Capacity building and sensitization of the people in proper irrigation methods
- The farmers should be sensitized about the proposed cropping patterns to enable them maximize production.
- Women being the major tillers of land should highly be encouraged to participate in irrigation fed agriculture.

- Irrigation and water user committees need to be put in place and strengthened to ensure the success of the project.

7.1.3.3 Improved and increased water supply

. The communities will fully benefit after the dam is constructed both in dry and wet seasons in terms of water supply for both domestic use and other productive uses like watering of animals. This because one of the core purposes of the proposed multipurpose dam is to provide water supply to the communities in the area. Currently safe water coverage in the two districts stands at 35% and at 27.7% respectively. Consultations further revealed that many people fetched water for domestic purposes from River Mwogo and its quality is questionable. The construction of the dam will improve on availability of safe water in the area and will thus contribute to a reduction of water related diseases and general sanitation. Furthermore, there will be a reduction in the distances to the water points and the time taken to fetch water which could be used in other productive ventures. It is proposed that several water storage tanks will be constructed in a number of places namely Nyamagabe, Gikongoro, Gasaka, Munombe, Kirehe Gasumba, Rwakamonyo, Rususa, Nyamvumba, Mukoni, Gasharu, Maraba, Nyantende, Nyamabuye, Gashikili, Mpanda, Nyangai, Kinyamakara, Murera, Gatare, Ngaryi, among others. The magnitude of the impact is expected to be **high positive** as it is long term and will benefit many people as it coverage is quite extensive.

Enhancement measure

- Continuous sensitization of the communities in regard to use and maintenance of the water facilities will be required at all levels.
- Regular maintenance programs of the water facilities should be put in place.
- Water user and maintenance committees should be put in place

7.1.3.4Impact on Water birds

The dam will create a permanent aquatic environment for the water birds of Rwanda. The reservoir will allow congregations of water birds which is one of the criteria under which Important Bird Areas are identified. The regionally near-threatened Water birds (Giant Kingfisher *Megaceryle maxima* and Grey Heron *Ardea cinerea)* that were recorded in the project area will undoubtedly benefit from the increased aquatic habitat and thus, the magnitude of the impact on water birds is generally considered to be **medium positive.** The congregation of water birds at the dam can be sustainably utilized as an ecotourism facility.

- **Enhancement of positive impacts**
- Sensitization of communities on ecotourism
- Training local residents in tourism guiding skills
- Training the communities in environmentally-friendly money generating activities such the production of handcrafts
- Plant trees around the dam for the birds to roost

7.1.3.5 Impacts on Amphibians and dragonflies

When the dam is operational, there will be more and permanent water in the reservoir. Amphibians recorded including the globally Vulnerable Albertine Rift reed frog *Hyperolius discodactylus*., dragonflies and other aquatic biodiversity will thrive better in the new ecosystem implying that the impact of the project on the ecology of aquatic biodiversity is **medium positive.**

7.1.3.6 Potential for fish farming

After construction of the project, it will be possible for fish farming to be undertaken by the local people. According to the draft feasibility report for Taba Gakomeye dam site, 57 subsistence fish ponds and 15 commercial fish ponds could be constructed in the year 2012 and 114 and 30 subsistence and commercial fish ponds respectively could be constructed by the year 2037. Fish farming will provide increased incomes and nutritional values to the households it can be done for home consumption and commercial purposes. However, fish farming was ranked low by the local people as compared to other priority purposes like irrigation and water supply. Although the benefit is long term and can easily boost people's income, it is not considered as critical and therefore not many may engage in it, thus the magnitude of the impact is expected to be **medium positive.**

Enhancement measures

- Continuous sensitization about fish farming and its advantages
- Provide potential farmers with fish stocks
- Training and capacity building in modern fish farming methodologies

7.1.3.7 Provision of employment

During the operation and maintenance phase, direct employment opportunities regarding operation and maintenance of the dam will be limited as the major activity will be desilting which may not even be yearly. However there will be multiplier effects from other project components like irrigation which will increase agricultural activities and fish farming. 167.6Ha are expected to be irrigated in Taba-Gakomeye and downstream areas as indicted in the project description. There is also potential for development of fish ponds as highlighted under potential for fish farming. All these activities are expected to increase with time and absorb a number of people. This will be a long term impact for the project life (about 25yrs) and area of impact is also large. Thus the magnitude of impact is estimated as **medium to high positive**.

Enhancement measure

- The local people should be considered for the available jobs during this phase.

7.1.3.8 Positive impacts on fish and fisheries

The Kagera River Basin is known to have many fish species including Mormyridae, Cyprinidae, Mochokidae, Clariidae, Schilbeidae, Poeciliidae, Protopteridae and Mastacembelidae. Some of these are caught in commercial quantities in the rivers and streams of the basin including its numerous lakes. The new Taba-Gakomeye reservoir when built could be considered for introduction of fish species with commercial prospects such as the ubiquitous Cichlidae, Cyprinidae and the Clariidae.

There are examples of other small lakes within the Kagera River catchment where effective commercial fishing using introduced fish species has been very successful as in Lake Rweru and Cyohoha where Mughanda, 1989 showed that there is potential fish production especially for *Cichlids* (3 species of *Tilapia*) which were introduced in 1950 but have now an average production potential of about 1,500 and 900 metric tons per annum respectively (Kagera River Basin Monograph (Basin Development Report); NBI 15 July 2008; Plan Directeur Pêches et Aquaculture, 1993 ; Rapport annuel 2006 et Rapport mois d'Août 2007, PAIGELAC-MINAGRI.

There is therefore no reason not to believe that similar fish production levels can not be achieved in the new Taba-Gakomeye dam as well as in the other small multi-purpose dams in the Kagera River Basin. This would greatly improve food nutritional capacity of the local communities and offer opportunity for employment. Fisheries can play an important role in ensuring food security, economic development and poverty alleviation among the local community around the Taba-Gakomeye dam site area. This will add value to the current status of capture fisheries in the Kagera River Basin where fish stocks in the majority of these lakes have been over fished.

