4.9.1.2 Climate

Available data indicates that the basin receives a mean annual rainfall of 1119 mm. The mean monthly rainfall distribution is bimodal with two rainy seasons. The long rains occur from March to May while the short rains occur between October to December. The maximum rainfall is received in April and averages 174 mm while maximum rainfall in the short rainy season is received in November and averages 139 mm. July is the driest month, receiving only 4 mm of rainfall on average. The mean annual potential evaporation is 1097 mm and varies over a narrow range between 71 mm in December and 125 mm in August. The average temperatures range between 19°C in June and 21°C in November.

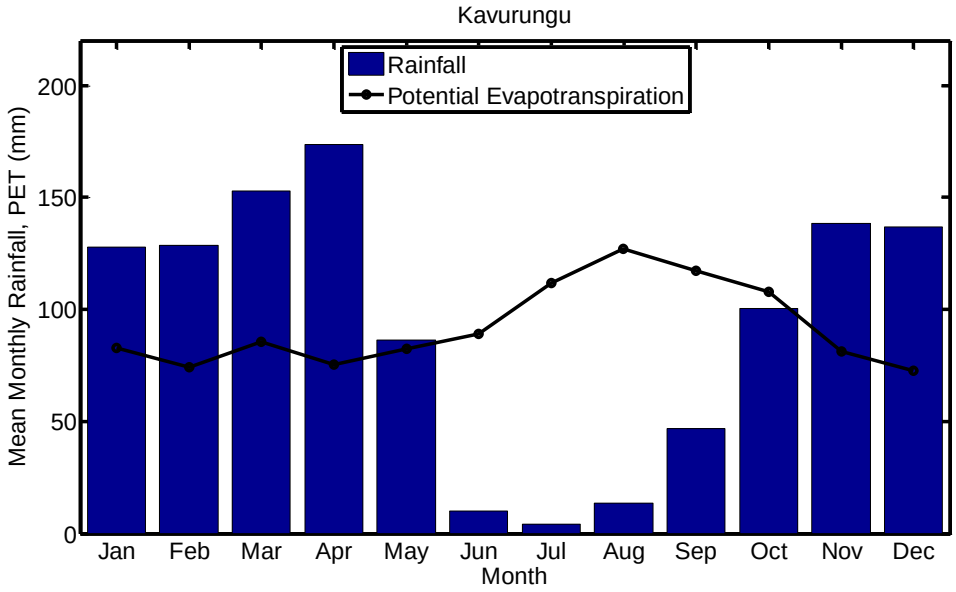

Figure 4.9-2: Kavuruga catchment mean monthly rainfall and potential evaporation

4.9.1.3 Geology

The central and eastern parts of the basin are dominated by intrusive rocks. The western part is mainly made up of the Muramba complex that is mainly composed of well banded greenish-grey sandstone shales with granites and other metamorphic minerals in some places. The southern is dominated by the Migogo system which is made of grayish banded shales and sandstones while the lower part may contain homogeneous quartz rocks. Further investigations are necessary to provide stronger understanding of the geology of the area and the dam site.

4.9.1.4 Soils

The soils are part of the wider province soils that are characteristically poor in nutrients as evidenced by state of poor crop stands around the site. The poor soils have driven communities to farm in the marshlands implying the planned development will go a long way to alleviate food situation in the areas. The crop stands of cassava are poor evidence that, the soils are poor to support cultivation.

4.9.2 Social Environment profile

Demographics and trends

Karuzi Province in 2003 had a population of 398,219 inhabitants, 191 527 being men and 206,692 women. The population under 25 years was estimated around 59%. The population density is estimated at 274 inhabitants per km2. The labor force is estimated at 187 614 inhabitants for 210 605 inhabitants of dependent population. The dependency ratio is 1.12%. The following table summarizes the physical, administrative and demographics of the Province of Karuzi.

Table 4.2: Census of the population in the Karuzi Province

Commune	Surface area (km²)	Zone	Population	Density (inhabit/km²)
Bugenyuzi	235	3	77.297	329
Buhiga	275	2	61.581	224
Gihogazi	192	3	66.906	348
Gitaramuka	211	3	78.225	370
Mutumba	178	2	35.208	198
Nyabikere	195	3	41.285	212
Shombo	170	3	37.717	221
Total	**1456**	**19**	**398.219**	**274**

(Source: MPDR, 2003)

4.9.2.1 Agriculture

Like almost everywhere in the country, agriculture occupies almost 90% of the population that is primarily engaged in crop production and food industries (coffee) and to a lower extent for vegetables and fruits. The production system is almost exclusively traditional. The agricultural sector has been affected in recent years by several problems handsets including weather, the effects of war, poverty, population, inadequate supervision, etc. In the province of Muyinga the different crops are coffee, bananas, sweet potato, cassava, beans, corn, rice, potato and vegetable crops (cabbage, tomatoes, eggplant, etc.). The main food crops grown in Muyinga province are cassava, beans, corn, banana and sweet potato. On the site, the communities are growing crops such as beans, sorghum and cassava and rice and it is all for basically for domestic needs.

Plate 4.9-2 Beans grown on the areas of the planned dam site

(a) **(b)**

Plate 4.9-3 Garden with cassava near the planned dam site; and (b) Woman with some sweet potatoes in the hand

A part from agriculture crops, the site has some relics of swamp forest trees such as *Sysygium guineense, Bridelia micrantha* and *Grewia mollis* (Plate 4.9-4). These exist as patches of 2-3 trees. There are no protected forests or game parks or even game parks in this part of country. Hence, the planned dam project will have no impact any ecologically sensitive ecosystems.

Plate 4.9-4 Isolated trees of *Syzygium spp* close to the site

4.9.2.2 Livestock

The livestock sector was equally affected by the political crisis that hit Burundi in past year and this has affected livestock population which is worsened by rampant thefts in the communities. The farming practiced in Muyinga is of traditional type and constituted of cattle, goats, sheep, pigs and poultry. Local breeds make up most of the common herd in Muyinga, the exception of the urban area where the introduction of modern breeds has started.

4.9.2.3 Employment

Agriculture and livestock are practiced by farmers using unpaid and family labour. The movement of young people to Bujumbura and other urban areas and especially Kayanza and Ngozi is extremely important developed cause of the scarcity of land, lack of activities income generation, idleness and very difficult social conditions.

4.9.2.4 Energy

There are no natural forests to supply the wood fuel even there are few woodlots for private supply of wood fuel. Communities sometimes try to source wood fuel from stumps and any other wood resources in their vicinity (Plate 4.9-5).

Plate 4.9-5 A tree stump where sections of the communities cut some wood fuel

4.9.2.5 Transport and communication

Movement of people and transport of goods services are provided by road. Means of transport Most common are the transport head, bike, motorcycle and automotive. The most common ways of transport are vehicles, bikes and motorcycles. There are three categories of roads: - National Roads (RN) - Provincial Roads (PR) - Local roads (LC) Rural roads that facilitate intra-municipalities communication are numerous and most of them in poor conditions.

4.9.2.6 Housing

In Muyinga province, almost 90,000 houses were destroyed during the political crisis. Efforts to reconstruct the country were undertaken by certain stakeholders and around 40,000 houses were constructed, this representing 38% of the destroyed houses. The house types include grass thatched, locally tiles and iron sheet roofed houses (Plate 4.9-6 to Plate 4.9-8).

Plate 4.9-6 Grass thatched House structure in the project area

Plate 4.9-7 House structure roofed with local tiles

Plate 4.9-8 Iron sheets roofed house structure

4.9.2.7 Health

Muyinga province has two hospitals in acceptable conditions, 22 health centres, 7 of which are to be rehabilitated and only one Nutrition Centre. The medical staffs counts 6 doctors, 7 technicians promoting health and 49 nurses.

4.9.2.8 Sand mining

The wetland is a source of construction sand and the youth are very much involved in sand mining (Plate 4.9-9). Large parts of the wetland have been degraded through sand mining activities (Plate 4.9-10). Sale of sand is one of the sources of livelihoods for the unemployed youth.

Plate 4.9-9 Youth mining sand near Kavuruga site

Plate 4.9-10 Degraded wetland through sand mining activities

4.9.2.9 Water and sanitation

Based on available water coverage information, Muyinga province as a whole has an estimated 31% safe water coverage. This is far below the National water coverage for Burundi which is at --%. The Province has about 2,090 sources of water of which about 650 are functional.

4.9.3 Previous studies

While carrying out the current assignment, the following related study/studies were reviewed

- Rapid identification and assessment of potential sites for multi-purpose storage reservoirs, NELSAP, Kagera River Basin Management Project

4.9.4 Alternative developments

The Kavuruga dam development offers only one option for development at the proposed site. There is an artificial reservoir about 4.5km downstream of the proposed Kavuruga site created by the Kayanza Hydroelectric Facility (0.850MW). How the Kavuruga reservoir interacts with this existing downstream reservoir has not been investigated in this study.

4.9.5 Hydrology

4.9.5.1 Runoff

Kavuruga basin is ungauged. Therefore, a hydrological modelling study was developed using a regionalization approach to estimate the daily flow at the dam site. The modelling results showed that daily flow at the dam site ranged between 0.1 m^3/s on 3-May-1977 and 11.0 m^3/s on 22-9-1982 and averaged 2 m^3/s (Figure 4.9-3). Flow duration curve analysis (Figure 4.4-6) shows that mean flow has an exceedance probability of 60% while the median flow is 1.9 m^3/s.

The mean monthly total flows vary between 8.8 Million m^3 (Mm^3) in April and 1.5 Mm^3 in August (Figure 4.9-4). The total annual flow averages about 63 Mm^3.

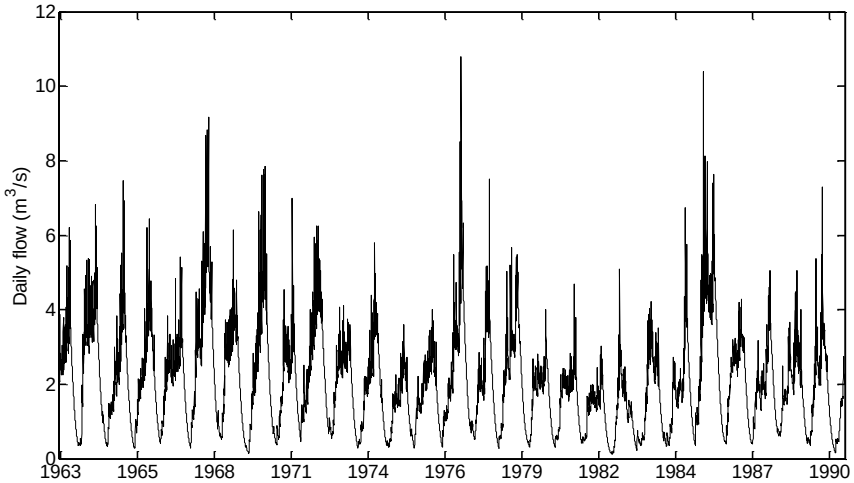

Figure 4.9-3: Kavuruga Daily flow variation

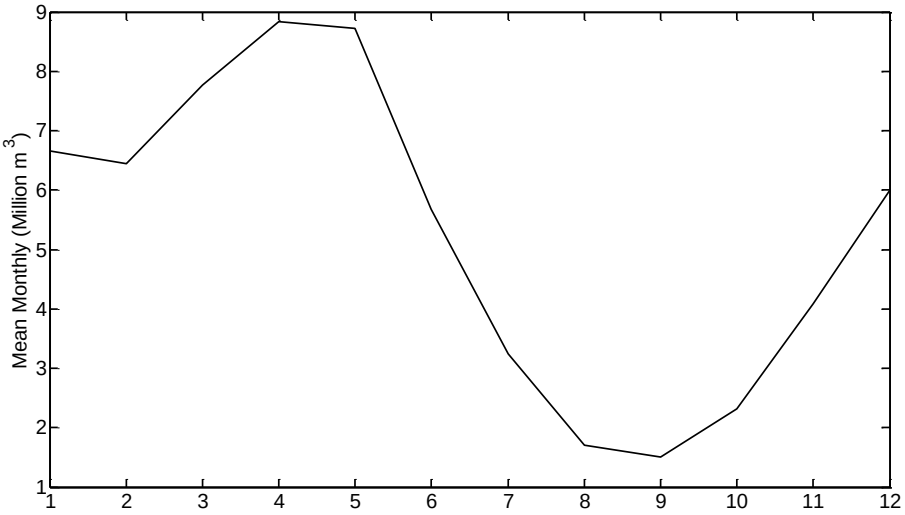

Figure 4.9-4: Kavuruga Mean monthly flow variation

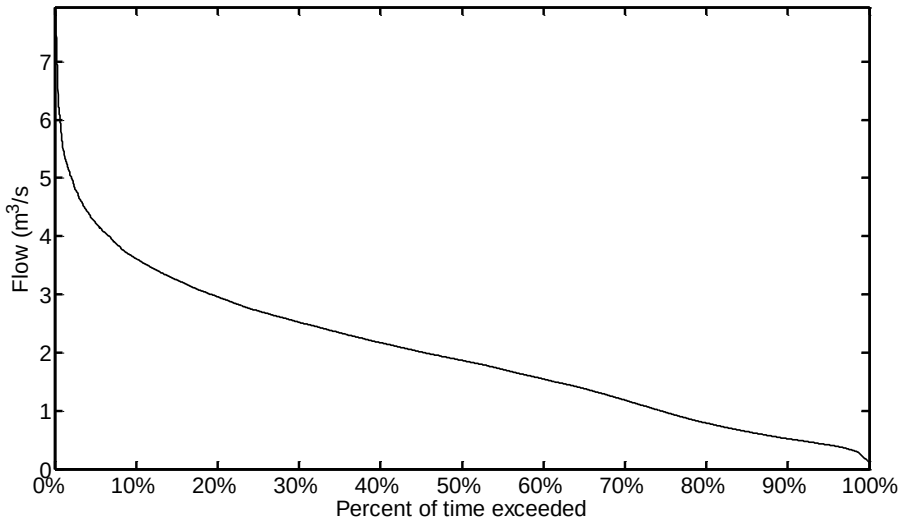

Figure 4.9-5: Kavuruga Flow duration curve

4.9.5.2 Reservoir

Using a 30m digital elevation model (DEM) of the area, reservoir elevation-area and elevation-volume curves were prepared and are shown Figure 4.9-6 in Figure 4.9-7 and respectively. Figure 4.9-6 shows that the inundation continues increasing with elevation at a uniform rate. However, an elevation of about 1407 m asl provides a physical limit as the reservoir may overflow into nearby watersheds. An elevation of 1403 is an optimum target for the maximum reservoir level for the Kavuruga site. Detailed socioeconomic assessments at the feasibility and detailed design stages will be necessary to assess the relative costs of different possible reservoir maximum elevations in terms of displacement of people and inundation of agricultural lands.

The proposed reservoir elevation will inundate 191 ha of land and will have a total volume of 11 million cubic meters of water. The reservoir fetch will be 4 km along the main river while the fetch along the tributary will be 1.5 km from its confluence with the main river (Figure 4.9-8). The average width of the reservoir will be about 400 m.

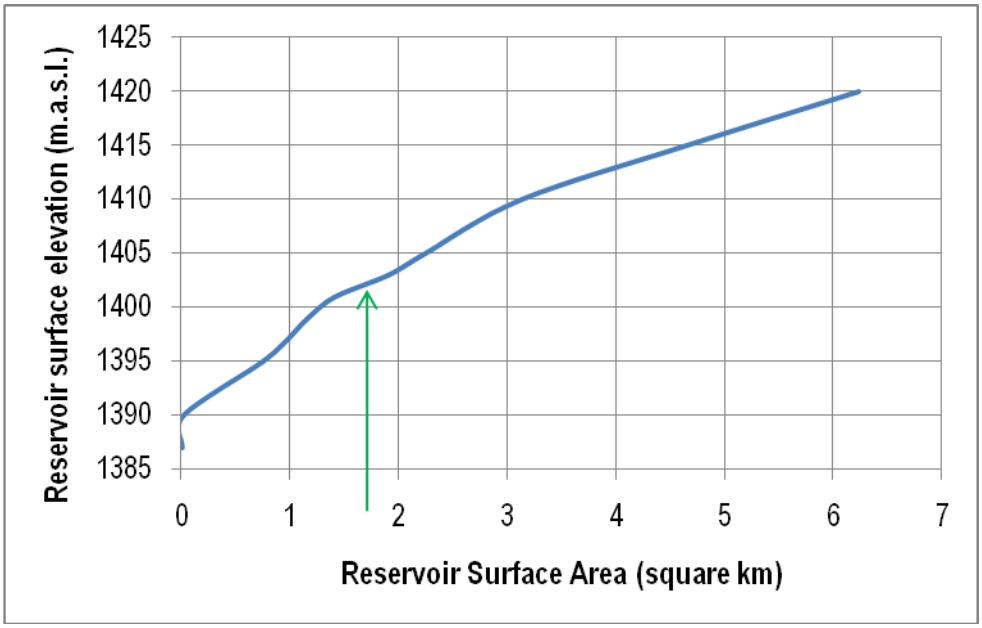

Figure 4.9-6: Plot of Kavuruga reservoir surface elevation versus reservoir surface area

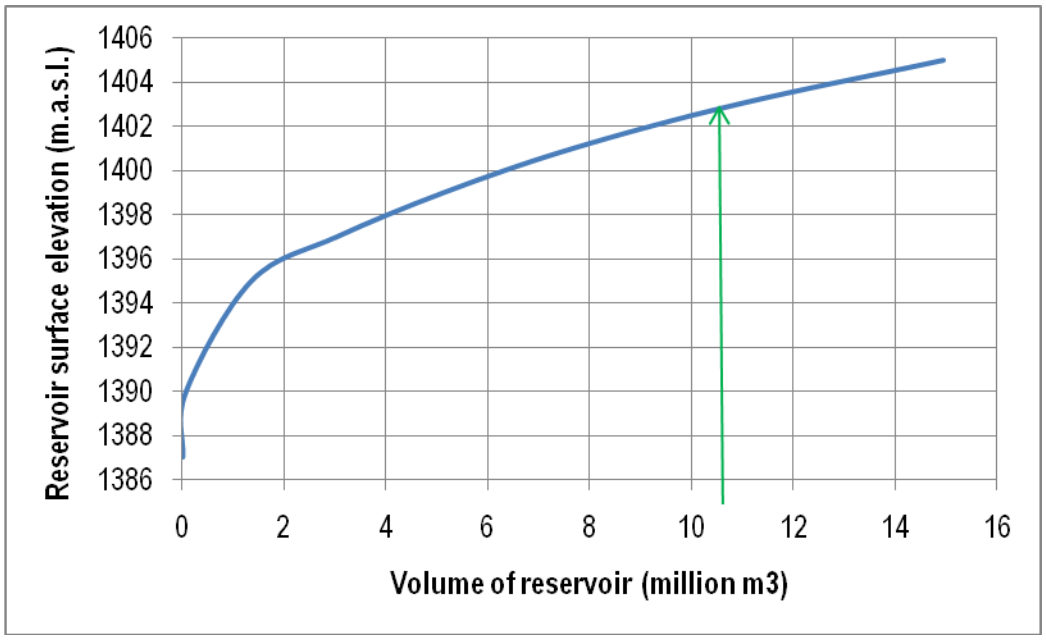

Figure 4.9-7: Plot of Kavuruga reservoir surface elevation versus reservoir volume

