



**NILE EQUATORIAL LAKES SUBSIDIARY ACTION PROGRAM  
(NELSAP)**

**KAGERA RIVER BASIN MANAGEMENT PROJECT**

**DETAILED IDENTIFICATION STUDIES FOR POTENTIAL LARGE DAMS IN THE  
KAGERA BASIN**

**FINAL REPORT**

**(Volume I)**

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## EXECUTIVE SUMMARY

### Background

The Kagera basin is characterized by low-productive peasant agriculture, endemic poverty, and 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<sup>1</sup> dam sites, and subsequently prepare their preliminary designs and cost estimates.

### Objective of the Assignment

The overall objective of this study was to undertake detailed identification studies for nine potential large dam sites within the Kagera Basin and prepare produce Initial Environmental and Social Evaluation (IESE) report as well as technical reports on nine sites in Kagera River Basin spread in the three partner states of Burundi, Rwanda and Uganda.

### The Initial Environmental and Social Examination

An Initial Environmental and Social Examination (IESE) or Scoping was undertaken on all the 9 potential large multi-purpose dams as part of the detailed identification studies. The overall objective of the IESE was to analyse potential adverse environmental impacts arising from site selection, design, construction, and operation of the Project. The IESE has been prepared to meet the requirements of the National Environment Management Authority (NEMA) Uganda as well as NELSAP requirements. In addition, the study also made reference to Sida's Guidelines for the Review of Environmental Impact Assessments of 2002 as well as the World Bank Safeguard policies which have all informed the preparation of this IESE.

### Focus of IESE Study

Preliminarily, the IESE study covered the following:

- provision of information about the general environmental and social settings of the project areas as baseline data;
- provision of information on the potential impacts of the project and the characteristic of the impacts, magnitude, distribution, who will be the affected group(s), and their duration;
- provision of information on the potential mitigation measures to minimize the impacts;
- establishing the existing social and economic profiles for the probable areas of project influence, which profiles included but was not be limited to: existing demographics and trends, social setting and structures, economic activities and livelihoods, level of

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<sup>1</sup> Large dams, as defined by the World Bank Environmental and Social Safeguards OP 4.37

access to safe water and sanitation and electricity, current water uses and demands; and Identification and justification of the potential water uses/demands for the site. These have helped to produce a socio-economic and environmental profile of the project areas with amongst others.

### Technical assessment of the sites

The study reviewed and analyse existing hydro-meteorological data and used it to delineate the contributing catchments for each of the 9 proposed sites. The catchment characteristics such as area, slope, soil type, and land cover for each site were established. Water availability (annual catchment runoff) at each site based on rainfall-runoff modelling was computed. The reservoir storage capacity (with a volume-depth-surface area relationship); the dead and active dam storage volumes, the reservoir area for inundation at maximum flood level were all established at each site. The study grappled with the difficult subject of sediment transport at the various sites and established the sediment yield rates using the suitable empirical relationships.

The reservoirs volumes and areas as well as people to be affected for the respective nine sites are shown in Table 1 below.

Table 1: Reservoir characteristics for the proposed dam sites

Property	Reservoir Capacity m <sup>3</sup>	Reservoir Area (km <sup>2</sup> )	Catchment Area (km <sup>2</sup> )	Potential number of people to be relocated
Kabuyanda	10.0	1.2	109.04	0
Kagitumba	26.3	2.8	712	751
Muvumba	108.7	7.1	956.12	1435
Akanyaru	333.9	14.9	1727.79	8450
R.Mbarara	9.9	1.6	30.69	1130
Upper Ruvubu	110.3	6.8	440	3327
Ruvyironza	372.6	15.0	1998.91	8580
R. Gashayura	20.4	2.8	159.23	740
R. Kavuruga	10.9	1.9	135.6	630

Water requirements and demands for the different multipurpose uses were computed; irrigation command areas the sites were established and their maps developed. The hydropower potential at each site was quantified [where applicable]; drawings of the conceptual designs and dam profiles were produced for each site. Table 2 below shows these potential various dam uses.