Aquaculture Fisheries

.Capture fisheries in the Kagera River Basin in general is facing increasing risks including over exploitation of natural fish stocks, use of irrational fishing gears, pollution of the basin waters from industrial effluents, domestic sewage and agrochemicals. Introduction of aquaculture in the Taba-Gakomeye dam area can therefore ensure sustainable fish production. Further, aquaculture can provide an alternative to capture fisheries in the existing lakes and rivers, hence preserving their biodiversity. It can also help the local people engage into other productive activities. Fish species with potential for aquaculture include the tilapias, *Oreochromis* spp., *Haplochromis* spp., *Bagrus* sp., *Clarias* spp., *Protopterus* sp. and the foreign carp species. The magnitude of the impact of the project on fish, fisheries and aquaculture therefore qualifies as **high positive.**

7.2 Negative Impacts

7.2.1 Preparation phase/planning

7.2.1.1 Social expectations generated by disclosure of information to the Community.

This stage may give rise to higher social expectations in anticipation for jobs than practicable from the project considering the higher rate of unemployment in the project area.
Another potential impact at this stage is the fear generated in the mind of the public with regard to land acquisition and loss of structures and crops through the activities relating to the stage of the project as expressed during consultation meetings. This is a **medium negative** impact; although it affects all the people in the community and can be mitigated, it will cease when the construction has been implemented (short term).

Mitigation

- To avoid negative social expectations, all information regarding the project and its relationship with the local community, including aspects of hiring labour and compensation should be disseminated to the community.
- There should be continuous community consultations and sensitizations throughout the project cycle so that all queries and fears are answered, reduced or eliminated from the public mind.

7.2.2 Construction Phase

7.2.2.1 Impacts of construction of the irrigation dykes and canals on crops

The main crops are currently planted during the main first rainy season. Any construction activity during this period will therefore have disastrous impacts on the crops as they will be destroyed. It is suggested that the major construction activity of the project for construction of the dam and the dykes and canals be done during the dry season after most of the crops will have been harvested. This impact could be high but it can be mitigated by undertaking the main cunstruction activity in the dry season when all the crops will have been harvested. The impact could now be rated as **low negative**.

7.2.2.2 Campsite establishment and Operation

Establishment and operation of the campsite has a number of negative impacts, these are briefly presented as follows

- Approximately 0.4 Km² of land will be required for the camp site. This land appeared to be owned. This will lead to loss of Eucalyptus trees. This is **low negative** as the area is small and can be compensated.
- Noise is expected to be generated by the different activities at the camp site including the movement of machinery. Noise impact is expected to be **low negative** as it will affect only three households in the vicinity of the camp site.
- Damage to cultural heritage sites uncovered by accident- None known to exist-**low negative**
- Liquid wastes and solid wastes will be generated at the camp site but this is **low negative** as it will involve only a few workers at the camp site and there will be guidelines for their proper disposal;
- Some plants will be destroyed but this is **low negative** as the area is small;
- Some animals, may be snakes and insects may get killed and some will be forced out of the area but this is **low negative** as the area is small and no animals were seen in the area;
- There will be loss of nesting grounds for birds but this is **low negative** as the birds can migrate;
- Influx of people but this will be **low negative** as the number of people will be few and entry will be restricted;
- Pressures on health services and water supplies- **low negative** as the number of people will be few and better services will be put in place by the Contractor;
- Increase in diseases **low negative** as the number of people will be few and better services will be put in place by the Contractor;

- Conflicts and insecurity- **low negative** as the number of people will be few and tight control mechanisms will be put in place by the Contractor.

- **Mitigation measures for the camp site**

- Areas identified for the camp site must be clearly marked with tape and survey markers and fenced off;
- Noise nuisance can be mitigated by control measures and using national standards like restricting night activities e.g. discos, bars, speed of vehicles;
- The few wildlife including birds can migrate to neighbouring areas; no mitigation proposed
- Restoration of the land to its former state through levelling, grassing and planting trees;
- Proper drainage at the camp site to avoid liquids finding its way to the nearest homesteads and the environment;
- Consultation with the local population must be conducted to make sure that there is no **sacred** site;
- Proper control and management of used oils and greases;
- Proper disposal of solid wastes through dump pits;
- Removal of all garbage, derelict materials and broken down machinery and metals;
- Contractor to put in place better health services, better water supply, tight control and security mechanisms;
- Demobilize work camp, equipment and staff, taking care to prevent adverse impact on the environment.

7.2.2.3 Quarrying for sourcing stones and gravel

Negative impacts are as follows:

- Perhaps approximately 1-2 Km² of land will be required for the quarry site and this will lead to loss of land for tree planting. This is **low negative** as the area is small;
- It is expected that there will be stone blasting at this site during the construction phase of the project. This may bring about psychological torture to the people as they may have never experienced this kind of noise of before. This impact is expected to be **medium negative** as it will cease after construction and given the location of the source of the stones and aggregates, only a few households will be affected;
- Proximity of the main Huye-Nyamagabe road will be cause for concern as stones from blasting may reach the road and cause accidents;
- Accidents may arise as a result of the flying stones that may cause damage to the neighbouring structures in Karambi rural growth centre or to any passers-by. The impact is expected to be **low negative** as it will be short term and not many people live in the area;

- There will be stockpiles of rock and earth materials and there is likely to be ponding and accumulation of still water. This is **low negative** as the area will be fully restored after the activity;

- Visual impacts resulting from landscape degradation- **low negative**
- Damage to cultural heritage sites uncovered by accident- **low negative** as none are known to exist;
- Some plants will be destroyed but this is **low negative** as the area is small;
- Some animals which hide in the area like snakes will be killed and some will be forced out of the area but this is **low negative** as the area is small;

Mitigation measures

- All requirements of the Government of Rwanda for the approval of earthworks and blasting will have to be met;
- Areas that will be identified for quarrying must be clearly identified with tape and survey markers and fenced off;
- Accidents: The contractor should carry out a structural baseline survey for all structures in the vicinity of the blasting area so as to monitor and measure the magnitude of damages in case of any accidents;

- Consultation with the local population must be conducted to make sure that there are no **sacred** sites;

- The contractor should implement a clear time table for blasting and this should be distributed to the local people in addition to continuous sensitization;
- Flag men/women with red flags must be stationed along the main Huye-Nyamagabe road to stop traffic during blasting periods;
- Communities should be given prior warning when blasting will take place so that they can move away from the neighborhood of the quarry (500m)
- Wet crushing is recommended to reduce noise although this method reduces plant out
- Regular watering of the roads that will be used to keep the dust down
- Speed limit is instituted on the construction workers to reduce accidents and dust
- Loss of plants is **low negative** as there are no indigenous plants left in the area;
- Loss of animals is **low negative** as there are no animals present in the area and a few wildlife including birds can migrate to neighbouring areas;
- Restoration of the land to its former state through back filling, levelling, grassing and planting of trees;
- Demobilize work camp, equipment and staff, taking care to prevent adverse impact on the environment.