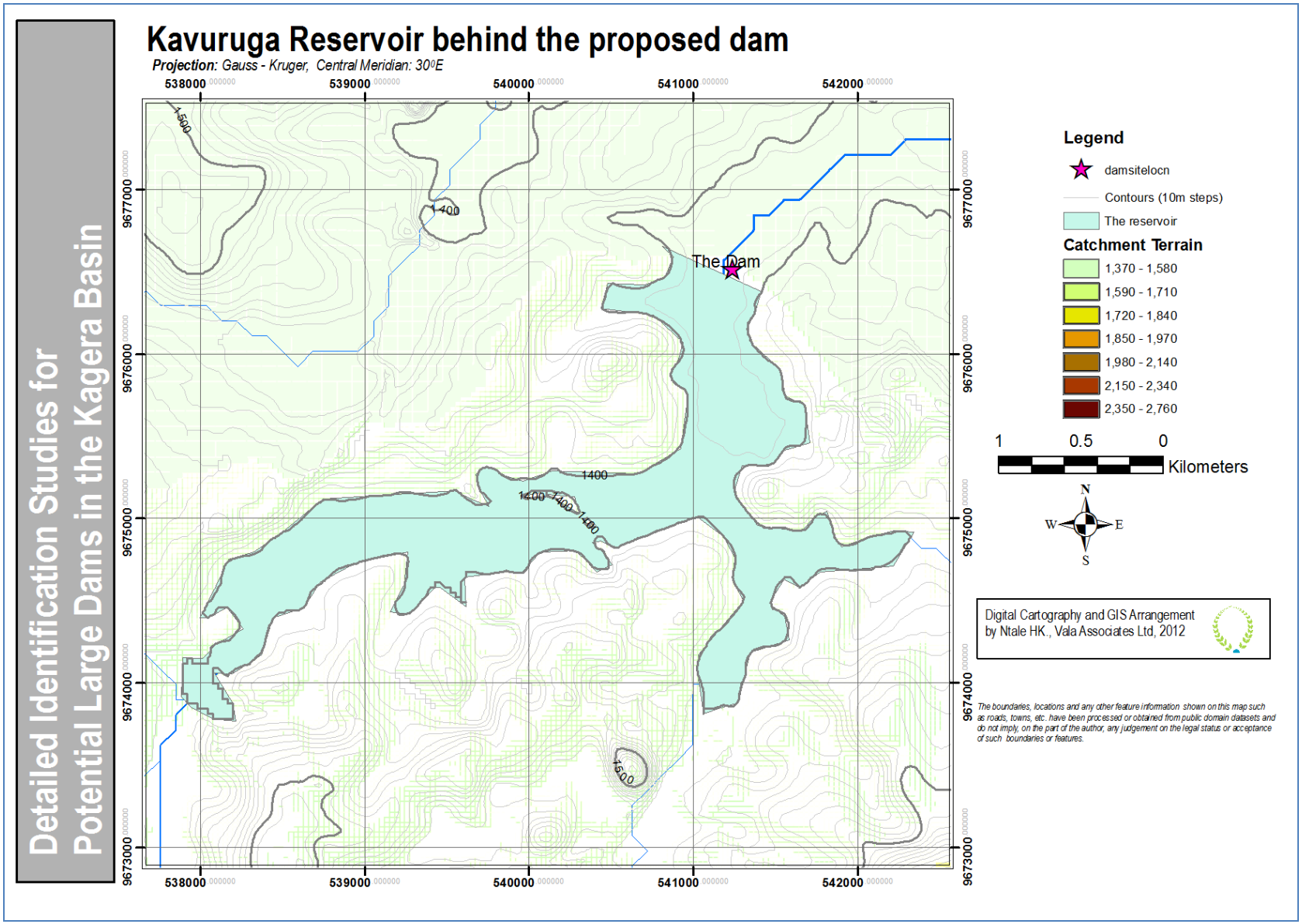

Figure 4.9-8 Kavuruga Reservoir at 1403 m above sea level

4.9.5.3 Reservoir evaporation

Being an open water body, the reservoir evaporation rates would be expected to be close to the potential evapotranspiration rates. Table 4.9-1 shows the daily and monthly potential evaporation rates estimated from data at 3 meteorological stations located close to the Kavuruga dam site.

Table 4.9-1: Kavuruga Daily and monthly potential evaporation rates

Month	Daily Evaporation (mm)	Monthly Evaporation (mm)
Jan	2.6	82
Feb	2.6	74
Mar	2.7	85
Apr	2.5	75
May	2.6	82
Jun	2.9	88
Jul	3.6	111
Aug	4.0	125
Sep	3.8	115
Oct	3.5	108
Nov	2.7	81
Dec	2.3	71
Annual	3.0	1097

4.9.5.4 Floods

The annual maximum series model was used for flood frequency analysis. The following approach was used

(i) Selection of the annual maximum 24-hour flows from the measured flow
(ii) Selection of the distribution that best fits the data. Lognormal distribution was shown to provide an acceptable fit to the annual maximum data
(iii) Estimation of the flood magnitudes corresponding to various return periods (Table 4.9-2)

Table 4.9-2: Flood estimates for the Kavuruga Project (assuming the design life of the dam to be 50 years)

Return period, T (years)	Flood magnitude (m3/s)	Risk of failure for a 50 year design life (%)
50	11.5	63.6
100	12.7	39.5
200	14.0	22.2
500	15.8	9.5
1000	17.2	4.9
2000	18.6	2.5
5000	20.5	1.0
10000	22.1	0.5

4.9.5.5 Sedimentation

Reservoir sedimentation estimates were carried out using a procedure developed by Lawrence et al (2004) for small dams in Zimbabwe and Tanzania. The study developed a regionalisation approach to predicting catchment sedimentation rates based on an assessment of catchment factors like area, rainfall, catchment slope, signs of active soil erosion, vegetation conditions over the catchment, soil type and drainage pattern. Table 4.8-5 shows the estimate of annual sedimentation rates while Table 4.9-4 shows the dead volume after 10, 25, 50 and 100 years.

Table 4.9-3: Estimation of Kavuruga annual sedimentation rates

Site Name	Kavuruga
Reservoir Volume (Mm3)	11
Catchm't area	136
Mean Annual Rainfall	1119
Slope (%)	17
Slope (degrees)	9.7
Active Erosion	5
Soil type and Drainage	20
Vegetation Condition	10
S_Y (t/km2/yr)	347.4
Assumed Sediment density (t/m3)	1.1
Dead Volume (Mm3)/yr	0.043

Table 4.9-4: Kavuruga Dead storage

Dead Volume	T (years)	Kavuruga
Dead Volume after	10	0.4
	25	1.1
	50	2.1
	100	4.3
Dead Volume/Reservoir Volume	10	0.04
	25	0.10
	50	0.20
	100	0.39

4.9.6 Irrigation command area

The Kavuruga reservoir would contain enough water to irrigate 1230 ha. However, owing to the fact that there is a large reservoir 4.5km downstream of the site, the immediate available irrigable land downstream, of the site is reduced to only 452 ha (Figure 4.9-9) located in the communes shown in Table 4.9-5. This is a serious constraint which must be given due consideration when further weighing the viability of this sub-project. The command area can support 903 farmers and provide food for about 4,517 people. The annual water demand for irrigation is about 2.3 Mm^3.

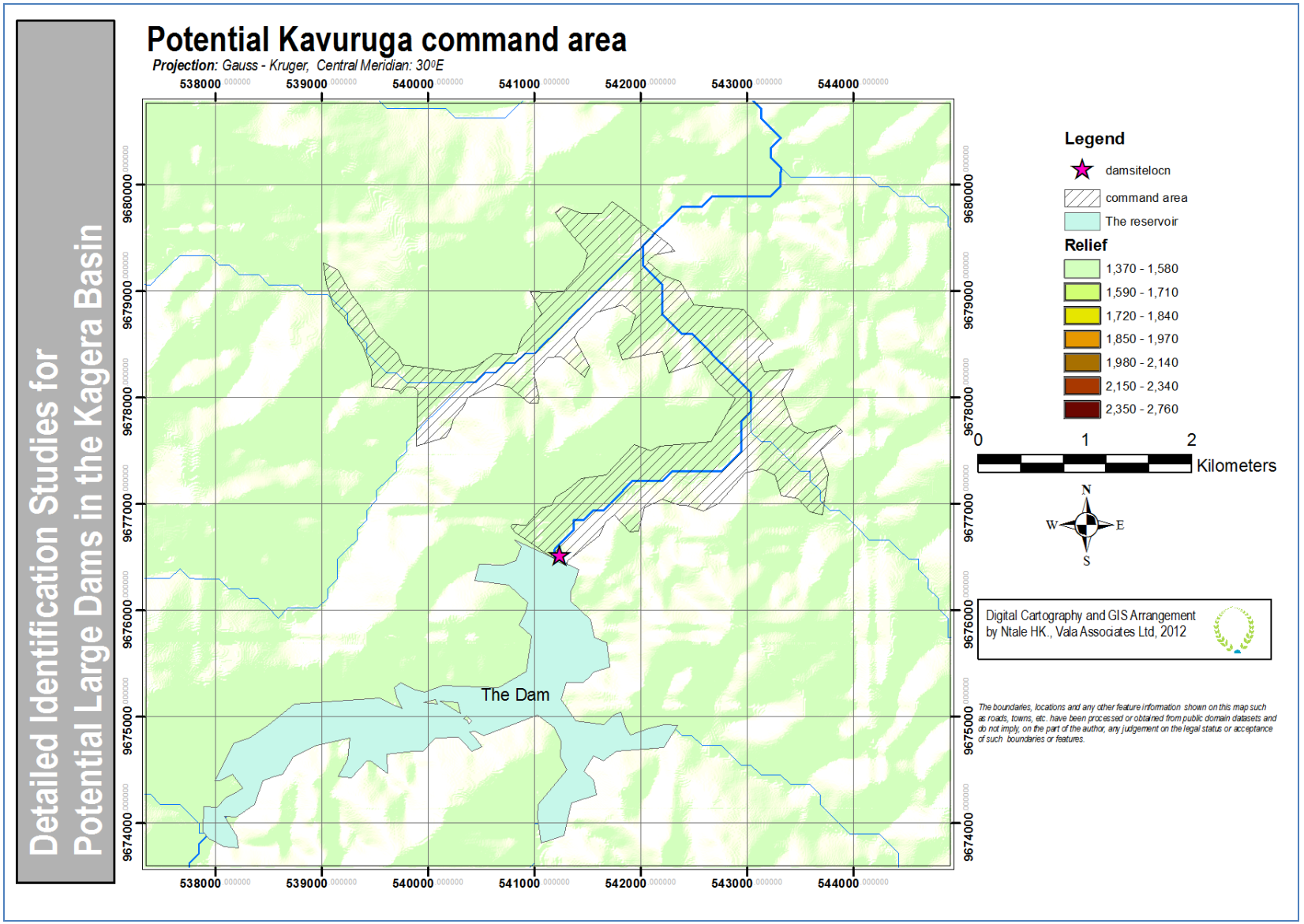

Figure 4.9-9 Kavuruga Command area

Table 4.9-5: Irrigation command area for Kavuruga

Province	Commune	Area (ha)
Muyinga	Buhinyuza	340
	Muyinga	111
Total		**452**

4.9.7 Water Supply

The total population that can benefit from water supply from the Kavuruga project in 2012 and 2062 was estimated at 47,764 and 180,978 people respectively (Table 4.9-6). The annual water demands are 0.5 Mm^3 and 2 Mm^3 for 2012 and 2062, respectively.

Table 4.9-6: Potential water supply beneficiaries for Kavurungu

Province	Commune	Population (2012)	Population (2062)
Muyinga	Buhinyuza	31,713	120,161
	Muyinga	16,051	60,818
Total		**47,764**	**180,978**

4.9.8 Dam Design Elements

4.9.8.1 General

The river valley cross-section at the dam site is U-shaped, the base having a width of 175 m at an elevation of 1385 m asl. An earth-fill embankment dam is proposed at the site. The bowl shape of the right embankment (Figure 4.9-10) provides a good location for the spillway and intake structures

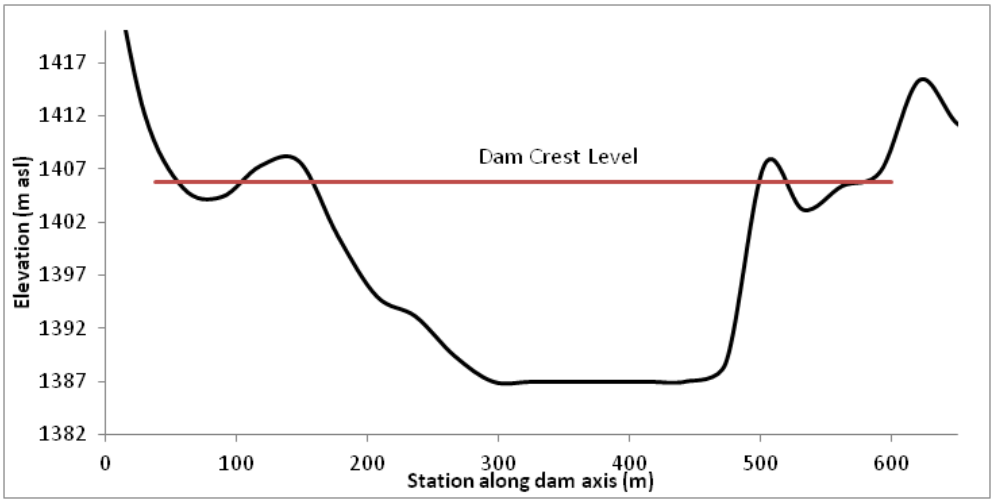

Figure 4.9-10: Ground profile at dam site. Stations measured from left flank towards right flank

4.9.8.2 Dam

The dam at Kavuruga has been designed as a concrete gravity dam with a roadway on top and an Ogee spillway section. This preliminary design proposes a downstream slope of 2:1

and an upstream slope of 2:1. The dam foundation will be located firm basement rock assumed to be 5 m below the ground level in the current design.

Table 4.9-7: Kavuruga dam design

Variable		Units	Value	Check	
				Criteria	Value
Dam location			Kavuruga		
Dam type			Earthfill Dam		
Reservoir base elevation			1,387		
Reservoir top elevation			1,403		
Reservoir depth at above dam base (Hnet)		m	16.0		
Free board (Flood control pool + 3% of dam height)					
	Flood control pool (flood height above spillway crest)	m	1.3		
	3% of dam height (for wave action, etc)	m	1.0		
	Freeboard on dam	m	2.3		
Dam height H		m	18.3		
Dam crest elevation		m asl	1,405		
Spillway crest elevation		m asl	1,403		
Crest length		m	340.0		
Base length		m	175.0		
Top width (7-12 m depending on dam height)		m	10.0	Allows for road on top	
Upstream slope N:1			2.0		
Downstream slope N:1			2.0		
Bottom width		m	83.4		
Impervious core	Top width	m	4.0	>=3.5 m	
	U/S slope N:1		0.6		
	D/S slope N:1		0.5		
	Core depth (1 m below crest level)	m	17.3	Protection of core	
	Base width	m	23.1	Min width 0.4*H=	7.3
Cutoff (compacted backfill trench)	Bottom width (contact with core)	m	23.1		
	Depth of pervious foundation material	m	10.0	assumed	
	U/S slope N:1		1.0		
	D/S slope N:1		1.0		
	bottom width (contact with impervious layer)	m	3.1		

4.9.8.3 Diversion works

During the construction of the dam, the river will be diverted by an upstream coffer dam through 2 culverts on the left of the bank. The culverts will be made of concrete and will be 160 m long. The culverts will be circular with a cross-sectional area of 2 m^2 that is needed for safely discharging a 100-year flood of 23 m^3/s without overtopping the cofferdam that shall be raised to an elevation of 1775 m asl. A cofferdam will also be provided upstream from the tunnel outlet to prevent the diverted water from rising into the works area. The cofferdams will be ransom fill embankments with impervious facings. The crest elevation of the upstream cofferdam will be 1888 m asl while that of the downstream cofferdam will be 1388 m asl. After construction, the two cofferdams will be breached and the culverts will be plugged.

4.9.8.4 Spillway

The spillway will be of the chute type. It will be located on the right side of the dam. Table 4.8-9 shows the main design parameters of the spillway. The spillway will discharge via a flared ski-jump into an existing an existing pond below the dam.

Table 4.9-8: Spillway design parameters

Variable	Units	Value
Spillway type	Chute, over crest	
Return period	years	10,000
Spillway crest elevation	masl	1,528
Design flood	cumecs	26
Discharge coefficient, Cd (assumed)		1.7
Spillway crest length, L	m	20.0
Head on spillway, H	m	1.0
Spillway discharge, Q=Cd*L*H^(3/2)	cumecs	34.0

4.9.8.5 Ancillary works

There is an existing road close to the dam site that links with the main road from Muramba. The road may require some limited remedial works to be able to provide access for the heavy trucks, construction materials and supplies during dam construction.

4.9.8.6 Construction materials

A full investigation of the availability of good quality construction materials will be carried out at the feasibility stage. Impervious materials can be obtained from silt and clayey deposits which are probably available within the river flood plain. Good quality concrete aggregates can partly be obtained from alluvial deposits in the river valley. However, the bulk of the aggregates may be obtained from a quarry opened above the left or right flanks of the river valley. Investigations may reveal that there may be other locations with better material quality and economic haul distances. Random fill for the cofferdams will be obtained from foundation stripping operations.

4.9.9 Project costs

The estimated costs for the Kavuruga project total to 12.4 million US dollars as broken down in Table 4.5-9 below.

Table 4.9-9 Estimated Kavuruga Project costs

No	Item	Units	Quantity	Rate (USD)	Amount (USD)
1.0	**PREPARATORY WORKS**				
	Mobilisation and demobilisation	Lumpsum	1	800000	800000
	Permanent access	km	2	100000	200000
	Temporary access	Lumpsum	1	100000	100000
	River diversion during construction	Lumpsum	1	500000	500000
	Resettlement and compensation	ha	231	2500	577500
	Subtotal				**2177500**
2.0	**MAIN DAM**				
	Excavation, loose	m3	52000	15	780000
	Excavation, rock	m3	13000	22	286000
	Foundation preparation	Lumpsum	1	300000	300000
	Dam earthworks - random fill	m3	170000	15	2550000
	Dam earthworks - impermeable core	m3	110000	20	2200000
	Subtotal				**6116000**
3.0	**SPILLWAY, INTAKE**				
	Excavation, loose	m3	1200	15	18000
	Excavation, rock	m3	4000	22	88000
	Concrete Spillway	m3	5000	200	1000000
	Concrete intake	Lumpsum	1	250000	250000
	Other civil structures	Lumpsum	1	300000	300000
	Subtotal				**1656000**
	TOTAL, CONSTRUCTION COST				**9949500**
	ADMINISTRATION AND ENGINEERING		0.1		994950
	CONTINGENCIES		0.15		1492425
	CAPITAL COST (WITHOUT VAT)				**12436875**

4.9.10 Project Anticipated Impacts and Mitigation Measures

4.9.10.1Positive Impacts

The following are some of the anticipated positive impacts of the dam project. They are:

- The dam will facilitate cultivation of crops to be done throughout the year and that will guarantee household income for the communities and food security. This areas of Kavuruga are reportedly food insecure;

- The project works will bring about some indirect developments into area such as emergence of restaurants and accommodation facilities for the workforce;
- It is possible local can also benefit from the project in terms of skills development and eventually skills transfer through engagement on project activities;
- The establishment of dam will lead to improved access in terms of roads that will equally be improved to facilitate delivery of construction of the dam facility; and
- During construction phase, the communities will get benefits in terms of employment and source of income through sale of food items to the workforce.