Table 2: Potential Irrigation areas, Hydropower Potential and No of people to benefit from water supply from the dams

Location	Population affected									
	Irrigation			Water Supply				Electricity		
	Command area (ha)	No of farmers	No of people fed	Year 2012	Year 2016	Year 2041	Year 2062	Annual Energy (GWh)	Population served	Households served
Upper Ruvubu	8,137	16,275	81,374	154,613	171,999	334,802	585,824	31	208,667	34,778
Ruvironza	14,674	29,348	146,739	264,531	294,278	572,822	1,002,303	241	1,606,667	267,778
Akanyaru	12,474	24,948	124,740	614,202	683,585	1,330,007	2,340,902	127	846,667	141,111
Kagitumba-Maziba	178	356	1,780	46,728	53,002	101,186	225,716	102	680,000	113,333
Muvumba	10,000	20,000	100,000	29,788	33,267	64,503	118,494	25	168,667	28,111
R. Kavurungu	452	903	4,517	47,764	53,136	103,430	180,978	-	-	-
R. Gashayura	1,212	2,425	12,124	170,720	189,918	369,682	646,856	-	-	-
R. Mbarara	489	978	4,889	79,783	88,754	172,763	302,295	-	-	-
Kabuyanda	4,203	8,407	42,033	69,753	79,119	151,044	336,934	1	6,000	1,000

### 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. 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 3 below gives a summary of the costs for the proposed dam sub-projects.

Table 3 Summary Costs of the proposed dam sub-projects

Dam site	Type of Dam	Dam height, (m)	Reservoir Capacity Million m <sup>3</sup>	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	Rock fill	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

### 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.

Preliminary Cost Benefit analysis was carried out for the sites. The principal outcome of this assessment was that 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

## **Conclusions:**

The following conclusions arise from the study:

1. The proposals 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 high way 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 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.

## **Recommendations**

1. The dam projects 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 or downstream of the site location. 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.
6. To ensure that, the life span and the capacity of the dams are guaranteed in line with their design capacities, there is need to institute integrated watershed management measures in order to address amongst others, potential erosion and siltation concerns. This can be achieved through better farming methods, agro-forestry, water conservation measures and sanitation practices which should all be part of the overall project costings.

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## List of Acronyms

AfDB	African Development Bank
CDM	Clean Development Mechanism
CFR	Central Forest Reserve
CRS	Catholic Relief Services
DSOER	District State of Environment Report
EMP	Environmental Management Plan
ESMP	Environmental and Social Management Plan
ESIA	Environmental and Social Impact Assessment
ESRF	Economic and Social Research Fund
EWSA	Energy, Water and Sanitation Authority, Rwanda
DPAE	Direction Provinciale de l'Agriculture et de l'élevage
FAO	Food And Agriculture Organization
GIS	Geographical Information System
GoB	Government of Burundi
GoR	Government of Rwanda
GoU	Government of Uganda
HIV/AIDS	Human Immuno Virus/Acquired Immuno Deficiency Syndrome
IESE	Initial Environmental and Social Examination
KBO	Kagera Basin Organization
KIRBMD	Kagera Integrated River Basin Management and Development
KIWRM	Kagera Integrated Water Resources Management
KRBMP	Kagera River Basin Management Project
KWAMP	Kirehe Community Based Watershed Management Project
MINAGRI	Ministry of Agriculture, Republic of Rwanda
MININFRA	Ministry of Infrastructure, Republic of Rwanda
MINIRENA	Ministry of Natural Resources, Republic of Rwanda
NBI	Nile Basin Initiative
NEA	National Environment Act
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NAPA	National Adaptation Plan of Action
PMU	Project Management Unit
PUP	Planning Unit of Population
RBM	River Basin Management
RDB	Rwanda Development Board
RECPA	Rwoho Environment Conservation and Protection Association
REMA	Rwanda Environment Management Authority
RNRA	Rwanda Natural Resources Authority
SAPs	Subsidiary Action Program
Sida	Swedish International Development Agency
SVP	Shared Vision Program
SWAT	Soil and Water Assessment Tool
tCO <sub>2</sub>	Tonnes of Carbondioxide
WCD	World Commission on Dams



# DETAILED IDENTIFICATION STUDIES FOR POTENTIAL LARGE DAMS IN THE KAGERA BASIN

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## 1 General Overview of the Assignment

### 1.1 Introduction

In December 2011, the services of a consultant were procured by NELSAP to undertake Detailed Identification Studies for 9 potential Large Dams in the Kagera basin. This report contains the study findings as per the requirements of the Terms of Reference.