7.2.2.4 Sites for sourcing Clay and Soils

Potential negative impacts of the action

- Areas required for sourcing soils and clay are currently used for crop farming. The activity will therefore lead to loss of farm land. This is **low negative** as the area is small; the loss is only of short term nature and will be adequately compensated;

- There are no indigenous plants and there are no animals on the site which has been greatly degraded and farmed. The impact will therefore be **low negative** as the area is small and many small animals can migrate and escape;
- Destruction of banana plantations and other crops; this is **low negative** as the activity is of a short term duration and the crops can be compensated;
- There will be stockpiles of rock and earth materials- **low negative** as there will be proper restoration works;
- There is likely to be ponding and accumulation of water- **low negative** as there will be proper restoration works;
- Digging and excavation will upset the drainage pattern in the area- **low negative** as there will be proper restoration works;
- The access road will be modified - **low negative** as access roads will be greatly improved by the Contractor;
- Soil erosion will increase- **low negative** as there will be proper restoration works;
- Visual impacts resulting from landscape degradation- **low negative** as there will be proper restoration works;
- Damage to cultural heritage sites uncovered by accident- **low negative** as none are known to exist. If any are found they will be protected and reported to the appropriate Ministry and Departments for due care including safe keeping of artefacts.

- **Mitigation measures**
- All national requirements for the approval of earthworks should be met;
- Environmental requirements for restoration works should be met;
- The owners of the land and crops will be adequately compensated;
- There should be selective removal of plants;
- Restoration of the land to its former state through back filling, grassing and planting trees;
- Proper drainage to be done all round the pits and burrows to avoid soil erosion;
- Removal of all garbage, derelict materials and broken down machinery and materials;
- Demobilize work camp, equipment and staff, taking care to prevent adverse impact on the environment.

7.2.2.5 Negative Impacts of noise and vibrations

Noise pollution in the dam site area will occur mainly during Construction Phase although there will be some noise during the preparatory phase. The construction phase will involve excavations, blasting, and clearance of vegetation within the reservoir burrowing, quarrying and large scale transportation of materials. This phase will have very significant negative impacts. It will cause physical removal and disturbance of plants and animals; it will destroy habitats, burrows and nests as well as feeding and breeding grounds. Hence many animals will have to flee to safer grounds. These are considered transitory impacts but could have medium term impacts.

Noise during project activity in the dam site area will be generated from the following sources.

i) Transport vehicles
ii) Vibrations from blasting and excavations
iii) Noise from camps

Noise impact evaluation can be estimated using two parameters as follows:
a) The extent of the noise impact expressed as extent of noise effect in space which refers to the distance or an area over which the noise effect is felt. Three levels of extent are recognized:

- Regional extent when an impact affects a large geographic area reaching a significant distance from the project site, or when it is experienced by the entire population or by a significant portion of the population in the study area;
- Local extent when the impact affects a relatively restricted area located within, near, or at a limited distance from the project site; or when it is experienced by a limited portion of the population in the study area; and
- Site-Specific extent when the impact affects only a very restricted area in the proximity of the project site; or is experienced by only a small number of individuals in the study area.

b) The Duration of the impact as the period of time the impacts last during project implementation and after.

Duration can therefore be:

- Long term if the effects are experienced continuously for the life of the activity or after if the impact is irreversible;
- Medium term if the impact occurs over a period of time, but less than the duration of the life of the activity;
- Short term if impact is short for example occurring during construction, start-up or over a single season.

In terms of noise intensity from these sources, noise will be maximum or highest during dam site clearing and construction. But this noise will be transitory, in other words, it will be temporary in that after construction phase noise intensity from transport vehicles, blasting, excavations and camps will disappear or be minimal at worst. The operation of the dam is not expected to be a significant source of noise. The variables of impact extent, duration and impact intensity, determine the significance of an impact on a given environmental component. Essentially, in the dam site, the intensity of the magnitude of impact of noise on the percentage of the population seriously affected by the noise made by the project will have limited site-specific spatial extent given that human population in the project area is near non-existent. Further, this impact will be highly limited duration period since the sources of noises themselves are transitory in nature. This would render noise pollution to be evaluated as **medium negative** in qualitative and quantitative terms and can therefore be considered as negligible and it could be excluded from further analysis.

Mitigation
Construction of a dam can use heavy machines which may cause noise and vibration and crack nearby houses. Fortunately, the dam site is far from community structures so the impact is very minimal or negligible. Vibrations can be mitigated through informing nearby homesteads in advance. The following mitigation measures are suggested to mitigate noise pollution:

Mitigation Measures for Noise Pollution

- Formulation of a Grievance Management Plan within the Environmental and Social Management Plan to handle complaints on noise;
- Limiting construction vehicles to travel during certain hours of the day;
- Limiting the speed of construction and operational vehicles;
- Limiting blasting to acceptable times during the day;
- Limiting social activities of camps like discos to certain acceptable times e.g. up to midnight.

7.2.2.6 Negative Impacts of Air pollution

Air quality in the project area can be evaluated in terms of aerial dust particulate matter and toxic gases like carbon monoxide, carbon dioxide and other acidic gases. Air pollution in the dam site will occur mainly during the construction phase of the project and it will originate from the following sources:

- Transport vehicles and machinery used for construction and transport of workers emitting toxic gases such as CO2, CO, NOx, SO2 and fine particulate matter;
- Excavation works during the construction;
- Excavations at quarries and borrow pits;
- Fumes and odors from operation of the plant and machinery;
- Green House Gas emissions (Carbon dioxide and methane) released by decay of inundated biomass at the bottom of the reservoir.

There will be maximum or highest potential for air pollution during dam site clearing and construction. But this will be transitory, in other words, it will be temporary in that after construction phase intensity of air pollution from transport vehicles, blasting, excavations and quarries will disappear or be minimal at worst. The operation of the dam is not expected to be a significant source of air pollution. Both during the preparatory phase and during construction and operation of the dam, air pollution can be minimized through mitigation measures as described below. This renders air pollution to be evaluated as **negative low** in qualitative terms and can therefore be considered as negligible and it could be excluded from further analysis.

Mitigation measures

The major effect on air quality during construction will be increase in dust during transportation of materials and disposal by vehicles murram extraction and stone quarrying will also produce a lot of dust because of the earth movements and blasting. The following mitigation measures are suggested to control air pollution during the construction and operational phases of the project:

Mitigation Measures for Air Pollution

- Dust control management plan in order to prevent dust emissions from movement and circulation of construction machinery and vehicles on unpaved roads;

- Formulation of transportation and traffic management plan to prevent risk of accident related to increased traffic due o the implementation of the project;
- Ensuring project vehicles are in top conditions and that they are properly and regularly maintained and serviced;
- Watering unpaved roads and trails during vehicle movements;
- Watering of roads that go through trading and rural growth centers in the countryside;
- All trucks carrying the granular material should be covered;
- Vegetation around the proposed campsite should be conserved;
- Providing dust respirators with filters to employees exposed to dust; and
- Instituting and enforcing speed controls through speed limits and humps on roads and trails used by project vehicles.
- Provision of dust respirators with filters to employees exposed to dust

It should be noted that the reservoir when built, will emit Green House Gases (GHG) during its first few years of operation but after this initial period, GHG emissions will decrease exponentially to reach levels typical of natural lakes. Therefore, there is no need to mitigate GHG.