4.9.10.2Negative Impacts

At this stage of the study, the preliminary potential impact examination has identified the following impacts:

- The dam works will displace farmers on their marshlands thereby depriving them of their area of livelihood. This is a fundamental impact that can have long term implications in terms of food security;
- The project will displace sand miners and this equally will affect the youth who currently benefit from sand mining as source of income;
- The dam will take up access road that passes through the planned site thereby denying communities access route to the neighboring villages south of the site;
- The dam construction will interfere with the community water sources downstream. In addition, social issues regarding land availability and sharing will be crucial for the success of the project;
- The erosion of river banks could be an issue due to the Project since areas around the site are heavily farmed;
- Loss of vegetation through clearances of the sites and access roads;
- Sedimentation transport could be an issue as the annual sedimentation is quite important, leading the site likely exposed to siltation. Thus, it should be taken into consideration during the ESIA as the area is highly cultivated;
- Noise and vibrations from equipment operations as well as air quality concerns;
- Pollution of water sources from loose soils, and agro-chemical residual impacts;
- HIV/AIDS from the workforce and the communities; and
- Water diseases through establishment of the dam could potentially occur and such diseases include malaria amongst others.

One of the tasks of this assignment is preliminary identification of potential environmental and social impacts of the project and proposing mitigation measures. At this point, the consultant has identified some key impacts as well as proposing mitigation measures to address such concerns and have been summarized in Table 4.8-11 as follows:

Table 4.9-10 Key impacts and mitigation measures for the planned Kavuruga dam site

No.	**Project Impact**	**Mitigation measures**
01.	Loss of marsh and cropland areas due to inundation where rice fields are in place.	Compensation for loss of crop and issuing early notice to farmers to harvest crops. For the women who are likely to be affected by the loss of the marshland, the project should propose feasible measures to for women to earn income upon uptake of the marshland. Such measures have to be

Nº.	Project Impact	Mitigation measures
		discussed participartorily; Some of the possible measures could include some group revolving fund from which they can borrow at lower interest rates to support start up and improvement of any of their on-going income ventures
02.	Impact on san miners	Alternate source of employment such as working on the project should be accorded to the youth.
03.	The dam site will take up a community road that passes through the site connecting the north-south villages.	Alternate route for the community be set up by the project.
04.	Land uptake through construction of the dam and access roads, camp sites, etc	Compensation for land uptake after Resettlement Action Plan (RAP) studies.
05.	Concerns relating to management of cut to spoil materials	Disposal sites for cut to spoil have to be approved by the Supervising consultant.
06.	Loss of marsh and cropland areas due to inundation where rice fields are in place.	Compensation for loss of crop and issuing early notice to farmers to harvest crops
07.	Loss of vegetation through clearances of the sites and access roads.	Restrict clearances to work/designated portions or areas. Compensatory planting of trees by the projects.
08.	Conflicts in water use due to a multiplicity of users (power generation, water supply and irrigations needs including local domestic uses). Some sections of the river have a number of dams and the planned ones will add to such existing dams along the same river system there by putting stress on water supply process.	Put in place site-based sectoral committees to handle equitable and rational use of water in the project. There is need to plan the development of this dam sites while ensuring that the needs of other users are taken care of.
09.	Impacts on water quality through upgrading of existing facilities and where communities draw water for their needs	Provide alternate site rather than disrupt this existing and functioning facility already in place.
10.	Soil erosion concerns which will likely arise through loose soil materials causing sedimentation	Soil control measures have to be instituted during works implementation.
11.	Pollution of water sources from loose soils, and agro-chemical residual impacts.	Impacts of water quality from agro-chemicals have to be mitigated through monitoring water quality parameters during the project phases.

Nº.	Project Impact	Mitigation measures
12.	Equipment related concerns in terms of oil spillages, used batteries and oil filters as well as used tyres.	Preparing decommissioning plan and site restoration and re-grassing.
13.	Human waste management especially in irrigation fields and workers camp sites.	Measures for human waste management to be instituted on the sites.
14.	Noise and vibrations	Noise from equipment and the workforce
15.	HIV/AIDS impacts due to influx of people in search of work opportunities in the project.	Contractors to work with HIV/AIDS service providers to sensitize communities on HIV/AIDS. There also be measures to work hand in with the existing health agencies in the area so as to come up avenues to address HIV/AIDS concerns even after the end of project works. Such measures include proving support to such institutions to enable them carry on with HIV/AIDS sensitization and awareness thereafter.
16.	Air Quality concerns likely to arise from project works	Dust suppression measures will be instituted to ensure air quality levels are kept appropriate.
17.	Possible increase in crime rate in the areas of the project.	Working together with the police and law enforcement agencies to control crime in the areas.
18.	Impacts on socio-cultural sites	No impact
19.	Impacts on biodiversity areas of high conservation concerns (Important Bird Areas-IBAs, national and central forest reserves etc).	No impact

5 Preliminary Economic analysis and ranking of the dam sub-projects

5.1 Background

The economic analysis of a proposed project focuses on the benefits the project would bring to the target population if developed. Once the project is evaluated to cause substantial benefits; and therefore contribute to optimum utilization of the country's resources, it is concluded to be robust and worth harnessing. To elaborate on this; a project that provides safe water reducing on the incidences of water borne diseases in a community is attractive albeit having no direct financial returns to the national economy. The socio-economic considerations for an attractive project are largely intangible (non-financial).

On the other hand, the purpose of financial analysis is to determine whether the proposed project is profitable for the owner/financier/investor. The reason for this is obvious; the financiers are interested to invest where they can make financial profits from the investments. The prime consideration is therefore anticipated revenue from the project. The main consideration is receipts from the products in relation to all financial variables such as initial investment, operating costs, taxes, inflation, and interest rates among others. Focus is on ensuring that after all these considerations; there should be surplus revenue (profit). The attractiveness of a project depends on the level of profitability. The specific objective relating to this chapter required "*undertaking an initial financial analysis for the proposed interventions for multipurpose use".* However, at this stage it is far-fetched to conduct comprehensive economic and financial analyses. The reason is that each of the nine sites is a project on its own that requires separate analysis. It is appropriate to do the analyses after conclusive decisions have been made regarding what development alternatives will be selected for each site and for what purpose. This study recommends that more elaborate economic and financial analyses to be done at feasibility study stage after conclusive consultations.

5.1.1 Assumptions

The following assumptions have been made in deriving the estimates of project beneficiaries

- *Population*: Use was made of spatially disaggregated population density data produced by Columbia University Centre for International Earth Science Information Network (CIESIN) in collaboration with the International Food Policy Research Institute (IFPRI), The World Bank, and Centro Internacional de Agricultura Tropical (CIAT). Raw data for deriving the spatial population data were derived from the UN population census database

- *Irrigation*
  - Farmland (Hectares per farmer): According to the World Development Indicators of the World Bank, the average size of a plot of land in the Burundi, Rwanda and Uganda in 2011 was 0.11 ha, 0.12 ha and 0.2 ha respectively.
  - Hectares needed to feed 1 person: To feed 1 person, 0.18 Ha of land was needed in Eastern Africa (based on calculations by Kastner et al (2011), "Global changes in diets and the consequences for land requirements for food" using data from

FAOSTAT food balance sheet data (http://faostat.fao.org/)). Irrigation should result in increased efficiency. This study has assumed a figure of 0.1 ha per person

- *Per capita energy consumption*: The per capita electricity consumption in 2011 for Burundi, Rwanda and Uganda was estimated at 12, 20 and 63 kWh/year (Source: CIA World Fact Book). These rates are very low by any standards and are responsible for the high rates of environmental degradation due to usage of biomass as energy sources. For an improved impact by the proposed projects, it is assumed that the energy balance for an average house in the 3 countries should be made up of; (a) four energy saving bulbs (20W@) operated for 6 hours per day = 0.48kWh/day; (b) one TV (70W) operated for 6 h per day = 0.42 kWh/day; and (3) one radio (20W) operated for 6 h per day = 0.12 kWh//day. Other household uses=20%. Total for household energy consumption = 450 kWh/year. Other types of uses (commercial, industrial) assumed at 100% of household consumption. Total consumption per house = 900 kWh/year. Average household occupancy assumed at 6 members. Per capita energy consumption = 150 kW/year

- The useful life of each project is 50 years

- Population growth rates (source: FAO)
  - Burundi 2.7%
  - Rwanda 2.8%
  - Uganda 3.2%

- For each site, the areas that can be supplied with potable water are assumed to be within a distance of 5 km from the reservoir and also within the irrigation command areas. Water demand for each category
  - Irrigation demand = 5,000 m^3/ha
  - Domestic demand = 30 l/cap/day

5.2 Preliminary costs

For the preparation of the preliminary costs, quantities of the dam structure and appurtenances were estimated from the site maps and proven formulae. The unit rates were derived basing on current rates in dam construction within the East African region. Estimates were also made for components such as the preparatory works (5 km access roads, resettlement and land compensation, river diversion works during construction, and construction of contractor's camp facilities such as offices & accommodation), irrigation infrastructure, hydropower infrastructure and water supply systems. A 15% contingency was included as part of the project costs, along with another 10% as consultancy fees for both the design and supervision of the construction. Table 5.2-1 gives a summary of the costs for the proposed dam sub-projects.

Table 5.2-1 Summary Costs of the proposed dam sub-projects

Dam site	Type of Dam	Dam height, (m)	Reservoir Capacity Million m^3	Cost of Dam Million US$
Kabuyanda	Earth Dam	20.0	10.0	13.3
Kagitumba	Concrete Gravity	20.5	26.3	32.1
Muvumba	Earth Dam	43.0	108.7	104.3
Akanyaru	Rockfill	52.0	333.9	92.0
Mbarara	Earth Dam	19.0	9.9	10.9
Upper Ruvubu	Concrete Gravity	45.5	110.3	70.0
Ruvyironza	Composite Earth Fill	58.9	372.6	137.3
Gashayura	Earth Dam	19.0	20.4	17.2
Kavuruga	Earth Dam	19.5	10.9	12.4

5.3 Ranking of dam sub-projects

A multi-criteria matrix was developed to guide evaluation and ranking of the different dam sub-projects for the feasibility stage. The criteria included:

(i) Reservoir capacity,
(ii) Storage/earth ratio,
(iii) Water use benefits of created and/or boosted irrigated agriculture and hydropower generation,
(iv) Cost of sub-projects,
(v) Environmental attributes: these included the following attributes;
- Land take area, expressed as reservoir area in hectares,
- Number of displaced people,
- Number of relocated settlements,
- Acreage of affected crops in hectares,
- Extent of affected infrastructure such as roads, bridges, schools, etc,
- Number of archaeological, cultural, historical and protected areas affected,
- Number of endangered/threatened species.

Table 5.3-1 below summarizes the ranking criteria used.

Table 5.3-1: Summary of the criteria and scoring system used for ranking

Ranking criterion	Scores					Weight
	1	2	3	4	5	
Reservoir capacity range (MCM)	0 - 25	25 - 50	50 - 100	100 - 200	> 200	3
Water storage/earth ratio	0 - 40	40 - 80	80 - 160	160 - 320	> 320	1
Irrigation command area (1000 ha)	0 – 0.5	0.5 - 1	1 - 5	5 - 10	> 10	4
Hydropower potential (MW)	0 - 1	1 - 5	5 - 10	10 - 25	> 25	3
Water Supply; Number of people site can serve in 2062 (million)	0-0.2	0.2- 0.5	0.5 – 1.0	1.0 – 5.0	> 5.0	1
Cost of sub-project (MUSD)	>120	60 – 120	30 – 60	15 - 30	0 –15	4
Environmental criteria*	> 18	14 - 18	12 - 14	9 - 12	0 - 9	4

*The *environmental criteria* are elaborated in section 5.3.4 below for several social and environmental attributes of the different dam sub-projects. The raw environmental score which is given for each sub-project in Table 5.3-6 below

The scores are multiplied by the weights to give the final points. The distribution of the weights is subjective and has been selected by the consultant to reflect the importance of the various ranking factors.

5.3.1 Reservoir capacity

The storage capacity was one key criterion used for the ranking (see Table 5.3-2).

Table 5.3-2: Evaluation criterion of reservoir capacity

Property	Reservoir Capacity Million m^3	Score
Kabuyanda	10.0	1
Kagitumba	26.3	2
Muvumba	108.7	4
Akanyaru	333.9	5
Mbarara	9.9	1
Upper Ruvubu	110.3	4
Ruvyironza	372.6	5
Gashayura	20.4	1
Kavuruga	10.9	1

5.3.2 Water storage/earth ratio

This ratio gives an indication of the storage capability of a particular reservoir geometry assuming the dam is an earth fill embankment. The ratio can help show the embankment volume and cost efficiency; the higher the ratio the higher the efficiency (see Table 5.3-3 below).

Table 5.3-3: Evaluation criterion of water/earth ratio

Dam site	Reservoir Capacity (million m^3)	Volume of Earth fill (million m^3)	Water/ Earth Ratio	Score
Kabuyanda	10.0	0.260	38.5	1
Kagitumba	26.3	0.145	181.4	4
Muvumba	108.7	3.800	28.6	1
Akanyaru	333.9	1.032	323.6	5
Mbarara	9.9	0.263	37.6	1
Upper Ruvubu	110.3	2.090	52.8	2
Ruvyironza	372.6	4.600	81.0	3
Gashayura	20.4	0.540	37.8	1
Kavuruga	10.9	0.345	31.6	1

5.3.3 Water use

Concerning water use, the purposes of irrigation watering, domestic water supply and hydropower generation were evaluated. The other purposes such as livestock watering and fishing, etc were left out because of lack of ready access to their data and with the assumption that their water requirements would be quite small.

The scoring for irrigation watering was based on the size of command areas that could utilize the impounded water through gravitational abstraction and low-head pumping.

The Table 5.3-4 shows the scoring of the 3 purposes of irrigation and potential hydropower and water supply highlighted above.

Table 5.3-4: Evaluation criterion of selected water uses

Dam site	Irrigation command area	Hydropower potential	Water Supply

	(ha)	Score	MW	Score	No of People who can be served with Water, 2062	Score
Kabuyanda	1283	3	0.1	1	336,934	3
Kagitumba	178	1	11.8	4	225,716	2
Muvumba	2198	3	2.9	2	118,494	1
Akanyaru	12474	5	14.5	4	2,340,902	5
Mbarara	489	1	-	1	302,295	3
Upper Ruvubu	8137	4	3.6	2	585,824	4
Ruvyironza	14674	5	27.5	5	1,002,303	5
Gashayura	1212	3	-	1	646,856	4
Kavuruga	452	1	-	1	180,978	2

5.3.4 Environmental ranking

During the IESE study, the assessment of the impacts was predicted in relation to the prevailing environmental and social settings of the sites. This was be done by comparing baseline conditions (i.e. the current situation without the project) with the conditions that would prevail when the project is implemented. The environmental and social impacts of the projects were predicted in relation to the baseline environmental and social receptors.

Based on these, the following parameters were used in ranking of the 9 dam sites:

- impacts on protected areas,
- impacts on settlements;
- impacts on cropped marshlands;
- impacts on settlements and community infrastructures;
- loss of vegetation and flora; and
- impacts on water sources for the communities.

The levels of negative impacts were drawn based on a continuous scale ranging from ***4 being Very Large Negative*** through to ***0 denoting minimal/no impact.***

For instance, an area/aspect or habitat of "high value" which is to be impacted by "highly negative impacts" results in an overall impact assessment for that particular aspect to be of "very large negative impact". An area/aspect of "high value" affected by "little/no impacts" will give an overall impact assessment of "minimal/no impact" or "small negative impact", depending on the specific characteristics.

Table 5.3-5 Impact Categorization

0	**Minimal/No Impact**
X	Small Negative Impact

XX	Medium Negative Impact
XXX	Large Negative Impact
XXXX	Very Large Negative Impact

From the environmental ranking of the sites in Table 5.3-6, it will be appreciated that although the Kabuyanda site has large negative impacts due to its location in a protected area (Rwoho CFR), its other impacts are quite low. It will however require serious consultations and good planning to implement the planned dam site.

Kavuruga is about 5km upstream of a hydroelectric facility at Kayanza. It is not clear how it shall impact the downstream facility hence the high impact on other infrastructure.

The Ruvyironza reservoir would inundate a major road corridor connecting Gitega and Ngozi hence the high impact on infrastructure.

Overall, the marshlands in Burundi and Rwanda support rice cultivation and when the planned dam developments are implemented that will interfere with both up and downstream paddy rice growing. It is important to note that, the impacts on rice cultivation downstream will be short term and restricted to the construction phases of the projects.

Table 5.3-6 Summary of the Environmental Ranking of Dam Sites

N°.	Impacts and their levels	Dam sites									Net impacts
		Gashayura	Kabuyanda	Kagitumba-Mirama	Kanyaru	Kavuruga	Mbarara	Muvumba	Ruvyironza	Upper Ruvubu	
01.	impacts on protected areas	0	xxxx	0	0	0	0	0	0	0	**4**
02.	impacts on cropped marshlands	xxx	0	x	xxx	xxx	xxx	x	x	xxx	**18**
03.	Impact on crops in the vicinity	xx	0	xx	xx	x	xx	xxxx	xx	xx	**18**
04.	impacts on settlements	x	0	xxx	x	x	x	x	xxx	xx	**13**
05.	Impacts infrastructures (roads, energy facilities)	x	0	x	x	xxxx	x	x	xxxx	x	**14**
06.	Impact on communities economic activities (sand mining, community conservation and brick/tile making)	x	xx	0	0	xx	0	0	0	0	**5**
07.	loss of vegetation and flora	x	xxx	x	x	x	x	x	x	x	**11**
08.	Impacts on water sources for the communities	xx	0	xx	xx	xx	xx	xx	xx	xx	**16**
09.	Impacts on physical cultural resources	0	0	0	0	0	0	0	0	0	**0**
Overall site scale of negative impacts		11	9	10	10	14	10	10	13	11	98
	Final environmental score	**4**	**5**	**4**	**4**	**2**	**4**	**4**	**2**	**4**	

5.3.5 Cost

The costs of the different dam sub-projects were also used to guide the selection and ranking of the sub-projects.

Table 5.3-7: Evaluation criterion for cost

Dam site	Cost of Dam Million US$	Score (Multiplicative)
Kabuyanda	13.3	5
Kagitumba	32.1	3
Muvumba	104.3	2
Akanyaru	92.0	2
Mbarara	10.9	5
Upper Ruvubu	70.0	2
Ruvyironza	137.3	1
Gashayura	17.2	4
Kavuruga	12.4	5

5.3.6 Overall ranking

The scores were done for all the 9 sites and were all multiplied by **weights** (as shown in Table 5.3-8) to get a total site score. All the sites were then ranked based on the total site scores, with the site having the highest score being the one with the highest priority for selection for feasibility studies.