7.2.2.7 Impacts on vegetation

Loss of vegetation cover / Land degradation
During construction of access roads to the dam as well as the dam itself, a relatively vast area will be cleared for setting up project components. The vegetation identified on the site was neither threatened nor endangered thus the magnitude of the impact is considered to be low negative. However mitigation has been proposed.

Mitigation

- Carry out large scale tree planting on the slopes and hill tops;
- Institue measures to enforce sustainable agricultural practices such as terracingand bunding;
- Senzitise communities about the bad effects of deforestation and the need for tree palnting and maintaining grass and tree cover over empty spaces;
- Adjust access road to the project site to avoid high valued features(habitats)
- Open minimal access road
- Avoid unnecessary clearance as much as possible

Inadequacies in Compaction and Resurfacing thus damage to exposed surface and decreased dam capacity. Excavation, site clearance and other earthworks for the construction of the dam and access road may result into loose soils which need to be well compacted and sufficiently resurfaced to avoid exposure of the constructed structures and cleared land to the elements - rain and wind. Exposed

surfaces are liable to damage, result in soil erosion, and increased sediment loads in runoffs etc. The long term impact of soil erosion, sedimentation and siltation is to reduce the volume of water in the dam and impair its quality. This impact is considered **high negative.**

Mitigation

- Conserve natural vegetation in the vicinity of the project area whenever possible to minimize soil erosion.
- Compaction of embankments shall be done to meet the recommended compaction in the design

7.2.2.8 Impacts on Mammals

The construction phase will certainly involve cutting of the vegetation which is a home of some mammals. Mammal species recorded are not neither threatened / near-threatened nor of specialized habitat, the impact of the project on the ecology and conservation mammals therefore **low**.

7.2.2.9 Impacts on Terrestrial birds

The construction phase will certainly involve clearing the existing vegetation which is a home of some terrestrial birds including the two regionally restricted range species recorded (White-eyed Slaty Flycatcher and Spot-flanked Barbet. However, because the global range of these three restricted range species is fairly large range (655,000km^2 and 1,270,000 km^2 respectively), the impact of the project on the ecology and conservation of these species is **low.**

7.2.2.10 Impacts on butterflies

None of the butterfly species recorded is globally threatened or near-threatened. Thus the impact of the project on the ecology and conservation butterflies **low**.

7.2.2.11 Loss of residential structures

About 13 residential houses are currently expected to be affected by the proposed area for the reservoir implying that 13 households will be displaced or resettled. Resettlement is expected to generate mainly three types of social impacts such as, psychological stress, loss of social networks and loss of livelihoods or business opportunities. The magnitude of the impact will be **high negative** because the impact of displacement is irreversible, has long term effects and will affect 13 households and their members.

- A Compensation and Resettlement Action Plan should be prepared in accordance with the national laws and the World Bank guidelines and implemented
- Livelihood restoration programs should be considered to ensure that PAPs livelihoods are restored.

7.2.2.12 Impact on Livelihood activities and sources of incomes (agriculture, sand mining etc)

The majority of sampled respondents (about 87.5 %) confirmed that their main source of livelihood was agriculture. In addition sand mining is the alternative source of income for some of the people especially the youth as confirmed by the communities. The area for the proposed reservoir is currently used mainly for crop farming and sand mining. Moreover, crop farming is carried out in associations which are comprised of mainly women. In addition, the proposed area for the reservoir comprises of fruit trees that contribute to the nutritional needs of households. The magnitude of the impact is expected to **high negative** as it will affect a big number of people's incomes and livelihoods, it is long term and irreversible.

Mitigation Measures

- A Compensation and Resettlement Action Plan should be prepared in accordance with the national laws and the World Bank guidelines
- Livelihood restoration programs should be considered to ensure that PAPs livelihoods are restored.

7.2.2.13 Loss of land and access to land

Due to acquisition of land for the reservoir some households are likely to lose their lands or proportions of their lands. Approximately 60.33 Ha of land will be lost to the project for the reservoir component. In addition land will be required for construction of the water supply network, irrigation channels and workers' camp. Most of the land belongs to the government but some of it is individually owned so many people will lose access to this land. The magnitude of impact is expected to be **high negative** as it is long term, irreversible, will affect many people yet there is scarcity of land in Rwanda in general and the project area in particular.

Mitigation Measures

- Adequate and fair compensation should be extended to the affected households

7.2.2.14 Impact of diversion of water during construction

During construction, water will be diverted at the section where the construction of the dam is going to be undertaken. The length of the diversion is approximately 300 m. The ecosystem at the section of the stream where water will be diverted is going to suffer as there will be no water flowing in this section during the period of the dam construction. However the impact is considered to be minimal as the section that will be involved is relatively short and the period of construction may also be a few months.

7.2.2.15 Impact on Infrastructure

The most expected negative impacts on infrastructure are related to the destruction of existing 4 bridges that interlink different villages surrounding the sub- catchment. In addition to the bridges there are also roads, footpaths, transmission line; vocational school that are likely to be negatively affected by the construction of the dam.

7.2.2.15.1 Impact on Transmission Line

In the project area, there is an electricity transmission line from a vocational institution (Centre Deformation Professional (C.F.P)) to Gasumba town that will be affected by the project. This transmission line supplies electricity to the vocational school and a nearby local factory that produces animal feeds. Inundation of the proposed area for the reservoir will lead to the destruction of this infrastructure which will in turn lead to an interruption in power supply to Gasumba town. Although shortage of power supply may greatly affect other activities and services, the impact can be avoided thus the magnitude of the impact is **medium negative.**

Mitigation

- Realignment of the reservoir should be considered to avoid the impact on the transmission line.
- Provide alternative power supply to the vocational institution and the key institutions supplied by this infrastructure.

7.2.2.15.2 Destruction of roads, bridges and footpaths

There are existing access roads, several footpaths and 4 bridges that interlink different villages surrounding the sub-catchment. These are used by several people in the project area to access different areas, to transport materials like sand, stones and agricultural produce like maize and to access social services. The magnitude of this impact is expected to be **high negative**. This is because the impact is long term and it will disrupt the movement, livelihoods and wellbeing of many people.

Mitigation

- Measures should be considered to avoid inundation of the community roads, bridges and footpaths.
- In case the road and bridge are to be inundated, an alternative road and bridge of similar or better standards should be constructed.
- Alternative crossings should be provided to maintain connectivity between households and villages.

7.2.2.15.3 Destruction of structures for a vocational school

There are 13 structures that are being used by the community that will be affected by the reservoir. These belong to a vocational institution known as Centre Deformation Professional (C.F.P). The educational institution provides vocational skills in carpentry and building to about 200 students per

year. The magnitude of the impact is expected to be **high negative** as it will negatively impact on skills development for many potential students.

Mitigation

- The designs should try as much as possible to avoid the vocational structures.
- An alternative school with similar or better structures should be constructed.

7.2.2.16 Influx of People in the Area

During construction, there will be a temporary increase in population whereby construction workers will settle in the area for a specific period of time. The expected workforce will include both skilled and non-skilled workers. The influx of people looking for work is a common phenomenon with all development projects since word spreads rapidly of the possibility of work and opportunities for earning money. The population increase and the project activities will have impacts on the community in the following ways.

7.2.2.15.1 Pressure on Health Infrastructure and Services

The baseline findings showed that Nyamagabe had district has 2 hospitals, 12 health centres and 1 dispensary and Huye District has 12 health centres serving a total population of about 290,677 inhabitants. Although, efforts have been put in place to improve health service delivery in the 2 districts, there are still gaps that need to be filled. Nyamagabe district has only 14 doctors as compared to 33 that are required while Huye District has 7 Doctors which is way much lower than the required 33. With an increase in population there will be increased strain on the already inadequate health facilities and services in the project area. The impact will be short term and will cease after the construction period hence the magnitude is **medium negative.**

Mitigation measures

- Where possible the project should support the health centres which are in close proximity to the project in terms of provision of drugs and equipment so as to boost their services and facilities.
- The project should plan for additional health infrastructure for its workforce to cater for the increased population.
- Employment opportunities should be extended to the local people to reduce on the influx of people in the area.

7.2.2.15.2 Pressure on water facilities

The baseline findings indicated that the project area is generally water stressed with insufficient water throughout the year. The majority of the population in Nyamagabe district uses dirty water from streams, dams, valleys or swamps and majority travel an average distance of 3.5 km to access clean drinking water whereas the standard norm determined by MINITERE is 250 m. In Huye district, 7% of the population use poor quality water and only 19.3% have access to clean drinking water. An increase in the population during the construction phase of the project will put pressure on the already inadequate water facilities in the area. The impact is short term as it will cease after project construction and its extent is medium thus qualifying it to be **medium negative.**

Mitigation measures

- Adequate water facilities should be constructed e.g. at the workers' camp and construction

site.
- The local people should be priority for job opportunities.

7.2.2.15.3 Pressure on Sources of Energy

More than 90% of the population in the project area relies on firewood for their energy needs. An increase in population will mean increased demand for wood which will in turn lead to deforestation and its consequences. This impact is long term and will not only affect the local area but the entire region. Although there will be a decrease in population after construction, the effects on the general environment of the area will be high thus the magnitude will be **medium negative.**

Mitigation measures
- Carry out large scale tree planting on the slopes and hill tops;
- Institue measures to enforce sustainable agricultural practices such as terracingand bunding;
- Senzitise communities about the bad effects of deforestation and the need for tree palnting and maintaining grass and tree cover over empty spaces;
- Employment opportunities should be extended to the local people to reduce on the influx of people in the area.

7.2.2.15.4 Impact on Sanitation

The baseline findings showed that 87% and 88.2% of the homes in Nyamagabe and Huye Districts own pit latrines respectively and 98.5 % of the sampled households in the project area have got waste disposal facilities. The statistics indicate that there are high sanitation levels in the project area. However, with an increase in population, it is likely that the high standards of sanitation might be compromised. The impact on sanitation is expected to be **medium negative.** Although the impact will be short term and the communities are already aware of dangers of poor sanitation, deterioration in sanitation levels could lead to hygiene related diseases like diarrhea and cholera.

Mitigation
- The project should provide additional sanitation facilities to its workers
- Bins for solid waste and garbage collection should be placed at the workers' camp to ensure that any wastes generated at the site are properly disposed of.

7.2.2.15.5 Increased Risk of Diseases

HIV /AIDS and other STDS

As indicated in the baseline, HIV/AIDS like in many societies of Africa still remains a challenge in Rwanda and the project area in particular. The rate of testing and Councilling is low. From dsistrict records, in 2007 HIV prevalence fo Huye was 3%. An increase in the population and the introduction of new people in an area is usually associated with risky behaviors among the people. Workers tend to leave their wives behind and as a result may be tempted to engage in sexual relationships with women and young girls in the project area. The project is therefore likely to increase the risk of STDs including HIV/AIDS to both workers and the communities. This impact

is likely to continue into the operation phase and is thus long term. The magnitude of impact therefore, is estimated to be **high negative.**

Mitigation

- The project should partner with Non-Governmental Organizations, or Health Centres that provide HIV/AIDS to scale up HIV/AIDS service delivery and awareness raising activities in the project area.
- Voluntary Counseling and Testing services to the workers and community members should constantly be made available.
- There is need for continuous sensitization of the workers and community members about HIV/AIDS and other STDs.
- Project workers should be provided with condoms.
- Condoms should be available at all health centres and should be accessed at no cost by the communities.

7.2.2.15.6 Conflicts

With new people coming into the area, it is likely that there will be an increase in conflicts in the area. This could be as a result of people of different backgrounds settling in the area. Learning and complying with the values and norms of the area might take some time and the process might come along with clashes and conflicts between the local people and the new comers. The magnitude of the impact is expected to be **medium negative** due to the fact that it will be short term in nature since most people will go back to where they came from after construction works are complete.

Mitigation

- Local labour should be given priority for employment as this will solve many of the problems associated with influx of people.
- There should be sensitization of the workers in cultural values and norms of the area.
- Local authorities shall need to be strengthened in order to deal with any cases of indiscipline and conflict brought about by the increased population influx, and any disputes that are likely to arise.