Table 5.3-8: Combination of all evaluation criteria

Site	Scores							Total weighted Score	Global ranking
	Reservoir Capacity	Water/earth ratio	Irrigation command area	Hydropower potential	Water Supply	Cost	Environmental Criteria		
Weights	*3*	*1*	*4*	*3*	*1*	*4*	*4*		
Max. Pts	***5***	***5***	***5***	***5***	***5***	***5***	*5*	*100*	
Kabuyanda	1	1	3	1	3	5	5	62	4
Kagitumba-Maziba	2	4	1	4	2	4	3	56	5
Muvumba	4	1	3	2	1	4	2	56	5
Kanyaru	5	5	5	4	5	4	2	81	1
Mbarara	1	1	1	1	3	4	5	50	8
Upper Ruvubu	4	2	4	2	4	4	2	64	3
Ruvyironza	5	3	5	5	5	2	1	70	2
Gashayura	1	1	3	1	4	4	4	55	7
Kavuruga	1	1	1	1	2	1	5	37	9

5.4 Cost Benefit Analysis

Preliminary cost benefit analysis (CBA) was carried out to assess whether multipurpose reservoirs constructed at the different sites are viable in terms of benefits accrued over the project period. For the analysis, it was assumed that the project construction would start in 2012 and each project would take 4 years to complete. The project economic life was taken as 25 years starting in 2012. Cost benefit analysis was carried out to check whether implementation each project would result in net benefit over the assumed time horizon. The criterion used to evaluate this was that the ratio of the present value of benefits to present value of costs (B/C) is greater than one.

5.4.1 Assumptions

The following key assumptions were adopted for the cost benefit analysis:

- Annual O&M cost = 1% of investment cost. Replacement costs for infrastructure not considered
- Discount rate = 10% as base case. This is approximately the average discount rate in the 3 countries between 2008 and 2011 (Source: CIA world fact book).
- The power price was adopted from figures used by Uganda's Electricity Regulatory Authority (ERA) at US$12 cents/kWh for the year 2009
- Construction period = 4 years.
- Commissioning carried out 3 years after start of construction.
- Project economic life = 25 years starting from commissioning date
- The distribution of investment costs with time during the construction period is 30%, 40%, 20% and 10% in year 1, year 2, year 3 and year, respectively
- Replacement of major electromechanical equipment carried out every 30 years
- Irrigated crops: Rice for Upper Ruvubu, Mbarara, Akanyaru, Ruvironza, Kavurungu and Gashayura. Maize for Muvumba. No irrigation in Kagitumba.
- Irrigation yields: According to the FAO Country Statistics database (www.faostat3.fao.org) , the current yields for the three countries (Burundi, Rwand and Uganda) average 1.6 ton/ha and 3.5 ton/ha for maize and rice, respectively. Maize yields in Australia and USA are about 6.0 and 9.5 Ton/ha while rice yields are in the order of 10 and 7.5 Ton/ha. It seems possible to achieve yields of about 5 Ton/ha for maize and 7 Ton/ha for rice with irrigation in the proposed schemes. This would mean an incremental yield of 3.4 and 3.5 Ton/ha for maize and rice, respectively, due to implementation of the projects.
- Maize and rice prices from The World Bank database (econ.worldbank.org) for commodity price averages for Jan-Sep 2012. Maize = 292 US$/ metric ton growing at 3% p.a. between 1990 and 2011 and for rice the price is 440 US$/ metric ton growing at 5% p.a between 1990 and 2011.

- Benefit from flood control: where flood control was considered as a benefit, it was assumed that all the benefits would be towards protecting agriculture land which is the dominant feature in most of the valleys. Annual flood control benefits were estimated as 50% of the annual agriculture benefits.

5.4.2 Key site data

Table Table 5.4-1 shows the input data which was used in the CBA computations for each multipurpose reservoir site

The CBA runs for the respective sites are given in Table Table 5.4-2 to Table 5.4-10

Table 5.4-1 Key input data for each multipurpose reservoir site

Variable		Upper Ruvubu	Ruvironza	Akanyaru	Kagitumba-Maziba	Muvumba	Kavurungu	Gashayura	Mbarara	Kabuyanda
Discount rate		10%	10%	10%	10%	10%	10%	10%	10%	10%
Proportion of Civil and Irrigation Investment Cost in Year	1	30%	30%	30%	30%	30%	30%	30%	30%	30%
	2	40%	40%	40%	40%	40%	40%	40%	40%	40%
	3	20%	20%	20%	20%	20%	20%	20%	20%	20%
	4	10%	10%	10%	10%	10%	10%	10%	10%	10%
Investment cost (US$) - Civil and hydropower infrastructure		69,956,250	132,303,125	91,978,750	32,102,838	116,710,625	12,436,875	17,226,250	10,905,625	13,250,000
Electromechanical equipment cost (US$)		5,800,000	9,300,000	7,100,000	6,300,000	4,500,000	-	-	-	725,000
O&M costs		1%	1%	1%	1%	1%	1%	1%	1%	1%
Investment cost for irrigation infrastructure (US$/ha)		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
O&M costs for irrigation infrastructure		2%	2%	2%	2%	2%	2%	2%	2%	2%
Investment cost for water supply infrastructure (US$/cap)		25	25	25	25	25	25	25	25	25
O&M costs for water supply infrastructure		1%	1%	1%	1%	1%	1%	1%	1%	1%
Unit power price (US$ cents/KWh)		12	12	12	12	12	12	12	12	12
Power sales (GWh/year)		31	241	127	102	25	-	-	-	1
Percent of firm power compared to maximum power		70%	70%	70%	70%	70%	70%	70%	70%	70%
Population - Year 1 (2016)		171,999	294,278	683,585	53,002	33,267	53,136	189,918	88,754	79,119
Population - Year 25 (2041)		334,802	572,822	1,330,007	101,186	64,503	103,430	369,682	172,763	151,044
Domestic water sales (m3) - Year 1 (2016)		1,883,394	3,222,349	7,485,260	580,376	364,272	581,835	2,079,606	971,861	866,349
Domestic water sales (m3) - Year 25 (2041)		3,666,082	6,272,399	14,563,574	1,107,985	706,311	1,132,560	4,048,015	1,891,757	1,653,930
Unit price of domestic water (US$/m3)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Irrigation demand (m3/year)		40,687,085	73,369,597	62,370,139	890,079	50,000,000	2,258,545	6,061,866	2,444,333	21,016,676
Irrigated area (ha)		8,137	14,674	12,474	178	10,000	452	1,212	489	4,203
Yield - Maize (Ton/ha)		3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Yield - Rice (Ton/ha)		3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Commodity price - maize (US$/metric ton)		292	292	292	292	292	292	292	292	292
Commodity price - rice (US$/metric ton)		440	440	440	440	440	440	440	440	440
Percent price increase (Maize) - % per annum		3%	3%	3%	3%	3%	3%	3%	3%	3%
Percent price increase (Rice) - % per annum		5%	5%	5%	5%	5%	5%	5%	5%	5%

Table 5.4-2: CBA for Kabuyanda

No. of years from...		Costs							Benefits				
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		3,975,000		6,305,003				10,280,003					-10,280,003
2		5,300,000		8,406,670				13,706,670					-13,706,670
3		2,650,000		4,203,335				6,853,335					-6,853,335
4	1	1,325,000	132,500	2,101,668	420,334	2,337,593	23,376	6,340,470	75,600	433,175	7,868,137	8,376,912	2,036,442
5	2		132,500		420,334		23,376	576,209	75,600	441,211	8,261,544	8,778,356	8,202,146
6	3		132,500		420,334		23,376	576,209	75,600	449,248	8,674,622	9,199,469	8,623,260
7	4		132,500		420,334		23,376	576,209	75,600	457,284	9,108,353	9,641,237	9,065,028
8	5		132,500		420,334	359,626	26,972	939,432	75,600	465,321	9,563,770	10,104,691	9,165,260
9	6		132,500		420,334		26,972	579,806	75,600	473,357	10,041,959	10,590,916	10,011,111
10	7		132,500		420,334		26,972	579,806	75,600	481,394	10,544,057	11,101,051	10,521,245
11	8		132,500		420,334		26,972	579,806	75,600	489,431	11,071,260	11,636,290	11,056,484
12	9		132,500		420,334		26,972	579,806	75,600	497,467	11,624,823	12,197,890	11,618,084
13	10		132,500		420,334	359,626	30,568	943,028	75,600	505,504	12,206,064	12,787,167	11,844,139
14	11		132,500		420,334		30,568	583,402	75,600	513,540	12,816,367	13,405,507	12,822,105
15	12		132,500		420,334		30,568	583,402	75,600	521,577	13,457,185	14,054,362	13,470,960
16	13		132,500		420,334		30,568	583,402	75,600	529,613	14,130,044	14,735,258	14,151,856
17	14		132,500		420,334		30,568	583,402	75,600	537,650	14,836,547	15,449,796	14,866,394
18	15		132,500		420,334	359,626	34,165	946,624	75,600	545,686	15,578,374	16,199,660	15,253,036
19	16		132,500		420,334		34,165	586,998	75,600	553,723	16,357,293	16,986,616	16,399,617
20	17		132,500		420,334		34,165	586,998	75,600	561,759	17,175,157	17,812,517	17,225,518
21	18		132,500		420,334		34,165	586,998	75,600	569,796	18,033,915	18,679,311	18,092,313
22	19		132,500		420,334		34,165	586,998	75,600	577,832	18,935,611	19,589,043	19,002,045
23	20		132,500		420,334	359,626	37,761	950,220	75,600	585,869	19,882,392	20,543,860	19,593,640
24	21		132,500		420,334		37,761	590,594	75,600	593,906	20,876,511	21,546,017	20,955,422
25	22		132,500		420,334		37,761	590,594	75,600	601,942	21,920,337	22,597,879	22,007,284
26	23		132,500		420,334		37,761	590,594	75,600	609,979	23,016,353	23,701,932	23,111,338
27	24		132,500		420,334		37,761	590,594	75,600	618,015	24,167,171	24,860,786	24,270,192
28	25		132,500		420,334		37,761	590,594	75,600	626,052	25,375,530	26,077,181	25,486,587
TOTAL		13,250,000	3,312,500	21,016,676	10,508,338	3,776,096	778,596	52,642,207	1,890,000	13,240,330	375,523,375	390,653,705	
Present value		10,889,779	1,202,708	17,272,977	3,815,384	3,161,417	254,072	**34,097,202**	686,224	4,475,989	108,179,493	**113,341,706**	
											B/C	**3.32**	
											NPV	**51,058,100**	

Table 5.4-3: Kagitumba-Maziba Dam site

No. of years from...		Costs							Benefits				
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		9,630,851		0				9,630,851					-9,630,851
2		12,841,135		0				12,841,135					-12,841,135
3		6,420,568		0				6,420,568					-6,420,568
4	1	3,210,284	321,028	0	0	1,565,978	15,660	5,112,949	8,568,000	290,188	0	8,858,188	3,745,239
5	2		321,028		0		15,660	336,688	8,568,000	295,572	0	8,863,572	8,526,884
6	3		321,028		0		15,660	336,688	8,568,000	300,956	0	8,868,956	8,532,268
7	4		321,028		0		15,660	336,688	8,568,000	306,340	0	8,874,340	8,537,651
8	5		321,028		0	240,917	18,069	580,014	8,568,000	311,723	0	8,879,723	8,299,709
9	6		321,028		0		18,069	339,097	8,568,000	317,107	0	8,885,107	8,546,010
10	7		321,028		0		18,069	339,097	8,568,000	322,491	0	8,890,491	8,551,393
11	8		321,028		0		18,069	339,097	8,568,000	327,875	0	8,895,875	8,556,777
12	9		321,028		0		18,069	339,097	8,568,000	333,258	0	8,901,258	8,562,161
13	10		321,028		0	240,917	20,478	582,424	8,568,000	338,642	0	8,906,642	8,324,218
14	11		321,028		0		20,478	341,506	8,568,000	344,026	0	8,912,026	8,570,519
15	12		321,028		0		20,478	341,506	8,568,000	349,410	0	8,917,410	8,575,903
16	13		321,028		0		20,478	341,506	8,568,000	354,793	0	8,922,793	8,581,287
17	14		321,028		0		20,478	341,506	8,568,000	360,177	0	8,928,177	8,586,671
18	15		321,028		0	240,917	22,887	584,833	8,568,000	365,561	0	8,933,561	8,348,728
19	16		321,028		0		22,887	343,916	8,568,000	370,945	0	8,938,945	8,595,029
20	17		321,028		0		22,887	343,916	8,568,000	376,328	0	8,944,328	8,600,413
21	18		321,028		0		22,887	343,916	8,568,000	381,712	0	8,949,712	8,605,796
22	19		321,028		0		22,887	343,916	8,568,000	387,096	0	8,955,096	8,611,180
23	20		321,028		0	240,917	25,296	587,242	8,568,000	392,480	0	8,960,480	8,373,238
24	21		321,028		0		25,296	346,325	8,568,000	397,863	0	8,965,863	8,619,539
25	22		321,028		0		25,296	346,325	8,568,000	403,247	0	8,971,247	8,624,922
26	23		321,028		0		25,296	346,325	8,568,000	408,631	0	8,976,631	8,630,306
27	24		321,028		0		25,296	346,325	8,568,000	414,015	0	8,982,015	8,635,690
28	25		321,028		0		25,296	346,325	8,568,000	419,398	0	8,987,398	8,641,074
TOTAL		32,102,838	8,025,709	0	0	2,529,646	521,590	43,179,783	214,200,000	8,869,834	0	223,069,834	
Present value		26,384,362	2,913,987	0	0	2,117,866	170,206	**30,023,557**	77,772,079	2,998,511	0	**80,770,590**	
											B/C	**2.69**	
											NPV	**30,660,583**	

Table 5.4-4: CBA for Muvumba

No. of years from...		Costs							Benefits						
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water sales (m3)	Water supply	Irrigation	Flood control	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M								
1		35,013,188		15,000,000				50,013,188							-50,013,188
2		46,684,250		20,000,000				66,684,250							-66,684,250
3		23,342,125		10,000,000				33,342,125							-33,342,125
4	1	11,671,063	1,167,106	5,000,000	1,000,000	987,853	9,879	19,835,900	2,125,200	364,272	182,136	12,422,474	6,211,237	20,941,047	1,105,146
5	2		1,167,106		1,000,000		9,879	2,176,985	2,125,200	371,252	185,626	13,043,598	6,521,799	21,876,222	19,699,238
6	3		1,167,106		1,000,000		9,879	2,176,985	2,125,200	378,233	189,116	13,695,777	6,847,889	22,857,982	20,680,998
7	4		1,167,106		1,000,000		9,879	2,176,985	2,125,200	385,213	192,606	14,380,566	7,190,283	23,888,656	21,711,671
8	5		1,167,106		1,000,000	156,182	11,440	2,334,729	2,125,200	392,193	196,097	15,099,595	7,549,797	24,970,689	22,635,960
9	6		1,167,106		1,000,000		11,440	2,178,547	2,125,200	399,174	199,587	15,854,574	7,927,287	26,106,648	23,928,102
10	7		1,167,106		1,000,000		11,440	2,178,547	2,125,200	406,154	203,077	16,647,303	8,323,652	27,299,232	25,120,685
11	8		1,167,106		1,000,000		11,440	2,178,547	2,125,200	413,135	206,567	17,479,668	8,739,834	28,551,270	26,372,723
12	9		1,167,106		1,000,000		11,440	2,178,547	2,125,200	420,115	210,057	18,353,652	9,176,826	29,865,735	27,687,188
13	10		1,167,106		1,000,000	156,182	13,002	2,336,291	2,125,200	427,095	213,548	19,271,334	9,635,667	31,245,749	28,909,458
14	11		1,167,106		1,000,000		13,002	2,180,108	2,125,200	434,076	217,038	20,234,901	10,117,450	32,694,589	30,514,481
15	12		1,167,106		1,000,000		13,002	2,180,108	2,125,200	441,056	220,528	21,246,646	10,623,323	34,215,697	32,035,589
16	13		1,167,106		1,000,000		13,002	2,180,108	2,125,200	448,036	224,018	22,308,978	11,154,489	35,812,686	33,632,577
17	14		1,167,106		1,000,000		13,002	2,180,108	2,125,200	455,017	227,508	23,424,427	11,712,214	37,489,349	35,309,241
18	15		1,167,106		1,000,000	156,182	14,564	2,337,853	2,125,200	461,997	230,999	24,595,649	12,297,824	39,249,671	36,911,819
19	16		1,167,106		1,000,000		14,564	2,181,670	2,125,200	468,978	234,489	25,825,431	12,912,715	41,097,835	38,916,165
20	17		1,167,106		1,000,000		14,564	2,181,670	2,125,200	475,958	237,979	27,116,703	13,558,351	43,038,233	40,856,563
21	18		1,167,106		1,000,000		14,564	2,181,670	2,125,200	482,938	241,469	28,472,538	14,236,269	45,075,476	42,893,805
22	19		1,167,106		1,000,000		14,564	2,181,670	2,125,200	489,919	244,959	29,896,165	14,948,082	47,214,406	45,032,736
23	20		1,167,106		1,000,000	156,182	16,126	2,339,414	2,125,200	496,899	248,450	31,390,973	15,695,486	49,460,109	47,120,694
24	21		1,167,106		1,000,000		16,126	2,183,232	2,125,200	503,880	251,940	32,960,521	16,480,261	51,817,922	49,634,690
25	22		1,167,106		1,000,000		16,126	2,183,232	2,125,200	510,860	255,430	34,608,547	17,304,274	54,293,451	52,110,219
26	23		1,167,106		1,000,000		16,126	2,183,232	2,125,200	517,840	258,920	36,338,975	18,169,487	56,892,583	54,709,350
27	24		1,167,106		1,000,000		16,126	2,183,232	2,125,200	524,821	262,410	38,155,924	19,077,962	59,621,496	57,438,264
28	25		1,167,106		1,000,000		16,126	2,183,232	2,125,200	531,801	265,901	40,063,720	20,031,860	62,486,680	60,303,448
TOTAL		116,710,625	29,177,656	50,000,000	25,000,000	1,612,582	331,302	222,832,165	53,130,000		5,600,456	592,888,638	296,444,319	948,063,413	
Present value		95,920,972	10,593,870	41,093,505	9,077,040	1,348,118	107,859	**152,712,909**	19,290,525	3,779,057	1,889,529	170,797,336	85,398,668	277,376,058	
													B/C	**1.82**	
													NPV	**55,683,829**	

Table 5.4-5: CBA for Akanyaru

No. of years from...		Costs							Benefits				
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		27,593,625		18,711,042				46,304,667					-46,304,667
2		36,791,500		24,948,055				61,739,555					-61,739,555
3		18,395,750		12,474,028				30,869,778					-30,869,778
4	1	9,197,875	919,788	6,237,014	1,247,403	20,321,742	203,217	38,127,039	10,668,000	3,742,630	23,349,878	37,760,508	-366,530
5	2		919,788		1,247,403		203,217	2,370,408	10,668,000	3,814,858	24,517,372	39,000,230	36,629,822
6	3		919,788		1,247,403		203,217	2,370,408	10,668,000	3,887,085	25,743,241	40,298,326	37,927,919
7	4		919,788		1,247,403		203,217	2,370,408	10,668,000	3,959,313	27,030,403	41,657,716	39,287,308
8	5		919,788		1,247,403	3,232,107	235,538	5,634,836	10,668,000	4,031,541	28,381,923	43,081,464	37,446,628
9	6		919,788		1,247,403		235,538	2,402,729	10,668,000	4,103,769	29,801,019	44,572,788	42,170,059
10	7		919,788		1,247,403		235,538	2,402,729	10,668,000	4,175,996	31,291,070	46,135,066	43,732,338
11	8		919,788		1,247,403		235,538	2,402,729	10,668,000	4,248,224	32,855,624	47,771,848	45,369,119
12	9		919,788		1,247,403		235,538	2,402,729	10,668,000	4,320,452	34,498,405	49,486,856	47,084,128
13	10		919,788		1,247,403	3,232,107	267,860	5,667,157	10,668,000	4,392,679	36,223,325	51,284,004	45,616,848
14	11		919,788		1,247,403		267,860	2,435,050	10,668,000	4,464,907	38,034,491	53,167,398	50,732,348
15	12		919,788		1,247,403		267,860	2,435,050	10,668,000	4,537,135	39,936,216	55,141,351	52,706,301
16	13		919,788		1,247,403		267,860	2,435,050	10,668,000	4,609,362	41,933,027	57,210,389	54,775,339
17	14		919,788		1,247,403		267,860	2,435,050	10,668,000	4,681,590	44,029,678	59,379,268	56,944,218
18	15		919,788		1,247,403	3,232,107	300,181	5,699,478	10,668,000	4,753,818	46,231,162	61,652,980	55,953,502
19	16		919,788		1,247,403		300,181	2,467,371	10,668,000	4,826,046	48,542,720	64,036,765	61,569,395
20	17		919,788		1,247,403		300,181	2,467,371	10,668,000	4,898,273	50,969,856	66,536,129	64,068,758
21	18		919,788		1,247,403		300,181	2,467,371	10,668,000	4,970,501	53,518,349	69,156,850	66,689,479
22	19		919,788		1,247,403		300,181	2,467,371	10,668,000	5,042,729	56,194,266	71,904,995	69,437,624
23	20		919,788		1,247,403	3,232,107	332,502	5,731,799	10,668,000	5,114,956	59,003,980	74,786,936	69,055,137
24	21		919,788		1,247,403		332,502	2,499,692	10,668,000	5,187,184	61,954,178	77,809,362	75,309,671
25	22		919,788		1,247,403		332,502	2,499,692	10,668,000	5,259,412	65,051,887	80,979,299	78,479,607
26	23		919,788		1,247,403		332,502	2,499,692	10,668,000	5,331,639	68,304,482	84,304,121	81,804,429
27	24		919,788		1,247,403		332,502	2,499,692	10,668,000	5,403,867	71,719,706	87,791,573	85,291,881
28	25		919,788		1,247,403		332,502	2,499,692	10,668,000	5,476,095	75,305,691	91,449,786	88,950,094
TOTAL		91,978,750	22,994,688	62,370,139	31,185,069	33,250,170	6,825,773	248,604,588	266,700,000	115,234,061	1,114,421,949	1,496,356,009	
Present value		75,594,584	8,348,948	51,260,151	11,322,725	27,788,260	2,221,078	**160,569,412**	96,833,863	38,861,558	321,038,873	**456,734,294**	
											B/C	**2.84**	
											NPV	**182,581,823**	

Table 5.4-6: CBA for Mbarara

No. of years from...		Costs							Benefits				
		Civil Structures		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		3,271,688		733,300				4,004,987					-4,004,987
2		4,362,250		977,733				5,339,983					-5,339,983
3		2,181,125		488,867				2,669,992					-2,669,992
4	1	1,090,563	109,056	244,433	48,887	2,638,905	26,389	4,158,233	0	485,931	915,100	1,401,030	-2,757,203
5	2		109,056		48,887		26,389	184,332	0	495,317	960,855	1,456,172	1,271,840
6	3		109,056		48,887		26,389	184,332	0	504,704	1,008,897	1,513,601	1,329,269
7	4		109,056		48,887		26,389	184,332	0	514,091	1,059,342	1,573,433	1,389,101
8	5		109,056		48,887	420,044	30,589	608,576	0	523,477	1,112,309	1,635,787	1,027,210
9	6		109,056		48,887		30,589	188,532	0	532,864	1,167,925	1,700,789	1,512,256
10	7		109,056		48,887		30,589	188,532	0	542,251	1,226,321	1,768,572	1,580,039
11	8		109,056		48,887		30,589	188,532	0	551,637	1,287,637	1,839,274	1,650,742
12	9		109,056		48,887		30,589	188,532	0	561,024	1,352,019	1,913,043	1,724,511
13	10		109,056		48,887	420,044	34,790	612,777	0	570,411	1,419,620	1,990,031	1,377,254
14	11		109,056		48,887		34,790	192,733	0	579,798	1,490,601	2,070,398	1,877,665
15	12		109,056		48,887		34,790	192,733	0	589,184	1,565,131	2,154,315	1,961,582
16	13		109,056		48,887		34,790	192,733	0	598,571	1,643,387	2,241,958	2,049,225
17	14		109,056		48,887		34,790	192,733	0	607,958	1,725,557	2,333,514	2,140,781
18	15		109,056		48,887	420,044	38,990	616,977	0	617,344	1,811,835	2,429,179	1,812,202
19	16		109,056		48,887		38,990	196,933	0	626,731	1,902,426	2,529,157	2,332,224
20	17		109,056		48,887		38,990	196,933	0	636,118	1,997,548	2,633,665	2,436,732
21	18		109,056		48,887		38,990	196,933	0	645,504	2,097,425	2,742,929	2,545,996
22	19		109,056		48,887		38,990	196,933	0	654,891	2,202,296	2,857,187	2,660,254
23	20		109,056		48,887	420,044	43,191	621,177	0	664,278	2,312,411	2,976,689	2,355,511
24	21		109,056		48,887		43,191	201,134	0	673,664	2,428,032	3,101,696	2,900,562
25	22		109,056		48,887		43,191	201,134	0	683,051	2,549,433	3,232,484	3,031,351
26	23		109,056		48,887		43,191	201,134	0	692,438	2,676,905	3,369,343	3,168,209
27	24		109,056		48,887		43,191	201,134	0	701,825	2,810,750	3,512,575	3,311,441
28	25		109,056		48,887		43,191	201,134	0	711,211	2,951,287	3,662,499	3,461,365
TOTAL		10,905,625	2,726,406	2,444,333	1,222,167	4,319,080	886,550	22,504,161	0	14,964,273	43,675,046	58,639,320	
Present value		8,963,007	989,908	2,008,924	443,746	3,609,443	288,460	**14,508,272**	0	5,046,257	12,581,758	**17,628,015**	
											B/C	**1.22**	
											NPV	**-1,264,083**	

Table 5.4-7: CBA for Upper Ruvubu

No. of years from...		Costs							Benefits					
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water sales (m3)	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M							
1		20,986,875		12,206,125				33,193,000						-33,193,000
2		27,982,500		16,274,834				44,257,334						-44,257,334
3		13,991,250		8,137,417				22,128,667						-22,128,667
4	1	6,995,625	699,563	4,068,708	813,742	5,113,999	51,140	17,742,777	2,629,200	1,883,394	941,697	15,232,265	18,803,162	1,060,385
5	2		699,563		813,742		51,140	1,564,444	2,629,200	1,919,775	959,888	15,993,878	19,582,966	18,018,522
6	3		699,563		813,742		51,140	1,564,444	2,629,200	1,956,157	978,078	16,793,572	20,400,850	18,836,406
7	4		699,563		813,742		51,140	1,564,444	2,629,200	1,992,538	996,269	17,633,251	21,258,720	19,694,276
8	5		699,563		813,742	814,013	59,280	2,386,597	2,629,200	2,028,919	1,014,460	18,514,913	22,158,573	19,771,976
9	6		699,563		813,742		59,280	1,572,584	2,629,200	2,065,301	1,032,650	19,440,659	23,102,509	21,529,925
10	7		699,563		813,742		59,280	1,572,584	2,629,200	2,101,682	1,050,841	20,412,692	24,092,733	22,520,149
11	8		699,563		813,742		59,280	1,572,584	2,629,200	2,138,064	1,069,032	21,433,326	25,131,558	23,558,974
12	9		699,563		813,742		59,280	1,572,584	2,629,200	2,174,445	1,087,222	22,504,993	26,221,415	24,648,831
13	10		699,563		813,742	814,013	67,420	2,394,738	2,629,200	2,210,826	1,105,413	23,630,242	27,364,856	24,970,118
14	11		699,563		813,742		67,420	1,580,724	2,629,200	2,247,208	1,123,604	24,811,755	28,564,558	26,983,834
15	12		699,563		813,742		67,420	1,580,724	2,629,200	2,283,589	1,141,795	26,052,342	29,823,337	28,242,612
16	13		699,563		813,742		67,420	1,580,724	2,629,200	2,319,971	1,159,985	27,354,959	31,144,145	29,563,420
17	14		699,563		813,742		67,420	1,580,724	2,629,200	2,356,352	1,178,176	28,722,707	32,530,083	30,949,359
18	15		699,563		813,742	814,013	75,560	2,402,878	2,629,200	2,392,733	1,196,367	30,158,843	33,984,409	31,581,532
19	16		699,563		813,742		75,560	1,588,865	2,629,200	2,429,115	1,214,557	31,666,785	35,510,542	33,921,678
20	17		699,563		813,742		75,560	1,588,865	2,629,200	2,465,496	1,232,748	33,250,124	37,112,072	35,523,208
21	18		699,563		813,742		75,560	1,588,865	2,629,200	2,501,878	1,250,939	34,912,630	38,792,769	37,203,904
22	19		699,563		813,742		75,560	1,588,865	2,629,200	2,538,259	1,269,129	36,658,262	40,556,591	38,967,727
23	20		699,563		813,742	814,013	83,701	2,411,018	2,629,200	2,574,640	1,287,320	38,491,175	42,407,695	39,996,677
24	21		699,563		813,742		83,701	1,597,005	2,629,200	2,611,022	1,305,511	40,415,734	44,350,445	42,753,440
25	22		699,563		813,742		83,701	1,597,005	2,629,200	2,647,403	1,323,702	42,436,520	46,389,422	44,792,417
26	23		699,563		813,742		83,701	1,597,005	2,629,200	2,683,785	1,341,892	44,558,346	48,529,439	46,932,434
27	24		699,563		813,742		83,701	1,597,005	2,629,200	2,720,166	1,360,083	46,786,264	50,775,547	49,178,542
28	25		699,563		813,742		83,701	1,597,005	2,629,200	2,756,547	1,378,274	49,125,577	53,133,051	51,536,046
TOTAL		69,956,250	17,489,063	40,687,085	20,343,542	8,370,051	1,718,067	158,564,057	65,730,000		28,999,632	726,991,814	821,721,447	
Present value		57,494,950	6,349,957	33,439,498	7,386,366	6,994,828	559,013	**106,020,524**	23,865,354	19,558,531	9,779,265	209,429,322	**243,073,941**	
												B/C	**2.29**	
												NPV	**76,604,526**	

Table 5.4-8: CBA for Ruvyironza

No. of years from...		Costs							Benefits				
		Civil Structures and Hydropower		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		41,190,938		22,010,879				63,201,817					-63,201,817
2		54,921,250		29,347,839				84,269,089					-84,269,089
3		27,460,625		14,673,919				42,134,544					-42,134,544
4	1	13,730,313	1,373,031	7,336,960	1,467,392	8,749,679	87,497	32,744,871	20,244,000	1,611,175	27,467,811	49,322,985	16,578,114
5	2		1,373,031		1,467,392		87,497	2,927,920	20,244,000	1,642,298	28,841,201	50,727,499	47,799,579
6	3		1,373,031		1,467,392		87,497	2,927,920	20,244,000	1,673,421	30,283,261	52,200,682	49,272,762
7	4		1,373,031		1,467,392		87,497	2,927,920	20,244,000	1,704,544	31,797,424	53,745,968	50,818,048
8	5		1,373,031		1,467,392	1,392,717	101,424	4,334,564	20,244,000	1,735,667	33,387,296	55,366,962	51,032,398
9	6		1,373,031		1,467,392		101,424	2,941,847	20,244,000	1,766,789	35,056,660	57,067,450	54,125,603
10	7		1,373,031		1,467,392		101,424	2,941,847	20,244,000	1,797,912	36,809,493	58,851,406	55,909,559
11	8		1,373,031		1,467,392		101,424	2,941,847	20,244,000	1,829,035	38,649,968	60,723,004	57,781,156
12	9		1,373,031		1,467,392		101,424	2,941,847	20,244,000	1,860,158	40,582,467	62,686,625	59,744,778
13	10		1,373,031		1,467,392	1,392,717	115,351	4,348,491	20,244,000	1,891,281	42,611,590	64,746,871	60,398,380
14	11		1,373,031		1,467,392		115,351	2,955,774	20,244,000	1,922,404	44,742,169	66,908,574	63,952,799
15	12		1,373,031		1,467,392		115,351	2,955,774	20,244,000	1,953,527	46,979,278	69,176,805	66,221,031
16	13		1,373,031		1,467,392		115,351	2,955,774	20,244,000	1,984,650	49,328,242	71,556,892	68,601,118
17	14		1,373,031		1,467,392		115,351	2,955,774	20,244,000	2,015,773	51,794,654	74,054,427	71,098,653
18	15		1,373,031		1,467,392	1,392,717	129,278	4,362,418	20,244,000	2,046,896	54,384,387	76,675,283	72,312,864
19	16		1,373,031		1,467,392		129,278	2,969,701	20,244,000	2,078,019	57,103,606	79,425,625	76,455,923
20	17		1,373,031		1,467,392		129,278	2,969,701	20,244,000	2,109,142	59,958,786	82,311,928	79,342,227
21	18		1,373,031		1,467,392		129,278	2,969,701	20,244,000	2,140,265	62,956,725	85,340,990	82,371,289
22	19		1,373,031		1,467,392		129,278	2,969,701	20,244,000	2,171,388	66,104,562	88,519,950	85,550,248
23	20		1,373,031		1,467,392	1,392,717	143,205	4,376,346	20,244,000	2,202,511	69,409,790	91,856,301	87,479,955
24	21		1,373,031		1,467,392		143,205	2,983,629	20,244,000	2,233,634	72,880,279	95,357,913	92,374,285
25	22		1,373,031		1,467,392		143,205	2,983,629	20,244,000	2,264,757	76,524,293	99,033,050	96,049,421
26	23		1,373,031		1,467,392		143,205	2,983,629	20,244,000	2,295,880	80,350,508	102,890,388	99,906,759
27	24		1,373,031		1,467,392		143,205	2,983,629	20,244,000	2,327,003	84,368,033	106,939,036	103,955,407
28	25		1,373,031		1,467,392		143,205	2,983,629	20,244,000	2,358,126	88,586,435	111,188,561	108,204,932
TOTAL		137,303,125	34,325,781	73,369,597	36,684,799	14,320,547	2,939,487	298,943,336	506,100,000	49,616,255	1,310,958,920	1,866,675,175	
Present value		112,845,332	12,463,060	60,300,277	13,319,575	11,967,640	956,431	**200,670,375**	183,755,598	16,731,609	377,656,573	**578,143,781**	
											B/C	**2.88**	
											NPV	**233,697,604**	

Table 5.4-9: CBA for Gashayura

No. of years from...		Costs							Benefits				
		Civil Structures		Irrigation infrastructure		Water supply infrastructure		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		5,167,875		1,818,560				6,986,435					-6,986,435
2		6,890,500		2,424,746				9,315,246					-9,315,246
3		3,445,250		1,212,373				4,657,623					-4,657,623
4	1	1,722,625	172,263	606,187	121,237	5,646,776	56,468	8,325,555	0	1,039,803	2,269,417	3,309,219	-5,016,335
5	2		172,263		121,237		56,468	349,968	0	1,059,889	2,382,887	3,442,776	3,092,809
6	3		172,263		121,237		56,468	349,968	0	1,079,975	2,502,032	3,582,006	3,232,039
7	4		172,263		121,237		56,468	349,968	0	1,100,060	2,627,133	3,727,194	3,377,226
8	5		172,263		121,237	898,817	65,456	1,257,773	0	1,120,146	2,758,490	3,878,636	2,620,863
9	6		172,263		121,237		65,456	358,956	0	1,140,232	2,896,414	4,036,646	3,677,691
10	7		172,263		121,237		65,456	358,956	0	1,160,318	3,041,235	4,201,553	3,842,597
11	8		172,263		121,237		65,456	358,956	0	1,180,404	3,193,297	4,373,701	4,014,745
12	9		172,263		121,237		65,456	358,956	0	1,200,489	3,352,962	4,553,451	4,194,495
13	10		172,263		121,237	898,817	74,444	1,266,761	0	1,220,575	3,520,610	4,741,185	3,474,424
14	11		172,263		121,237		74,444	367,944	0	1,240,661	3,696,640	4,937,301	4,569,358
15	12		172,263		121,237		74,444	367,944	0	1,260,747	3,881,472	5,142,219	4,774,275
16	13		172,263		121,237		74,444	367,944	0	1,280,833	4,075,546	5,356,379	4,988,435
17	14		172,263		121,237		74,444	367,944	0	1,300,918	4,279,323	5,580,242	5,212,298
18	15		172,263		121,237	898,817	83,432	1,275,749	0	1,321,004	4,493,290	5,814,294	4,538,545
19	16		172,263		121,237		83,432	376,932	0	1,341,090	4,717,954	6,059,044	5,682,112
20	17		172,263		121,237		83,432	376,932	0	1,361,176	4,953,852	6,315,028	5,938,095
21	18		172,263		121,237		83,432	376,932	0	1,381,262	5,201,544	6,582,806	6,205,874
22	19		172,263		121,237		83,432	376,932	0	1,401,347	5,461,622	6,862,969	6,486,037
23	20		172,263		121,237	898,817	92,420	1,284,737	0	1,421,433	5,734,703	7,156,136	5,871,399
24	21		172,263		121,237		92,420	385,920	0	1,441,519	6,021,438	7,462,957	7,077,037
25	22		172,263		121,237		92,420	385,920	0	1,461,605	6,322,510	7,784,114	7,398,194
26	23		172,263		121,237		92,420	385,920	0	1,481,691	6,638,635	8,120,326	7,734,406
27	24		172,263		121,237		92,420	385,920	0	1,501,777	6,970,567	8,472,343	8,086,423
28	25		172,263		121,237		92,420	385,920	0	1,521,862	7,319,095	8,840,957	8,455,037
TOTAL		17,226,250	4,306,563	6,061,866	3,030,933	9,242,044	1,897,055	41,764,709	0	32,020,816	108,312,668	140,333,483	
Present value		14,157,740	1,563,634	4,982,066	1,100,476	7,723,550	617,251	**26,403,663**	0	10,798,070	31,202,344	**42,000,413**	
											B/C	**1.59**	
											NPV	**5,151,870**	