7.2.2.16 Health and Safety

7.2.2.16.1 Occupational Health and Safety:

The project will require skilled, semi-skilled and unskilled workforce. However, given the nature of the project, the workforce is likely to be made up of more semi-skilled and unskilled labourers compared to the skilled workers. Usually, the unskilled and semi-skilled workers are recruited locally and may never have been exposed to projects of such nature, and therefore may not be aware of the safe operating procedures while undertaking their assignments. It is likely that the limited exposure might increase the likelihood of occurrence of occupational accidents. Likely occupational hazards include; exposure to physical hazards from use of heavy equipment , trip and fall hazards, exposure to dust and noise, exposure to falling objects, exposure to electrical hazards from the use of tools and machinery and increased risk of accidents as a result of blasting among others. Although, the impact has far reaching consequences if not properly handled, it is mitigable thus qualifying its magnitude to be **medium negative.**

Mitigation

- Training of workers in safe operating procedures
- Provision of appropriate Personal Protective Equipment to protect project workers lie masks, helmets, jackets and gloves.
- Labeling of danger zones and hazardous materials
- Restrictions/control of access to potential danger zones or usage of hazardous chemicals
- Instituting, enforcing and disseminating procedures to be followed when blasting

7.2.2.16.2 Increased traffic and accidents

Currently, traffic on the existing access roads like that of Nyamagabe to site is not heavy. It is rare to see vehicles in this area other than medium and light trucks that usually come to carry the sand that is scooped from the valley. The roads also are small and in bad condition and are almost impassable during the rainy season. Therefore, the presence of more trucks that will be carrying construction materials may lead to congestion, as the demand for use of the road would exceed its capacity, so a traffic snarl-up would set in for some time during the day. There is also a possibility of over speeding by the project drivers thereby leading to accidents. If the traffic is not handled properly, it could lead to accidents and destruction of property. The accidents could affect the the hired labour and children who might be curious to see what would be happening at the construction site. The magnitude of the impact is expected to be **medium negative** as it will be temporary and can be avoided.

Mitigation Measures

- Skilled and properly trained drivers should be employed.
- Safe speed limits should be instituted and enforced.
- Warning signs and humps should be installed at different intervals of the road.
- Flag men should be employed by the project in order to control traffic.
- Existing access roads should be widened and upgraded to handle project traffic and any other additional traffic.
- Together with local authorities, enforce restrictions on unnecessary entry into the project site or even the protected zone
- Constant watering of the road to reduce dust and related diseases

7.2.2.16.3 Risk of Malaria

Malaria was identified as a major cause of morbidity and mortality in the project area. During construction, pools of stagnant water in excavated and cleared areas are expected during the rainy season and these might act as breeding places for mosquitoes and leading to an increase in the number of malaria cases. In addition, the existing health facilities in the area might not be in position to handle the increase in malaria cases as they have inadequate facilities in terms of staff, drugs, equipment among others. However, since malaria cases in the area are already high and the population will decrease in the operation phase, the magnitude of impact is therefore expected to be **medium negative.**

Mitigation

- The project should put in place strategies to control malaria such as distribution of mosquito nets and sensitization of communities in the project area.
- The project can also support some of the health centres in the project area with a view of improving service delivery.
- The Project should have its own health facility, and offer services to its workforce and their families to reduce pressure on existing health facilities.
- Local people should be given priority for employment opportunities.

7.2.2.17 Impact on Vulnerable Groups

As it is the case in the entire country, there are vulnerable groups in every social setting and these include, women heads of households, the elderly, orphans, disabled people, the unemployed youth and people living with HIV/AIDS among others. During survey, it was found that 23% of households were women headed. Furthermore, over 18% households were widowed. These are really vulnerable. The impacts of the project on vulnerable groups in the area could be in form of child labor: Construction workers might knowingly or unknowingly employ children below 18 years of age, exploitation in form of defilement, rape, sexual harassment among others. The magnitude of the impact will be **medium negative** as it can be prevented.

Mitigation

- The developer and the contractor should ensure that women are not marginalized during the employment process.
- Able bodied women including widows should be encouraged to seek for employment in the project.
- The developer and contractor should ensure that persons below 18 years are not employed.

7.2.2.18 Expected negative impacts on gender

The negative impacts on gender aspects may not be so much pronounced. However, we speculate the following possible gender issues that may arise during construction of the dam.

- There is likely to be developments of relationships between workers and the women of the area that are either engaged or already married, this can result into marriage break ups.
- Immorality could also result especially with the young girls of the area in efforts to gain favour for employment opportunities, this can result into spread of sexually transmitted diseases such as HIV/AIDS. Impact on HIV will be long-term as its spread and associated impacts will continue even after construction.

In general therefore, the impact on gender is expected to be **medium negative.** Although some of the impacts are long-term and spread beyond project area they can be avoided.

Mitigation

- Information dissemination about dangers of HIV/AIDS to the community should be done all throughout the period of the project. The messages should be passed on using the locally understood language for better understanding.

- The parents should advice their girls against indulging in any kind of relationships with the workers.

7.2.3 Operation and maintenance/ Post construction stage

7.2.3.1 Impacts related to down stream water users during filling of the reservoir

Aftre construction, the dam will be allowed to fill up by closing embarkment gates. This will take a long time but it means that downstream water users and the ecosystem down stream will be negatively affected. Wild life and plants down stream may actually die due to dsication. This means there will be little or no water for irrigating crops and the maintenance of ecosystem functions downstream. After the dam has filled, there will be a minimum environmental flow allowed downstream. The problem is that the length of tiem it will take for the dam to fill up is not known but it could take many months of several rainy seasons. Although the impact is severe, it will not last for ever as it will be corrected when environmental flows will be allowed down stream upon the filling of the dam. This impact can therefore be rated as medium impact as it will stop after filling of the dam.

Mitigation measure

- Minimum water flow must be allowed down stream during filling of the dam. It is suggested this should be at 10% of annual flow rate to equal minimum environmental flow.

7.2.3.2 Risk of drowning

During this phase there is a risk of drowning by both children and adults in the reservoir. The children or adults may be enticed to swim in the reservoir and may end up drowning or may drown accidentally while passing by. Furthermore, domestic animals may also drown in the reservoir while trying to drink from it. Although this risk leads to loss of lives it can be avoided and mitigated thus the magnitude of the impact is considered to be **medium negative.**

Mitigation measure

- Trees and other vegetation should be planted around the reservoir to minimize access to the reservoir and accidents
- Surveillance of the reservoir by project and sector authorities should be prioritized
- Sensitization of the community of an emergency plan of action in case of a an accident
- Safe watering points for animals should be provided.

7.2.3.3 Risk of increased water and insect-borne diseases

There will be a risk of increased water and insect-borne diseases including malaria as a result of the reservoir. The water in the reservoir will be stagnant and will act as a breeding ground for mosquitoes and this will increase the prevalence of malaria in the area. The water in the reservoir

may also be contaminated by human activities in the vicinity of the dam, thereby leading water borne diseases.