Table 5.4-10: CBA for Kavuruga

No. of years from...		Costs							Benefits				
		Civil Structures		Irrigation infrastructure		Water supply		Total Cost	Hydropower	Water supply	Irrigation	Total benefits	Net benefit
Construction start	Commissioning date	Investment	O&M	Investment	O&M	Investment	O&M						
1		3,731,063		677,564				4,408,626					-4,408,626
2		4,974,750		903,418				5,878,168					-5,878,168
3		2,487,375		451,709				2,939,084					-2,939,084
4	1	1,243,688	124,369	225,855	45,171	1,579,863	15,799	3,234,744	0	290,918	845,545	1,136,463	-2,098,281
5	2		124,369		45,171		15,799	185,338	0	296,537	887,822	1,184,360	999,021
6	3		124,369		45,171		15,799	185,338	0	302,157	932,213	1,234,370	1,049,032
7	4		124,369		45,171		15,799	185,338	0	307,777	978,824	1,286,601	1,101,262
8	5		124,369		45,171	251,472	18,313	439,325	0	313,396	1,027,765	1,341,161	901,836
9	6		124,369		45,171		18,313	187,853	0	319,016	1,079,154	1,398,169	1,210,316
10	7		124,369		45,171		18,313	187,853	0	324,635	1,133,111	1,457,747	1,269,894
11	8		124,369		45,171		18,313	187,853	0	330,255	1,189,767	1,520,022	1,332,169
12	9		124,369		45,171		18,313	187,853	0	335,875	1,249,255	1,585,130	1,397,277
13	10		124,369		45,171	251,472	20,828	441,840	0	341,494	1,311,718	1,653,212	1,211,372
14	11		124,369		45,171		20,828	190,368	0	347,114	1,377,304	1,724,418	1,534,050
15	12		124,369		45,171		20,828	190,368	0	352,734	1,446,169	1,798,903	1,608,535
16	13		124,369		45,171		20,828	190,368	0	358,353	1,518,477	1,876,831	1,686,463
17	14		124,369		45,171		20,828	190,368	0	363,973	1,594,401	1,958,374	1,768,006
18	15		124,369		45,171	251,472	23,343	444,355	0	369,593	1,674,121	2,043,714	1,599,359
19	16		124,369		45,171		23,343	192,882	0	375,212	1,757,827	2,133,040	1,940,157
20	17		124,369		45,171		23,343	192,882	0	380,832	1,845,719	2,226,551	2,033,668
21	18		124,369		45,171		23,343	192,882	0	386,451	1,938,005	2,324,456	2,131,574
22	19		124,369		45,171		23,343	192,882	0	392,071	2,034,905	2,426,976	2,234,094
23	20		124,369		45,171	251,472	25,858	446,870	0	397,691	2,136,650	2,534,341	2,087,471
24	21		124,369		45,171		25,858	195,397	0	403,310	2,243,483	2,646,793	2,451,396
25	22		124,369		45,171		25,858	195,397	0	408,930	2,355,657	2,764,587	2,569,190
26	23		124,369		45,171		25,858	195,397	0	414,550	2,473,440	2,887,989	2,692,592
27	24		124,369		45,171		25,858	195,397	0	420,169	2,597,112	3,017,281	2,821,884
28	25		124,369		45,171		25,858	195,397	0	425,789	2,726,967	3,152,756	2,957,359
TOTAL		12,436,875	3,109,219	2,258,545	1,129,273	2,585,753	530,761	22,050,426	0	8,958,832	40,355,412	49,314,244	
Present value		10,221,496	1,128,900	1,856,231	410,018	2,160,906	172,695	**14,706,225**	0	3,021,100	11,625,449	**14,646,550**	
											B/C	**1.00**	
											NPV	**-3,702,056**	

5.4.3 Summary of the CBA results

The results of the Preliminary Cost Benefit analysis are summarized in Table 5.4-11 below. Apart from Kavurungu site, the net present value of benefits accrued over the project lives of all reservoir sites are higher than the net present value of costs. The viability of Kavurungu site is impacted by the existence of another reservoir only 4 km downstream from the proposed site which limits the irrigation command area. Kabuyanda site has the highest B/C ratio while those of Upper Ruvubu, Ruvironza, Akanyaru, and Kagitumba are also high

Table 5.4-11: Summary of CBA results

Site	Benefits (B)	Costs (C)	B/C
Kabuyanda	113,341,706	34,097,202	3.32
Kagitumba-Maziba	83,811,054	30,876,488	2.71
Muvumba	191,977,390	152,712,909	1.26
Akanyaru	456,734,294	160,569,412	2.84
R. Mbarara	17,628,015	14,508,272	1.22
Upper Ruvubu	243,073,941	106,020,524	2.29
Ruvironza	578,143,781	200,670,375	2.88
R. Gashayura	42,000,413	26,403,663	1.59
R. Kavuruga	14,646,550	14,706,225	1.00

The cost benefit analyses carried out at this stage are preliminary and based on the limited available data. More rigorous analysis should be carried out during feasibility studies for the respective sites, including sensitivity analysis to assess the impact of limited knowledge about some of the input variables.

6 Conclusions and recommendations

The study carried out Initial Environmental and Social Examinations, hydrology and engineering assessments for nine selected sites and consequently developed preliminary conceptual designs for the sites. Preliminary costs were also estimated together with detailed multi-criteria evaluation of the different proposed dam sub-projects to guide the selection of the best suited sub-projects to move to feasibility level.

6.1 Ranking of dam sub-projects

The following multi-criteria matrix was developed to guide evaluation and ranking of the different dam sub-projects:

(i) Reservoir Capacity
(ii) Water Storage/earth ratio,
(iii) Irrigation command area
(iv) Hydropower potential
(v) Water Supply
(vi) Cost of sub-projects
(vii) Environmental considerations

The ranking indicated that the Kanyaru subproject shared between Rwanda and Burundi should be given the highest priority among the nine dam sites while Kavuruga should be ranked the least. The Kavuruga site surprisingly has excellent environmental scores but registers poor scores in other areas, due in part by its close proximity to the Kayanza hydropower reservoir/dam complex 5 km downstream on the river.

6.2 Conclusions

The following conclusions arise from the study:

1. The proposal to develop multi-purpose dams seeks to ensure efficient and optimal use of water resources in light of changing environmental and social parameters;
2. Some of the sub-projects are on the same river separated by a distance of less than 20km. The Kagitumba and Muvumba can properly co-exist on the same river because the water use emphasis of each subproject is different. However, the situation is not clear with Mbarara and Upper Ruvubu sites which are separated by about 6 km only. Further hydrology modelling is necessary to investigate the suitability of the multiple sites to co-exist on the same river system
3. Seven of the nine proposed dam sites present no major negative impacts. However, attention is drawn to Kabuyanda site which is located inside Rwoho Central Forest Reserve at the same time, Rwoho CFR is one of the CDM sites being implemented in collaboration with the communities, therefore, details on implementation modalities for the project on this site need to be explored before it is confirmed as a candidate area.
4. The Ruvyironza reservoir would inundate a major highway and also flood lots of settlements. Hence it has considerable negative impacts despite its technical suitability of the site in terms of site geometry and available water resources.

5. It is evident that, the proposed multi-purpose dams will have a wide range of positive economic impacts to the immediate communities, partner states and their sectors;
6. The dams will go a long way to supplement sectoral efforts towards sustainable development and poverty eradication through improved household incomes and food security;
7. It is recognized that, the proposed dams will all be located on the River Kagera system which supports a large part of population in the region and are all multi-purpose in nature. Despite this, there are a number of potentially significant and unknown negative environmental and social impacts associated with the projects that need to be established and responsive mitigation measures instituted before undertaking to implement the projects; and
8. The study concludes that the significance of some predicted environmental impacts and uncertainties about the compatibility of multiple site developments on the same river systems demonstrate the need for a full Environmental Impact Assessment and feasibility studies.

6.3 Recommendations

1. The dam project will be multipurpose types serving water supply, electricity generation and irrigation and each of these has set of activities with their own impacts which will be in the same ecosystem. It is therefore noted that, there will be need to put in place multi-stakeholder committees to over-see implementation and general compliance of project works with environmental and social requirements as enshrined in the line polices and laws in partner states;
2. Additional studies and consultations need to be instituted with regard to appropriateness of Kabuyanda site since it inside a protected area (Rwoho CFR);
3. Staff gauges should be placed at the selected sites to start monitoring the discharge as soon as possible. The collected data will be used to augment the already existing data for those rivers that are gauged upstream of downstream. For the ungauged rivers such as Gashayura, early placement of the discharge station will prove very valuable in a few months' time when further downstream, studies commence.
4. Recognizing the importance of an accurate assessment of current sediment loads to the planning of reservoirs, it would be prudent to carry out observations of sediment concentration in the rivers at the proposed dam sites during at least one flood season.
5. The implementation of the nine sub-projects should take cognizance of lessons learned from other trans-boundary water resources management frameworks. These should include the need to have focused missions; the need for autonomy and impartiality; the need to have high level of political support; the need to focus on common crosscutting issues of immediate challenges; the need to avoid areas of conflict with governments; the need to have full stakeholder participation at all stages of project implementation; the need to build reliable funding mechanisms;

the need to build on existing institutions and the need to build transparent systems of sharing information, costs and benefits

References

District of Nyanza, Sector Statistics, June 2007. Organic Land law N0 08/2005 of 14/07/2005, article 6).

District State of Environment Report 2009, Isingiro District, Uganda

IGEBU, (2001) - Evolution climatique actuelle et développement des scénarios de changements climatiques à l'horizon 2050.

IPCC (1997) - Introduction aux modèles simples employés dans le deuxième rapport d'évaluation du GIEC . L.D.

Kabale District Development Plan 2008-2012, Kabale, Uganda.

District of Gisagara, Sectors Gtatistics, June 2007-Rwanda.

Lahmeyer International GmbH, (2010) Feasibility study for the rehabilitation of Maziba SHPP, Efficient and Sustainable Energy Supply in Uganda.

Lawrence, P., Cascio, L. A., Goldsmith P. & Abbott, C. L., 2004. Sedimentation in Small Dams: Development of a catchment characterization and sediment yield prediction procedure,' Report OD TN 120, HR Wallingford and Department for International Development (DIFD)

National Adaptation Programme of Action (NAPA) for Burundi (2006), Bujumbura-Burundi.

National Environment Management Policy, 1994, Ministry of Natural Resources, Kampala-Uganda

NFA (2006), ESIA for Rwoho CDM site, Kampala-Uganda.

Neitsch, S.L., J.G. Arnold, J.R. Kiniry, R. Srinivasan, and J.R. Williams. (2002). Soil and Water Assessment Tool User's Manual, Version 2000.

Nile Basin Initiative, (2010). "Development of Kagera Integrated River Basin Management and Development Strategy", Main Report, NBI/NELSAP/Kagera TIWRMDP/RFP01/2009

Nile Basin Initiative, (2010). "*Development of Kagera Integrated River Basin Management and Development Strategy",* Main Report, NBI/NELSAP/Kagera TIWRMDP/RFP01/2009.

Norconsult A.S. and Electrowatt. April 1976. Hydropower potentials of Burundi (including basins outside Kagera river basin) Kagera River Basin Development Phase II. Burundi – Rwanda – United Republic of Tanzania. Sectoral Studies. Technical Report, Volume 3. Report prepared for the United Nations acting as executing agency for UNDP

Ntale H. K. (2011) "Rapid identification and assessment of potential sites for multipurpose storage reservoirs", a report prepared for the Kagera River Basin Project.

Nyagatare Water Resources Assessment Project (2008) By M&E Associates in association with Real Contractors S.a.r.l on behalf of Government of Rwanda.

Republic of Burundi; Ministry for Land Management, Tourism and Environment. National Adaptation Plan of Action (NAPA) , Bujumbura-Burundi.January 2007.

The Constitution of the Republic of Uganda 1995, Kampala-Uganda

The EIA Regulations 1998, Kampala Uganda

The Employment Act, 2006, Kampala Uganda

The Land Act, Cap 227, Kampala Uganda

The National Environment Act Cap 153, Kampala-Uganda

The National Forestry and Tree Planting Act, 2003 Kampala Uganda

The National Gender Policy 1997, Ministry of Gender Labour and Social Development, Kampala Uganda

The National HIV/AIDS Policy, 2004 Kampala, Uganda

The National Water Policy 1999, Kampala Uganda

The Water Act, Cap 152 Kampala Uganda

The Workman's Compensation Act, 2000

United States Department of the Interior Bureau of Reclamation, "*Design of Small Dams",* A Water Resource Technical Publication, Third Edition,1987

USAID 2008: Land Dispute Management in Rwanda. Final Report United States Department of the Interior Bureau of Reclamation, "Design of Small Dams", A Water Resource Technical Publication, Third Edition,1987

Williams, J.R. (1975). Sediment-yield prediction with universal equation using runoff energy factor. p. 244-252. In Present and prospective technology for predicting sediment yield and sources: Proceedings of the sediment yield workshop, USDA Sedimentation Lab., Oxford, MS, November 28- 30, 1972. ARS-S-40

Wischmeier W. H., and Smith D., 1965. Predicting Rainfall Erosion East of the Rocky Mountains", US Department of Agriculture Handbook No. 282.

WMO, (2003). Operational Hydrology Report No. 4, Manual on Sediment Management and Measurement, WMO-No. 948. Secretariat of the World Meteorological Organization, Geneva, Switzerland.Lawrence, P., Cascio, L. A., Goldsmith P. & Abbott, C. L., 2004. Sedimentation in Small Dams: Development of a catchment characterization and sediment yield prediction procedure,' Report OD TN 120, HR Wallingford and Department for International Development (DIFD)

Annex 1: Summary of the consultative meetings held for the entire 9 dam sites

Note: The summary captures all consultations for all the sites visited in the study i.e. those in Rwanda, Burundi and Uganda

No.	Name of Stakeholders	Organization	Designation	Issues Raised
Rwanda Consultations				
01.	Ms. Gertrude Ngabirano	NELSAP/Kagera River Basin Management	Regional Project Manager	○ It is important the consultant critically assess appropriateness of the sites to enable early decisions are taken on the projects from informed technical perspectives; ○ Ensure the study is consultative at all levels i.e. at national and grass root levels to ensure ownership of the projects; and ○ At all stages of the study the client should be kept informed so that time is not lost over delays that could be avoided if information flow was well managed.
02.	Mr. Godfrey Sengendo	NELSAP/Kagera River Basin Management	Assistant Regional Project Manager Water Resources	○ The study should be exhaustively consultative especially with government line agencies to ensure they own up the projects right from their initial stages; ○ The study to establish consistency of the projects with the national sectoral development plans; and ○ The reports be produced on time to enable the secretariat circulate them for regional stakeholder input.
03.	Ms. Francoise Kayigamba	NELSAP	Environmental Specialist	○ The study should explore land ownership issues for the project especially regarding marshlands. In Rwanda, the land belongs to government while in Burundi land is owned by the people. This is important when it comes to the usage of marshlands (compensation may be an issue and how will it be handled in the project?); ○ These are multi-purpose dams and therefore, potential issues of water use conflicts are likely to arise, these concerns should be built into the ToRs for subsequent detailed ESIA investigations; ○ How will agro-chemicals concerns be managed especially where there will be water supply components? May be water supply components could be revisited in view of potential high operational costs relating to water supply processes in case of pollution from agro-chemicals; ○ The study in the end should propose sustainability mechanisms for the investments. There should be a good exit strategy which allows locals to take over and continue to

				run the dams. The key question is, who actually owns the dams at the end of the project especially the irrigation dams once they are built? o The ESIA should explicitly propose **FEASIBLE** measures for watershed management to avoid siltation of the dams which impacts on the efficiency of the dams.
04.	Ms. Mwikali Wambua	NELSAP	Social Development Specialist	o There are a number of development projects planned for R. Kagera and the designs for most of these are variable leave alone their purpose. These will likely have impacts on the R. Kagera hydrological regimes and in a way affect the livelihoods of the communities who largely depend on this river for marshland cultivation; o There is need to harmonize the developments on the Kagera so as not to cause conflict over water and land; and o Sometimes sector Ministries in Partner countries need to harmonize their development plans on Kagera so that, planned interventions are coherent with the needs in the communities; and o In all the ESIA should very well capture social dynamics relating to the planned developments on this river basin under the Programe.
05.	Mr. Remy Nobert Duhuze	Rwanda Environment Management Authority (REMA)	Director, Environmental Regulation and Pollution Control	o The idea of multi-purpose dams on rivers is technically sound as it minimizes the possible number of dams across rivers for independent needs which in the end multiplies adverse environmental and social impacts; o The dams should be developed based on accurate hydrological data to avoid having malfunctioning facilities developed which tends to be based on insufficient scientific, environmental and social data; o The ESIA should come up measures to compensate for inundated crop areas due to the height of the reservoirs. Such a zone taken up by the water height should not be regarded as a normal buffer zone; o During the development of the dams, the people should be kept informed on the

				projects timelines. There have been some instances where farmers have been stopped from cultivation to allow for dam construction and yet in the end the project does not take off and this makes people vulnerable to famine due to poor project planning; ○ Measures for ensuring water quality is maintained be put in place measures especially where there will irrigation, water supply and fish farming. Concerns of water pollution from agro-chemicals and fish activities tend to characterize such multi-purpose dams; ○ Modalities for equitable water usage to be set out early in the projects to avoid future conflicts amongst the water users (irrigation, water supply, fish farming and power generation); ○ The operators of the dams especially with regard to releasing of water should be based on the needs of the users and the water levels. The practice of simply keeping water gates open without bearing in mind the needs of the beneficiaries does not serve the purpose of the dams which is to improve production and livelihoods; ○ The dams will be located in valleys which are prone to siltation. Therefore, the study should propose wider watershed management measures around the dams to ensure soil erosion is minimized thereby protecting the dams; and ○ Irrigation canals are sometimes damaged by livestock during their watering process. It is important that, livestock watering points are designated early and accordingly designed in the project for such purposes.
05.	Ms. Jacqueline Nyirakamana	Ministry of Natural Resources-MINIRENA, Kigali-RWANDA	National Liaison Officer	○ The study should ensure relevant line agencies are consulted and their in-put integrated into the project development; and ○ There is need for the team to make contacts with the agencies responsible for irrigation and hydro power development.
06.	Mr. Barinda Pierre	Kabuga/Mutara	Village Farmer	○ The project will help improve water supply for irrigation and electricity will be within reach in the communities.
07.	Mr. Joseph Nsabirimana (mjosephkhan@gmail.com)	Kirehe Community Based Watershed Management Project (KWAMP)-Gatore District	Water Management Officer	○ The planned re-development of Kagogo at Cyunuzi marshland should be directed by the Ministry of Agriculture especially the Directorate of irrigation.
08.	Eng. Jean Claude	Ministry of Agriculture	Irrigation Engineer	○ First and foremost, the construction of the dams should be based on field data taking into considerations historical considerations in the areas (hydrology and rainfall

	Musabyimana	and Livestock (MINAGRI)		patterns); ○ Once the sites are confirmed then monitoring stations should be established for purposes of collecting necessary data for the projects development; ○ Where there are plans to serve water supply needs, such schemes should have water treatment components in line with the GoR which prohibit supply of untreated and unsafe water; ○ On the side of Ministry, NELSAP planned interventions are consistent with GoR especially MINAGRI mandate and priority programmes; ○ The planned development of a multi-purpose dam at Kagitumba/Maziba site should of necessity take into considerations the fact that, those are water stressed areas and therefore the river systems are major sources for domestic, livestock and agricultural needs; ○ The catchment for the river is large and during the rainy season, there are problems of floods in the area. The planned construction of the multi-purpose dam would help address issues of floods during rainy seasons; ○ There are a number of on-going and planned irrigation and water supply projects on the Mivumba river system and it is important that the planned project understands where such infrastructures are located and their water needs for sustainability of the planned dam; ○ The river banks are lined with a strips of an *Acaccia* sp and these strips are important for water conservation in the river. The planned development should take measures to conserve the *Acaccia* trees; ○ It also important to note that, the same river system supports the Akagera National Park south of the river; ○ On reconstruction/remodeling of Kagogo dam, this is not feasible on grounds that, it is a recently launched investment which already supports the population in terms of domestic water supply and irrigation needs and cannot be simply re-modified; ○ In addition, the current design of Kagogo dam is for a small dam (7m dam) and this implies, re-modifying it to 25m high dam will imply rebuilding the facility afresh to accommodate the planned capacity of 39.5Mm^3 which will be costly socially and financially and will not be acceptable to GoR ; ○ MINAGRI will be will willing to propose potential alternate sites than rebuilding Kagogo

				dam; ○ The study should outline some dam safety measures in view of potential risks associated with such facilities; and ○ On Akanyaru dam site, the project should take into consideration the requirements and specifications for large dams for Rwanda and Burundi.
09.	Eng. Vincent Ndererimana	Energy Water and Sanitation Authority (EWASA)/Ministry of Infrastructure (MINIFRA)-KIGALI	Civil Engineer	○ The planned NELSAP multi-purpose dams especially for power generation will provide addition power to the national electricity grid of GoR and also electrification of rural areas; and ○ The EWASA Unit will reconfirm the exact locations of the planned dams to establish the consistency of the project with the national electricity plans for such areas.
10.	Mr. Jean de Dieu Karara	Rwanda Development Board (RDB)	Environmental Analyst, Investment Implementation Unit	○ The dam effects of inundating the lands will trigger compensation for crops and peoples assets; ○ ESIA needs to address the potential risks of dam collapse. Other risks the ESIA should bring out clearly relate to risks to the population and livestock; ○ The multi-purpose dams need to address potential conflicts relating to a multiplicity of users (water supply, irrigation/farming and power generation). All these need to be balanced to avoid conflicts in use and management of the ecosystems e.g. use of agro-chemicals in the fields and safe water supply for human/domestic usage; ○ Measures to ensure management of silt so as to maintain dam efficiency; and ○ Understanding of river biodiversity and associated physic-chemical properties is important in providing data for monitoring the project compliance during its implementation.
11.	Murenzi Samuel	Nyagatare District	District Environment Officer, Nyagatare District	○ The need to plan the developments to ensure sustainable usage of waters in R. Muvumba
Burundi Consultations				
01.	Eng. Epimaque Nurengerantwari	Ministry of Water, Environment, Land and Urban	Permanent Secretary	○ Ensure there is coordination with other Partner States on all the developments on the Kagera Basin so that, Burundi which is an upstream country is not impacted by the flooding due to the dams.

		Development		
02.	Celestine Karikurubu	Ministry of Water, Environment, Land and Urban Development	National Liaison Officer/Kagera Basin Development	○ Such projects need to consult sectors and the communities who are using such sites to avoid conflicts with communities; and ○ The project needs to harmonize its plans with similar and related projects being planned for the Kagera Basin under different study components.
03.	Mr. Nsabinana Salvator	Ministry of Water, Environment, Land and Urban Development	Director, Environmental Department	○ The study should ensure the ToRs for detailed ESIA are responsive to issues in the project capturing concerns of the communities in the project areas; ○ Measures to reduce impacts on the communities using the marshlands should be minimized if not, the project increases peoples vulnerability even after the project.
04.	Desire Nsabiyumva	REGIDESO	Director for Electricity	○ There is an ongoing World Bank sponsored study for 10 sites on R. Ruvubu and it is trying to compare their potential for power generation. It is important that, harmony is developed with such study so as not to cause conflicts in projects and, water issues in the region and more so in Kagera River system.
05.	Mr. Emile Bakizuruwuraye	Ngozi Governor Advisor	Advisor, Water ways and Forests	○ The study process should link with provisional and district agencies so that, the projects are consistent with priorities and acceptable from their start.
06.	Mr. Lazore Nsaguye	Ngozi Province	Provincial Rural Water Planner	○ Need to confirm the sites and see how they need are to address the needs of the target communities.
Uganda Consultations				
01.	Paul Buyera	Director, Corporate Affairs	National Forestry Authority	○ Details of the project should be availed to National Forestry Authority so that, the Authority will be in a better position to know the extent of the project and its implication on the Clean Development Mechanism (CDM) site in Rwoho Central Forest Reserve.
02.	Mr. Byarugaba Ignatius	Local Council V	Isingiro Local Government Administration	○ Make people aware of the project before implementation to avoid unnecessary anxiety and poor relation between the project and the communities.
03.	Mr. Gumisiriza Aloysius	Sub-county Chief	Kabuyanda S/County	○ The project should have enough planning period so that, communities get well mobilized to be part of the project.
04.	Mr. Niwamanya Boaz	Assistant Engineering Officer	Isingiro Local Government	○ The ESIA should look more on multi-purpose uses of the planned dam project because the District is water stressed.

			Administration	
05.	Mr. Mwesigwa Joseph	District Environment Officer	Isingiro Local Government Administration	○ Need to consult exhaustively on matters of land uptake to avoid community wrangles over land.
06.	Mr. Bagambe John	District Natural Resources Officer	Isingiro Local Government Administration	○ Issues of land ownership during resettlement process; ○ The ESIA should be careful to critically look at the issues of ethnicity in the project area. There can be complaints that, some group is favoured more than others in terms of payments of compensations packages; ○ Issues of water use conflicts due to multiple uses (irrigation vs power generation); ○ Conflicts over resources between migrant workers then and the resident communities; and ○ Watershed considerations during the ESIA rather than focus on the dam site alone.

Annex 2: Draft ToRs for the Feasibility Study of the proposed 9 multi-purpose dam sites

1.0 INTRODUCTION

1.1 Background

The Kagera River Basin Management Project is one of the three trans-boundary river basin management projects implemented under the framework of the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) of the Nile Basin Initiative (NBI), the others being the Mara and Sio-Malaba-Malakisi river basin management projects. The objective of the Kagera RBM project is to establish a sustainable framework for the joint management of the water resources of the Kagera river basin and prepare for sustainable development oriented investments, in order to improve the living conditions of the people and to protect the environment.

The Kagera River Basin lies west and southwest of Lake Victoria in the equatorial zone of Africa between the latitudes of 0°45' and 3°55' South and longitudes of 29°15' and 30°50' east. It has a total area of about 59,800 km^2 which is distributed among Burundi (22%), Rwanda (33%), Tanzania (35%) and Uganda (10%). Most of the basin lies between elevation 1,200 and 1,600 m.a.s.l. and consists largely of woody and grassland savanna. The mountainous areas in the west and northwest, which mark the Nile-Congo Divide, rise to altitudes of more than 2,500m.a.s.l.

The Kagera River rises in the western highlands of Burundi and Rwanda. Its main tributaries are the Ruvuvu River, which drains an area of about 12,300 km^2 in central and northern Burundi, and the Nyabarongo River, which drains about 16,000 km^2 in west central and eastern Rwanda. The Nyabarongo discharges into Lake Rugwero in southeastern Rwanda on the border with Burundi. Below Lake Rweru the river is known as the Kagera, and it marks the southern border of Rwanda with Burundi and Tanzania to the confluence of the Ruvuvu. At the border of Uganda and Tanzania, Kagera River is joined on the left bank by the Kagitumba River, which drains 5,200 km^2 of northeastern Rwanda and Southern Uganda. The main tributaries in the lower reach are the Mwisa and Ngono Rivers, which drain 2,000 km^2 and 3,200 km^2 respectively of the Kagera Region in Tanzania on the right bank of the Kagera river.

1.2 Rationale for the Consultancy Services

The Kagera basin is characterized by low-productive peasant agriculture, endemic poverty, extensive land degradation caused by population pressure and deforestation, and increasing water scarcity. Water scarcity and growing food insufficiency are some of the major issues facing the Kagera river basin and the situation is expected to get worse as the population increases and as demand by the different water use sectors out-matches the existing supply and is exacerbated by the imminent effects of climate change. A multipurpose water resources development project with a focus on storage for energy, irrigation and other uses is thus conceived to address issues related to water, food and energy security within the basin. Some potential dam sites have been identified in earlier rapid identification studies and their suitability shall be further investigated by the individual

consultant. The Consultant shall be required to make detailed appraisal of 9 large[2] dam sites, and subsequently prepare preliminary designs and cost estimates.

1.3 Description of the study site(s)

A description of the selected study sites would follow

2 STUDY OBJECTIVE

2.1 Overall Objective

The study objective is to undertake feasibility study for nine dams for multipurpose storage at Kabuyanda, Kagitumba in Uganda; Muvumba in Rwanda; Akanyaru shared by Rwanda and Burundi; as well as Mbarara, Upper Ruvubu, Ruvyironza, Gashayura and Kavuruga in Burundi.

(The above statement would be edited if some of the dams are omitted from the study)

2.2 Specific Objectives

The consultancy will have the following specific objectives:

- To review various reports including but not limited to Pre-feasibility Study Report, Rapid Assessment Report on multi-purpose water storage reservoirs development.
- Carry out investigations, which include topographical, hydrological surveys and geotechnical investigations
- To undertake feasibility study
- Undertake Preliminary Environmental and Social Analyses, which should comply with the international standards and environmental and social requirements (REMA, NEMA, Uganda, Rwanda and Burundi) and the World Banks safeguards policies.

3 DETAILED SCOPE OF SERVICES

Task 3-1 *Review of Existing Documentation and Field Reconnaissance*

The Consultant will review available reports and documents from previous studies. These will include but not necessarily be limited to the reports and documentation described in the section 6. The Consultant will carry out necessary field reconnaissance to the project areas and to relevant affected downstream areas in order to familiarise themselves with the project and the specific issues involved. All relevant basic information for the projects will be compiled and new data prepared, to deepen the information whenever necessary and possible. This encompasses amongst others the following:

- Electricity system – Update of data on electricity systems, supply and demand in the sub region
- Topography - Preparation of additional topographical maps and information, which are needed for feasibility studies.

[2] Large dams, as defined by the World Bank Environmental and Social Safeguards OP 4.37

- Hydrology - Processing of raw hydrological stage gauge data to produce discharge data of the gauging stations.
- Sediments – Observations of sediment concentrations and calculation of sediment discharge ratings and estimated sediment loads.
- Geology - Review of geological information and preparation and supervision of a program of field investigations for the project sites.
- Irrigation – review of available information/reports on irrigation

Task 3-2 *Surveys*

3-2-1 Socio-economic surveys

The consultant will survey the potential water uses to be served by the project in order to determine the magnitude of each demand and the seasonal and long-term variations in the demand schedule; assess the relative uses in terms of communities' social and economic conditions, livelihoods, and relative value for each use in the area; develop a relative priority for each purpose – irrigation water supply, domestic water, power supply, etc and determine the levels of service and required priority that will be necessary to serve each purpose establish the total power, water supply, and low-flow regulation requirements for competitive purposes during each season of the year and the seasonal variation of the storage requirement to satisfy these needs. In undertaking the socio-economic surveys, the consultant will make use of the initial social and economic findings results in the design of the survey based on the pre-feasibility study report for multipurpose storage reservoirs, as well as feasibility studies for irrigation development, being undertaken by the governments of Uganda and Kenya, within the reservoir project areas, as well as other relevant reports regarding future water demands to catchment management strategies etc. The demands for each of the purposes should be computed at intervals of 10-daily/monthly.

3-2-2 Topographical Investigations

The consultant will undertake topographical surveys commensurate with feasibility level studies for multipurpose storage reservoirs. The surveys will be carried out to establish dam alignment , extent of reservoir area, spillway and stilling basins, river channel profile, downstream surveys related to locations of hydraulic structures like bottom outlets, penstocks etc. The survey will also capture and geo-reference, existing and proposed infrastructure within the proposed project area, trees and vegetation, rock outcrops, borrow areas, trial pit locations, access roads, site camps etc. The following specific activities will be undertaken:

- Preparation of topographic maps of (i) the dam sites, at a scale of not more that 1:500 and with contour intervals of not more than 0.5 m, showing all of the features upstream, downstream, left and right of the proposed sites, and including the locations of observation and test pits and holes, and (ii) the projected reservoir area, at an appropriate scale and with contour intervals of 1 m, covering the area up to an elevation of maximum expected water level plus 6 m. Adequate numbers of control points should be tied into the national coordinate systems, located on the topographic maps, and fully detailed in tabular form.

- Topographic survey of dam sites cross sections at appropriate intervals, and preparation of corresponding longitudinal and cross-sectional profile drawings at both vertical and horizontal scales of 1:100 showing also all pertinent site features.
- The consultant will also consider the use of aerial photography as necessary to capture details related to the reservoirs at various spatial extents.

3-2-3 Geotechnical and geological investigations

The consultant will conduct geotechnical investigations commensurate with feasibility level studies primarily to determine suitability of the foundation and abutments (at the selected dam site areas including power house location), required foundation treatment, excavation slopes, reservoir rims and bottom stability (for water holding capacity and side slopes stability during filling and sudden drawdown, seismic shocks etc) and availability, characteristics and suitability of construction materials (through in-situ and laboratory tests) to aid in dam design. The work shall be directed towards determining all relevant parameters, e. g., thickness of alluvial deposits in the river bed; occurrence and nature of joint sets; extension of weathering zones; permeability of the rocks and reservoir tightness; nature of contact zones of geological strata; slide risks at steep valley sections; groundwater level effects due to additional loads and pressures; geomorphology of areas within acceptable transport distances from where to draw construction materials." It is also necessary to clarify the geological and geotechnical conditions at the selected dam site and powerhouse area. The investigations shall include the following work:

- Establishment of the bedrock conditions between the river banks by means of boreholes, and seismic profiling to confirm the geometry and characteristics of the deposits underlying the abutments, and to assess the jointing pattern and the opening of discontinuities; determination of the bedrock conditions at all structures, appraisal of its geotechnical characteristics; exploration of the overall geometry of the bedrock in the riverbed by borehole drillings and seismic profiling;
- Assessment of the seismic risk at the Project site, including the determination of earthquake-induced stresses, accelerations, and forces to be taken into account for dam safety and other design work;
- Investigation of possibilities for a grout curtain configuration and drainage at the dam foundation;
- Definition of quarry areas for construction materials (including the identification and avoidance of environmental impacts due to borrowing); local potential for concrete aggregates shall be ascertained. Furthermore, investigations shall be carried out to ascertain the properties of available materials for construction, including whether part of the pozzolana and natural cement needed for construction of roller compacted concrete dams could be covered by materials found close to the project sites."
- Establishment of the dynamic loads through regional-areal geologic history, events, features with regard to properties of rocks and the imposed loads from the proposed project.
- Preparation of special site maps with emphasis on stratigraphy, geologic /geomorphologic Features, at a scale of 1:10,000. The work shall be directed towards determining all relevant parameters for preliminary design.

A report will be prepared covering the approach to field Investigations, tasks carried out, constraints and conclusions and recommendations from the investigations.

Task 3-3 Multi-Purpose reservoir studies

3-3-1 Hydrological analyses

The consultant shall undertake hydrological analyses such as rainfall-runoff and sediment modelling to estimate inflows, reservoir and sediment yields at the proposed dam sites as well as storage yield relationships. Specific Hydrological Analyses should include for each dam site:

- Updating hydrological analyses and completing the data sets for the base period up to the end of 2010.
- Constructing inflow data sets for both projects with 10-day/monthly time step.
- Estimation of reservoir evaporation rates (monthly/10-day period) considering recent information.
- Estimates of sediment transport at relevant hydrometric stations. The consultant will also predict the sediment inflow into the proposed reservoirs (based on local geological formation information and sediment measurements from hydrometric stations upstream of the reservoirs);
- Preparation of flood studies, considering past and recent information, climatic conditions surrounding extreme events, flood durations and accumulated volumes, and multiple/ successive flood events on the rivers. The analyses should establish the inflow design floods to facilitate the sizing of hydraulic structures.
- Determination of flow duration curves to facilitate more reliable hydraulic design of the dam and reservoir components such as spillways, bottom outlet structures turbines, tail race canals, penstock, etc.
- The consultant will also assess the impacts of climate change on the hydrological characteristics.
- Establishment of area capacity curves based on sedimentation say at half life (50 years) of reservoir life as well as possible dead storage levels.

A report will be prepared outlining field activities, methods of analysis, and site specific catchment models. All data will be stored as shapefiles /arcinfo format.

3-3-2 Reservoir studies

The consultant will develop a reservoir simulation model (consultant should define the proposed numerical model they intend to use). The model shall be such that different combinations of multipurpose uses and project scenarios can be studied in order to arrive at the optimum solution, and to calculate the benefits in the economic analysis for the two projects. Input to the numerical model shall include key project parameters from downstream multipurpose uses (both existing and planned). The following shall be taken into consideration in the numerical model and in the multipurpose use of the water: Flood control, irrigation, i.e. from the reservoirs created or downstream fisheries/aqua-culture; siltation downstream; water conservation effect; potential for drought mitigation and climate variability effects. The analyses will include information on the magnitude and seasonal variations of each demand, long-term changes in demands, relative priority of each use, and shortage tolerances. The results should determine the consequences of various priorities to potential water uses. The consultant will then investigate possible operation rules and objectives for the different water uses per site. For each reservoir, the simulation

shall include as inputs, hydrological time series, storage for flood control and projected abstractions for irrigation, municipal water supply, and environmental flows. The simulation will optimize reservoir releases for the different water uses as well as sensitivity analyses to evaluate the impact of consumptive and non consumptive use.

Task 3-3 Preliminary Design

Based on the above analyses, and investigations, the consultant shall carry out preliminary designs for the two dams. Major features of design to be considered include: foundation treatment, abutment stability, seepage conditions, stability of slopes adjacent to control structure approach channels and stilling basins, stability of reservoir slopes, and ability of the reservoir to retain the water stored. These features should be studied with reference to field conditions and to various alternatives. The consultant shall recommend the best dam type considering size and other conditions. Specifically, the Consultant shall prepare preliminary designs, drawings, quantities and specifications, to internationally recognized standards but also in conformity with local norms and standards where these are compatible, covering

- Hydraulic and geotechnical design of coffer dams for river diversion and site protection
- Hydraulic, geotechnical and structural designs for the dams, including intakes, bottom outlets, taking into account the geological and geotechnical investigation findings,
- Hydraulic and structural design for the spillways, energy dissipation, downstream channel protection structures, and of downstream flow stabilization and channel protection structures
- Design and specifications of dam measuring and monitoring equipment and instrumentation,
- Design of access road and corresponding drainage control systems
- Layout and project components which should be carried out based on field investigation and reservoir operations studies Drawings for the main structures shall be elaborated such that they can readily be converted into tender drawings at the detailed design phase. The layouts, designs and drawings shall include, but will not be limited to : (a) regulation works, (b) intake and waterways, (c) power stations, (d) transmission works, (e) irrigation network, (flood control measures etc.; (f) construction planning and scheduling; and (g) construction cost estimates.
- Estimation of quantities and unit rates according to the CESSM 3
- Estimation of dam and reservoir implementation support and annual O & M, requirements and inputs.
- Estimation of costs by year for implementation, operation and maintenance s.
- Finalization of dam and reservoir preliminary designs and cost estimates following agreement and approval of the feasibility-level development details.