Mitigation measures

- Sensitise communities to constantly sleep under treated mosquito nets
- Distribute treated mosquito nets to communities surrounding the reservoir.
- Clear bushes around the reservoir periodically

7.2.3.4 Impact of HIV/AIDS and other STDs

The impact of the sexually transmitted diseases like HIV/AIDS will continue even in the operation phase. Individuals who will have acquired the disease will face its consequences like reduction in productivity, poverty due to the constant spending on medicine among others and an overall negative impact on the welfare of the whole family. However, with mitigation measures in place during the construction phase, it is expected that the proportion of affected people will be small thus the magnitude of the impact is thus expected to be **medium negative**.

Mitigation measures

- Continuous HIV/AIDS sensitization and awareness programs should be put in place at all levels and also in schools.
- Equip health centres at all levels with HIV/AIDS testing kits and HIV/AIDS Counsellors so as to be able to provide free testing and counselling services to the affected people and communities.
- Condoms should be available at all health centres and should be accessed at no cost by the communities.

7.2.3.5 Dam Safety related impacts and Flooding

Poor project designs may lead to dam breakage and therefore flooding that may lead to deaths and destruction of property especially downstream. According to the baseline, downstream from the reservoir, there are settlements and a trading centre, there is road, a school playground and functional fish ponds. This impact will affect a big stretch along the river but narrow. This will only occur in case of dam break. Although its occurrence may have far reaching consequences, the impact is mitigable and probability of its occurrence is minimal as the design team is putting into consideration that aspect. The magnitude of this impact therefore is **medium negative**.

Mitigation measures

- Emergency plans and procedures have been developed and are contained in the Dam Safety Report (**Error! Reference source not found.).**
- Warning signs in case of the event of the dam breaking should be put in place.
- Any destroyed property as a result of dam breakage should be compensated.
- There should be coordination of the different institutions in case such an event occurs.
- Sensitisation of the community of an emergency plan of action in case of a disaster should be done continuously.

7.2.3.6 Negative impacts on vegetation

The construction of the Taba-Gakomeye dam will undermine the naturally occurring flooding regime that has been recurring over a very long time and this will affect the ecology of the area. The dam will reduce downstream flooding. This will cause the disappearance of the ecologically important wetland plants in the floodplain below. Further, the reservoir will destroy over one km^2 of wooded grassland. The initial filling of a reservoir floods the existing plant material, leading to the death and decomposition of the carbon-rich plants and trees. The rotting organic matter will release large amounts of carbon into the atmosphere. The decaying plant matter itself will settle to the non-oxygenated bottom of the reservoir, and the decomposition unmitigated by a flow pattern that would oxygenate the water will produce and eventually releases methane gas. Hence, although there were no plant species of conservation importance recorded as threatened or endangered in the study area according to the IUCN (2007) red list, the impact of the project on the ecology and conservation of plant species in the dam area will be **medium negative.**

Change in local species composition
The presence of the dam and increased volumes of water compared to the existing reservoir and flood plain after impoundment may attract various types of fauna and avifauna and change the local species composition. The presence of a permanent water body will also attract hazardous species such as crop pests, dangerous reptiles (crocodiles and water snakes) and disease vectors e.g. malaria mosquitoes, bilharzias snails and invasive species such as water hyacinth. Moreover, some of terrestrial plants could be replaced because of continuous flooding of the area. These impact is considered negative, long term and of high significance

Mitigation
Project owner shall monitor invasive species (algae, water hyacinth, water animals-crocodiles, snakes, etc) and seek professional advice to rectify as appropriate

7.2.3.7 Negative Impacts on Fauna

Mammals
There are 189 mammal species in Rwanda of which 2 are critically endangered, 4 are endangered, 11 are vulnerable, and 5 are near-threatened (IUCN 2007). Mammals unique to Rwanda include Hill's Horseshoe Bat *Rhinolophus hilli* and the Rwandan Shaggy Rat *Dasymys rwandae*. The Taba-Gakomeye project lies within an agro-ecosystem area that has food crops species. The mammals that live in this habitat are those that are adapted to extreme habitat disturbance especially the rodents which are also crop pests. The black rat (*Rattus rattus*) was the only species of small mammals recorded in the area. Taba-Gakomeye project area has low mammal diversity because it has been heavily degraded for agriculture. The project activities will thus have a **low negative** impact on the ecology and conservation of mammals of the area.

***Protected Area*s**

The nearest protected area to the Taba-Gakomeye project is the Nyungwe National Park (924 000 hectares) (RW007) (29^0 14.00' East 2^0 30'. Nyungwe forest is situated in south-west Rwanda

between Lake Kivu and the international border with Burundi, where it is contiguous with Kibira National Park (BI002). The Nyungwe ecosystem harbours forest biodiversity of very high conservation significance which even if they found their way to the Taba-Gakomeye project area they would not survive because the latter is a cultivated area. Further more, Nyungwe is very far from the project area. Thus, the impact of the project on the biodiversity of Nyungwe will be **low negative.**

7.2.3.8 Negative Impacts on Fisheries

Capture fisheries production in the Kagera River basin is faced with a number of problems, including uncontrolled fishing methods and lack of proper fishing gear. Immature fish are captured leading to extinction of some species. Often local people use poisoning and dynamite, which leads into complete destruction of the lake ecosystem and extinction of fish and other related organisms from the lake. Continued dependence on one type of species also leads to their extinction and loss of biodiversity. For example, some studies carried out in Lake Ihema (Mughanda, 1989) shows species preference was mainly on *Clarias gariepinus, Haplochromus Group,* and other *Tilapia* species such as *Marcusemus victoriae, Alestes Sp., Synodontis Spp, Gnathonemus longibarbus,* and *Schilbe mystus.* Capture fisheries problems are also compounded by lack of extension services to educate the local community on sustainable fishing methods and lack of infrastructure for fish preservation. The following are therefore strategies suggested to enhance fish survival and fisheries in the new Taba-Gakomeye dam.

Mitigation measures on Fisheries

There is therefore need to formulate fishing regulations to control access to the lake and fishing grounds as well as to control fishing gears and methods to avoid destructive methods. There will be need to educate the local community about fish, fishing methods and best seasons to fish. It will also be necessary to establish and train a cadre of extension staff to guide, monitor and regulate fishing activity and use of dam water resources in general.

Strategies to mitigate negative impacts of the Project on the Fish and Fisheries in the new Taba-Gakomeye reservoir

- Institute a Water Use Committee to oversee fishing activities in the dam;
- Formulate and enforce fishing regulations to control access to the dam and fishing grounds;
- Formulate enforce fishing regulations to control fishing gears and methods to avoid destructive methods;
- Educate the local community about fish, fishing methods and best seasons to fish;
- Establish and train a cadre of extension staff to guide, monitor and regulate fishing activity and use of dam water resources in general;
- Provide access feeder roads to landings on the dam;
- Provide clean fresh water for the communities;
- Provide fish handling and fish processing equipment and facilities in the landings
- Provide fish cooling and chilling facilities at the landings;
- Provide market outlets for fish from the dam;

- Provide good health and sanitation facilities for the communities living in the villages and landings along the dam shores.

7.2.3.9 Negative impacts of reservoir inundation on the ecosystem

When the Taba-Gakomeye dam is constructed and inundated, it will flood much of the biomass including plant vegetation material in the dam site. The effect of this swill be that all these materials will decompose, consume all the oxygen and produce gases like carbon dioxide, methane and other acidic gases like sulphides and nitrous oxides. De-oxygenation will of-course kill fish and other aquatic biota. The presence of toxic acidic gases will not favour aquatic life. The good news is that these putrification and decomposition phenomena in the newly flooded dam will be short lived as the water will eventually clear with ample algal growth thereby oxygenating the water column. Any residual toxic gases will be restricted to the bottom layers of the new dam. Hence aquatic life will prosper including fish and its fry. It can be concluded that in terms of fish and invertebrates and other aquatic organisms, there are no long term negative impacts of the construction of the dam. The impact of the project on the ecosystem of the dam area will therefore expected to be **low negative.**

Mitigation measures

In order to reduce de-oxygenation in the new reservoir and to improve its water quality, the following steps will need to be taken:

Mitigation measures

- Clear all vegetation and woody biomass from the reservoir prior to filling it;
- Institute and enforce good watershed management practices including aforestation, terracing, and good agricultural practices;
- Institute management committees for the over all supervision of all activities in the new dam; and
- Control livestock access to the dam.

7.2.3.10 Impacts of the action on archaeology and culture

No direct physical positive effect of the project on archaeological and cultural assets is envisaged. But since archaeology and culture is not only what we see physically, there is a possibly that some other important cultural assets may be discovered in the course of the construction. This therefore calls for careful construction process and thorough involvement of archaeologists during the construction process. A few jobs are anticipated but since archaeology includes even what is not immediately seen, more opportunities may crop up during and even after construction and therefore the effect may be long term, the magnitude of the impact could be considered to be **low positive**.

Enhancement of Positive Impacts on archaeology and culture

- Professional archeologists should be involved right from project planning through to project implementation and monitoring;

- Sensitization of communities through public/community archaeology so that they can know the importance of preserving and conserving cultural heritage sites and be able to disclose any site known to them;
- Thorough involvement of community members in some of the project areas where they fit;
- Training of the residents in basic skills in cultural heritage management and identification of archaeological sites.

As noted earlier, the project area did not attract much human settlement due to unfavorable environmental condition. This however may not be true archaeologically because other cultural objects may be underneath and could be recovered during construction. Hence, there will be some negative impacts of the action on archaeological and cultural assets. These will include the following.

Some of the heritage resources in the study area include those that have not been detected but these may be impacted (affected, altered, damaged) by the proposed project. There is a high possibility that a number of archaeological sites both in Taba-Gakomeye as well as outside will be encroached upon. The projected sites for acquisition of materials such as stones and murram may lead to destruction of archaeological sites and artifacts. In terms of artifacts, some artifacts may be graded unknowingly and others may be destroyed due to limited skills by some contractors. The overall impact of the project on archaeological assets and culture therefore can be evaluated as **low negative as the sites and value of the assets is currently not known.**

Mitigation measures

- Contractors need to work hand in hand with professional archaeologists so that any chance findings may be rescued and taken to the National Museum for proper conservation;
- Contractors should be trained in basic skills of handling artefacts so as to avoid breakage, destruction and loss of priceless assets;
- All murram and stone/rock sites need to be first surveyed in order to ascertain the intensity of cultural assets in the place;
- Any valuable cultural item got in absence of the concerned cultural officials must be reported;

7.2.3.11 Hydrological impacts

The construction of the proposed dams will result in changes in the flow regime downstream of the dams. The reservoirs will store excess water during the rainy season and spillage will occur when the reservoirs are full. Thereafter the reservoirs are filled with water, the inflow flood hydrographs will get modified as they travel through the reservoirs (i.e. from inlet, storage and outlet over the spillway). The modification, which will take place, is that the peak of the inflow hydrograph will be reduced (peak attenuated) and the time base of the inflow hydrograph will be stretched such that there is time lag between the time of the peak of the outflow hydrograph and the time of the peak of the inflow hydrograph.

The amount of outflows from the dam storages will depend on both hydraulic conditions such as the height and width of the spillway and operational rules of the dam. Operational rules for the dams will take into account the various uses of water downstream of the dam. This includes water for domestic use, agricultural requirements including irrigation and water requirement for aquatic and environmental health. The hydrological assessment which involved public consultations and field survey identified likely impacts from the hydrological point of view. The most significant impacts for Taba-Gakomeye dam site are presented below:

i) The seasonal nature of the stream at which the dam is to be constructed, firm yield of water flow into the reservoir cannot be guaranteed. In some of the years the water available may not be enough to fill in the reservoir.

ii) The characteristic of the catchment is that it is hilly. This characteristic makes the catchment susceptible to erosion which will cause siltation in the reservoir. It is also likely that the population of livestock in the area is going to increase and this will cause degradation in the catchment which will enhance erosion and thus causing siltation in the reservoir.

iii) Agricultural activities taking place on the hilly slopes of the catchment in combination with the steep slopes of the catchment will cause the problem of erosion in the catchment and sedimentation in the reservoir. The end effect of erosion on the catchment will cause sedimentation into the reservoir. In addition, during the construction, the clearing of the site for construction, excavation of the dam foundation, excavation of construction material and transportation to the construction site will generate considerable amounts of sediments that will eventually be deposited in the reservoir storage;

iv) Downstream wetland will diminish due to changes in the river flow pattern when the stream will be dammed by constructing an embankment;

v) The houses built very close to the floodplain and the access road which is located close to the flood plan will be impounded once the dam is constructed.

Mitigation

- Minimize the erosion on the catchment by adopting an integrated approach of managing and conserving the dam catchment by the appropriate local institutions.
- Identify a suitable site for mining construction material that will not be easily subject to erosion.
- Guarantee water releases downstream of the dam to meet the ecosystem requirements
- Establish appropriately the environmental flow required to be released downstream of the dam to take care of the environment
- The people whose houses will be impounded are to be re-settled in another location to give way for the dam construction. The people affected to be compensated appropriately for their land and property before shifting to another location that will be identified.
- Relocate the access road to another location that will not be affected by the dam impoundment. The dam embankment can possibly be used as an access road across the stream.