Task 3-4 Environmental and Social Studies

The consultant will undertake a preliminary environmental and social analysis to ensure that the project contributes to sustainable ecosystem management, and if potential negative impacts on the ecosystems and communities are identified, explore possible mitigation measures to avoid, or reduce, adverse impacts. The consultant is to make a

preliminary identification of potential environmental and social impacts with particular attention given to potential impacts for which changes in location, size, design, or construction technique would be the mitigation measures, so that recommendations could be passed to the team members working on the engineering aspects for incorporation in the project design. The consultant will also examine alternatives within the project such as changes in dam location, dam height, reservoir size, access road alignment, etc and make a comparison of such alternatives, in technical, economic, social and environmental terms. The assessments will be guided by the NELSAP preliminary Environmental and Social Management Framework, national environmental legislation as well as World Bank environmental and social safeguards. The social analysis will include assessment of socio-economic information including population, land tenure, use and rules of access affecting existing livelihoods. It will also identify groups within the project areas/basin who will benefit from and/or use the proposed works, and groups who may be adversely affected. The studies will identify the cultural attachments to land and resources, and any archaeological and historical significance of the identified sites. A preliminary environmental and social analysis (including a resettlement policy framework (RPF) report will be prepared to inform the feasibility studies and preliminary designs. *Independent and detailed environmental and social analysis studies and (RAP) will be undertaken in parallel to this study (by another consultant) and will inform the detailed design stage of the projects.*

Task 3-5 Institutional analysis

The consultancy is being undertaken within a framework of Kagera Transboundary Water Resources management project, under the Nile Equatorial Lakes Subsidiary Action Program. The consultant shall thus undertake an institutional analysis which will aid in the definition of a suitable institutional setup and arrangements for project implementation including mechanisms to implement nationally while maintaining a transboundary dimension. The institutional analysis will define the linkages with the current institutional set-up of the transboundary management of water resources of the basin.

Task 3-6 Economic and Financial Analysis.

The Consultant shall carry out financial analyses of the projects and the project entity. The consultant shall analyze the economic viability of the projects taking into account the various costs (including costs of the environmental management/mitigation measures and resettlement) and tangible benefits identified and costed. The cost of construction management shall also be included in the estimate as separate items. Appropriate contingencies will be applied to take account of factors which cannot be adequately defined at the feasibility phase. The analysis will involve establishment of an economic rationale for the projects; forecasting effective demand for project outputs; choosing the least-cost design for meeting demand or the most cost-effective way of attaining the project objectives; assessing the sustainability of the project's net benefits throughout the life of the project; testing for risks associated with the project; identifying the distributional effects of the project, particularly on the poor; undertaking a sensitivity analysis (to check impact of important parameters on the economic viability) for the two project sites and enumerating the non-quantifiable effects of the project that may influence detailed design and the investment decision. *Indicators such as Net Present Value, Benefit Cost ratio and Economic Internal Rate of return shall be calculated.*

4 EXPECTED OUTPUTS

The principle outputs will be a feasibility study report with the following outputs as annexure: (i) Field Investigations report (ii) Institutional Analysis report, (iii) Preliminary designs, (iv) Annex on Analysis of Alternatives, (v) Financial and Economic Analysis Report (vi) Environmental and Social analysis report for the project area (vii) Implementation plan.

5 REPORTS AND SCHEDULE OF DELIVERIES

The Consultant will report to the Project Manager, Kagera Water Resources River Basin Project who will be responsible for approving the outputs. The Consultant shall prepare and submit the following reports and documents, in English, in an approved format to the Client. Save for the interim progress reports, the Consultant will initially submit two copies of draft reports for comments by the Client. The comments of the Client shall be incorporated in the final version of the reports. Ten (10) hard copies and two (2) soft copies on CD of each of the final reports/documents listed below shall be sent to the Client. The Consultant shall submit the following reports:

5.1.1 Inception report (Month 2)

The inception report including a quality assurance plan shall be submitted within two months of commencement of the assignment for comments and approval. The report shall outline the Consultant's mobilization, the work plan, strategy, methodology and timetable for the services. The quality assurance plan shall include the following (i) A quality policy statement setting out the objectives of the plan and (ii) The personnel who will implement the plan, their responsibilities and authority.

5.1.2 Interim Report (Month 8)

This report shall comprise an interim progress reports, with thematic reports as annexure (Topographical and aerial maps of project area, hydrological analysis report, geotechnical investigations report, economic analysis report and ESIA report).

5.1.3 Draft Feasibility Study Report (Month 12)

The Consultant shall prepare and submit within 12 months of commencement, a draft feasibility study report. The report shall comprise results of all technical, environmental and socio-economic investigations carried out in the 12 months and covering all the thematic areas for multipurpose water storage and uses, preliminary designs, Project Institutional arrangements and Environmental and social management plans.

5.1.4 Final Feasibility Study report (Month 14)

Following receipt of the Client's comments on the draft feasibility study reports, the Consultant shall prepare and submit the final Feasibility Study report for the Multipurpose Water Infrastructure Development project within 14 months of commencement, 2 months after receiving comments from the client on the draft reports. The report shall also include as annexure thematic reports, preliminary dam designs, Project Institutional setup and arrangements and Environmental and social management plans.

5.1.5 Monthly progress report 1st week of every month.

This report (1-2 pg maximum) comprising a narrative and bar charts or other graphic presentation, showing details of the Consultant's progress, changes in the assignment schedule, impediments and proposed remedies will be submitted on a monthly basis.

5.1.6 Workshops

Three workshops will be organized. The first will be conducted at the end of the inception phase. The second will be held to discuss the interim report stage. The third workshop will be organized after submission of the draft final report to discuss the report with stakeholders. The workshops will be facilitated by the Client. At each workshop, the consultants will make PowerPoint presentations and provide concise reports for discussion.

The detailed schedule for the required reporting is contained in Table 1 below.

Table 1: Reports and schedules of deliverables

ITEM	REPORT/DOCUMENT TITLE	CONTENT	NO. OF COPIES
A.1	Inception report: 2 months from commencement	Work plan, state of mobilization, perception on assignment, issues identified for Client's attention etc.	10 to the PMU
A.2	Interim Report at Month 8	This report shall comprise an interim progress reports, with thematic reports as annexure (Topographical and aerial maps of project area, geotechnical investigations report, economic analysis report and ESIA report).	10 to the PMU
A.3	Draft Feasibility Study Report 12 months from commencement	Draft report with a complete technical description of the recommended schemes, including justification, analysis, computation, drawings, figures and maps. Detailed reports on all subjects treated in the scope of the study, such as social and environmental impacts of the project.	10 to the PMU
A.4	Final Feasibility Study Report : 14 months from commencement	Report covering draft feasibility study for Multipurpose Water Infrastructure, dam including as annexure, preliminary designs, field Investigations, Institutional analysis, Environmental and social management plan.	10 to the PMU
A.5	Monthly progress reports	Narrative and bar charts showing details of the Consultant's progress and any changes in the assignment schedule, impediments and proposed remedies.	1 to the PMU Electronic

6 DATA, LOCAL SERVICES, PERSONNEL AND FACILITIES TO BE PROVIDED BY THE CLIENT

Data and documentation on hydrological, meteorological, water quality and other relevant aspects of the Kagera Watershed which the project may have will be availed to the consultant; however, the consultant has the ultimate responsibility for collecting the required data and documentation which cannot be made available by the project from official sources. The Client will provide to the Consultant Relevant documents for the assignment in both hard copy and soft.

Services to be provided to the Consultant:

- Liaison and assistance to obtain any other information and documents required from other government agencies both in Kenya and Uganda and which the Client considers essential for the proper conduct of the assignment;
- Assistance to obtain work permits for staff of the Consultant.
- Assistance in obtaining Customs and Tax Exemptions as detailed in Special Conditions of the Consultancy Agreement and General Conditions of Service.
- Arrange consultative meetings and linkage with relevant regional authorities.
- Organizing workshops, workshop venues and allowances for participants excluding the consultant's team

7 PROJECT ORGANIZATION/ INSTITUTIONAL ARRANGEMENTS

The Consultant will be directly supervised by the Kagera Water Resources Project PMU on behalf of the Nile Basin Initiative/NELSAP. Results from the study will be regularly communicated to the funding agencies (World Bank) through the NELSAP CU. The client will hold discussions with the consultants at various stages in the consultancy to asses work progress, discuss challenges and constraints encountered and interventions with an aim of ensuring standard work is completed at the agreed time lines. At each stage the consultant will be expected to produce brief progress reports on the status of the work for the clients' records.

8 METHODOLOGY AND STANDARDS

The Consultant will be expected to employ the most effective methodology and standards to achieve results with optimum national stakeholder involvement. In addition the Consultant will be expected to: (i) Collect most data from review and analysis of existing secondary sources of information such as assessment reports and various other regional and global publications on the sub-sector (iii) Prepare clear, concise and focused reports and (iv) Ensure reports and necessary documents are delivered in time and as per the agreement.

9 CONSULTANT EXPERIENCE AND PERSONNEL REQUIREMENTS

The Consultant should demonstrate past experience in design and implementation of multipurpose water storage infrastructure for the last ten years. . Specialists in water resource planning & modeling, hydro power development, geotechnical,, hydraulic and irrigation engineering are a pre-requisite. Expert in Financial and Economic investment

appraising, social & environmental impact analysis are equally crucial. The qualifications of the Key experts are as follows:

Position	Competencies
Water Resources Planner – Team Leader.	The expert should have an Msc in Water Resources Engineering as well as extensive experience in water resources modeling and institutional analysis. The expert will have at least 15 years of relevant international experience in projects related to preparation and/or implementation of multipurpose water resources infrastructure development (dam design). He/She should have sound knowledge of and experience in water resources planning, water infrastructure design, as well as institutional analysis.
Hydraulic Engineer/Dam Engineer	The Expert should have a minimum of Msc in Hydraulic Engineering. He/she shall have a minimum of 10 years experience in design of hydraulic structures including dams and hydraulic modeling skills.
Irrigation Engineer.	The Expert shall have an Msc in Irrigation Engineering or any other relevant field. He/she shall have a minimum of 15 years experience in irrigation engineering development..
Hydrologist.	The Expert shall have a masters degree in water resources engineering/hydrology with proven experience in undertaking hydrological analyses for water infrastructure.
Surveyor/GIS expert	The Expert shall have a university degree in surveying with relevant postgraduate qualifications in remote sensing/GIS applications. He/she shall have a minimum of 10 years experience in remote sensing techniques and engineering surveys in similar assignments.
Geo Technical Engineering Expert.	The Expert shall be a professional engineer with a Masters Degree in Geotechnical engineering. He/she shall have a minimum of 15 years experience in the geotechnical engineering field, with proven experience in undertaking geotechnical investigation works.
Hydropower Engineer/Planner	The Expert shall have a minimum of Masters Degree in hydropower planning and development. He/she shall have a minimum of 15 years in the hydropower planning.
Social Development Expert	The Expert shall have a minimum of a Masters' degree qualification in Sociology, with 10 years relevant experience in economic planning and management development in the field of water sector. He/She will also be expected to have excellent social analysis skills.
Environmental Expert.	The Expert shall have an Msc in Environmental Sciences with a minimum of 10 years overall experience in environmental assessments of infrastructure projects.
Economist	The Expert shall have a Masters Degree in Economics, with a minimum of 15 years in project planning and economic analyses. The expert should also have excellent technical skills in economic

Position	Competencies
	and financial analysis of investment projects.

10 QUALITY MANAGEMENT REQUIREMENTS

The Consultant will be required to demonstrate in their proposal, evidence of adoption of use of a Quality Management System (ISO 9001 or equivalent) as well as to describe how quality control will be implemented in the course of the project.

11 SCOPE OF SERVICES, NATURE AND TIMING OF FUTURE/DOWNSTREAM WORK

Future downstream work will include detailed design and implementation supervision of physical infrastructure development projects expected to commence xx/xx/20xx subject to availability of financing. This will involve detailed design, costing and tender documentation, tendering and construction supervision works for the physical works. The outputs of this assignment will provide the basis for the detailed design and costing and mobilization of resources for implementation of identified interventions.

Annex 3: Draft ToRs for the ESIA study of the proposed 9 multi-purpose dam sites

1. **The Background, Introduction, Rational and Site description would be as in Annex 2: for the feasibility study.**

2. THE OBJECTIVES OF THE ESIA

The objectives of the ESIA will be:

a. To carry out an Environmental and Social Impact Assessment, to identify and assess the potential environmental and social impacts, and make recommendations for their mitigation;

b. to prepare an Environmental and Social Impact Analysis (ESIA) Report/Environmental Statement incorporating the full results of the environmental analysis;

c. to conduct consultations with relevant stakeholders, including potentially affected persons, to obtain their views and suggestions regarding the environmental and social impacts of the proposed rehabilitation activities. The outcome of the consultations will be reflected in the ESIA report and incorporated into the project design as appropriate. The results of the consultations will be made available to all relevant stakeholders, including potentially affected persons; and

d. To develop an Environmental and Social Management Plan (ESMP).

3. SCOPE OF THE ESIA

The ESIA will comprise of the following key activities:

a. Document environmental and social baseline conditions in the 8 potential project dam sites. This exercise should be conducted using standard scientific and social investigation protocols in order to provide adequate baseline data that will be used in monitoring of project activities during subsequent phases;

b. Establish water requirements by the communities for cultivation and livestock needs in the Kagera River basin riparian communities. In particular, the multi-purpose dams project need to address potential conflicts relating to a multiplicity of users (water supply, irrigation/farming and power generation). In view of these, there is need to establish threshold needs for the various water needs so as to strike a balance between the various needs;

c. As part of the study, the consultant will make arrangements for public consultations with the affected population and other relevant stakeholders. The outcome of these public consultations shall be recorded in the environmental analysis report. The results of these consultations will also be made accessible to the relevant stakeholders, including potentially affected persons;

1. Assess potential implications of climate change on the multi-purpose dam projects as well as their impacts on the climate;

2. Identify and Assess potential environmental and social impacts of other sectors on-going and planned project developments in both the upstream and downstream areas of the dams in the respective sites;
3. Provide measures for the management of agro-chemicals in view of the proposed multi-purpose nature of the dams to serve water supply, electricity generation and irrigations functions as well as possible fish farming that can be undertaken on some of the sites;
4. The ESIA study should explore land ownership issues for the project especially regarding marshlands. In Rwanda, the land belongs to government while in Burundi land is owned by the people. This is important when it comes to the usage of marshlands (compensation may be an issue and how will it be handled in the project;
5. ESIA needs to address the potential risks of dam collapse and propose risk reduction and management programs for the projects;
6. Identify and assess the environmental and social impacts arising from the proposed dam development projects and related activities during their construction and propose appropriate mitigation measures, including cost estimates and capacity building needs for effective implementation of such mitigation measures;
7. Review and discuss of the national environmental policy, legal and administrative frameworks, as well as environmental assessment requirements so as to establish compliance requirements during implementation of the projects. This should take into account the Conventions and Protocols to which respective national governments are signatories;
8. Review and discuss safeguard policies for development partners such as Sida, World Bank and AfDB amongst others and present recommendations on compliance regimes with such requirements;
9. Document any socio-cultural factors or constraints such as customs and beliefs in the project areas and put in place measures to reduce such impacts;
10. Establish the HIV/AIDS prevalence in the areas and its implications on the project;
11. Establish gender dimensions in the project with a view to assess the implications of the projects on the vulnerable groups in society such as women and related categories;
12. Assess impact of potential impact of population influx into the areas and the likely implications on service delivery as well as in the environment;
13. Impacts on landscape and visual amenity implications of the planned development;
14. Assess the implications of construction, operations, maintenance and closure of labour camps in the project areas;
15. Identify, Assess and Evaluate the different Alternatives (including a Zero Alternative) to the proposed dams projects and recommend least cost option taking into account ecological, social and economic considerations amongst others;
16. Propose appropriate monitoring indicators that can be followed-up during projects implementation;
17. Prepare an Environmental and Social Management Plan (ESMP) for the dam sites including cost estimates; and

18. Assessment of the institutional capacities in the line sectors responsible for Agriculture and/or power generation that are to take a lead in the implementation and monitoring of the environmental mitigation measures.

4. OUTPUTS

The outputs of this assignment will be:

Scoping Report

The consultant shall submit a Scoping Report two (2) months from the date of signing the contract.

Detailed ESIA Report

The consultant shall submit ESIA report for project shall include the following sections;

a. Cover page
b. Table of contents
c. List of acronyms
d. Executive Summary
e. Introduction
f. Description of the proposed project
g. Description of the area of influence and environmental baseline conditions
h. Discussion of policy, legal, regulatory, and administrative frameworks
i. Discussion of the World Bank, SIDA environmental safeguard policies likely to be triggered by the proposed project
j. Methods and techniques used in assessing and analyzing the environmental and social impacts of the proposed project
k. Discussion of the environmental and social impacts of the proposed project
l. Discussion of alternatives to the planned development investments
m. Discussion of the proposed mitigation measures
n. Presentation of consultations with relevant stakeholders and affected persons
o. Environmental and Social Management Plan (ESMP) for the proposed project
p. Monitoring indicators for the proposed project
q. Recommendations
r. List of individuals/institutions contacted
s. References

5. DURATION OF THE ASSIGNMENT

The estimated duration of this assignment is estimated to be 8 man months. The Client as well as financing institutions shall review and comment on the submitted ESIA report within

one month from the date of report receipt and thereafter the consultant shall incorporate the clients comments before submitting the final ESIA reports.

The final ESIA report shall be submitted in ten (10) hard copies and one (1) soft copy on a CDROM. The final ESIA report shall be disclosed in the respective partner states Environment Management agencies as well as that of financing institutions Infoshops in line with their respective environmental legal requirements.

6. CLIENT'S INPUTS TO THE ESIA

(a) The Client shall designate an officer to take oversee for supervision of the ESIA process and he/she shall be empowered to take all day-to-day decisions required for the implementation of the ESIA. The officer designated shall co-ordinate all the activities connected with the ESIA and shall be the main link between the consultant and the client; and

(b) The Client will provide the Consultant with all available reports relating to the study.

7. PERSONNEL

Consultant shall provide all personnel necessary for the completion of the Study. The following key personnel shall be included as a minimum requirement for the consultant's personnel:

No.	Expert	Expert Specifications
01.	EIA Specialist/ Team Leader	At least postgraduate degree in environmental sciences or MSc. Environmental Engineering with 7 years experience in Environmental Impact Assessment for development projects. Experience in ESIA for infrastructure projects will be an added advantage.
02.	Sociologist	Be a holder of at least an M.A. degree in Social Sciences or Development Studies with a minimum of 5 years of relevant experience in conducting ESIA.
03.	Hydrologist	He/she must have at least an MSc. degree in Hydrology or in Water Resources with at least 5 years experience in ESIAs.
04.	Natural Resource Management Specialist	MSc. degree in ecological sciences or Forestry with 5 years relevant experience.
05.	Irrigation Engineer	Must he a holder of MSc. degree in Irrigation Engineering with 5 years relevant experience in ESIA work.
06.	Power Engineer	The Power Engineer must be a holder of a BSc. in power engineering plus, postgraduate training in EIA. He/she must have at least 5 years experience in conducting ESIAs for development projects.
07.	Environmental Economist	Environmental Economist must be a holder of BSc. degree in Environmental or Natural Resource Economics with 5 years relevant experience in ESIAs work.