### 1.2 Project Rationale and Origin

The Nile Basin Initiative (NBI) is a partnership of riparian states of the Nile, which seeks to develop the River Nile in a cooperative manner, share socioeconomic benefits, and promote regional peace and security. The NBI's Strategic Action Program is made up of two complementary programs: the basin wide Shared Vision Program (SVP) to build confidence and capacity across the basin, and Subsidiary Action Programs (SAPs) to initiate concrete investments and action on the ground in the Eastern Nile (ENSAP) and Nile Equatorial Lakes sub-basins (NELSAP). The programs are reinforcing in nature. The SVP focused on building regional institutions, capacity and trust, to lay the foundation for unlocking the development potential of the Nile, which will be realised through concrete investments carried out through the Subsidiary Action Programs.

The Countries of the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) have identified a number of projects to promote poverty alleviation, economic growth, and reversal of environmental degradation in the sub-basin. The investments are grouped into two major groups: Natural Resources Management and development of projects, and the Power Trade and Development program. The two programs target investments in agricultural development, fisheries development, water resources management, water hyacinth control, hydropower development and transmission interconnection. The Natural Resources Management sub program consists of three transboundary river basin management projects, namely Kagera, Mara and Sio-Malaba-Malasiiki River Basin Management Projects. The Projects are aimed at poverty reduction and achieving socio-economic development through the rational and equitable use of the shared water resources of their respective River Basins.

The project objective of the Kagera RBM Project is to establish a sustainable framework for management of water resources of Kagera River Basin, in order to prepare for sustainable development oriented investments that will improve the living conditions of people while protecting the environment. The Kagera River is the largest of 23 rivers that drain into Lake Victoria and it carries 34% of the annual inflow to the lake. The river basin covers some 59,800 km<sup>2</sup> and has a population of nearly 15 million people. The basin covers portions of the four countries of Burundi (22%), Rwanda (33%), Tanzania (35%) and Uganda (10%).

The Kagera basin is characterised by low-productive peasant agriculture, endemic poverty, extensive land degradation caused by population pressure and deforestation, 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 demand by the different water use sectors out-matches the existing supply and 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 nine of these have been selected for detailed investigation and appraisal.

### 1.3 Study Objective

The primary objective of this study was to undertake detailed identification studies for nine potential large dam sites within the Kagera Basin and prepare preliminary designs and cost estimates. The nine potential large dam sites included 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 location map of these sites is shown in Figure 1.5-1 below.

### 1.4 Scope of Services

As outlined in the ToRs, the scope of services included:

- (i) Desk review of relevant documentation to the assignment:
- (ii) Preliminary socio-economic analysis of the project sites
- (iii) Environmental and social scoping of the project sites
- (iv) Preliminary hydrological studies of the project sites
- (v) Preliminary technical design of the project sites
- (vi) Preliminary economic/financial analysis
- (vii) Ranking of the sites
- (viii) Development of Terms of reference for downstream feasibility studies

The above scope of services could be broadly summarised into two categories, the Initial Environment and Social Examination (IESE) for the sites on one hand and on the other; preliminary hydrological and technical assessment of the sites crowned with their respective preliminary economic and financial assessment.

### 1.5 Expected Outputs of the study

As per ToR requirement, this report contains the following outputs from the study;

- (i) Detailed synthesis of the collected and reviewed data, with clear deductions and issues pertinent to this assignment. (This informs all the analysis and deductions of all the report chapters)
- (ii) Environmental and Socio-economic profiles of the project areas, with clear justification for the potential water uses/demands. (Chapter 3 and 4)
- (iii) Initial Environmental and Social Examination (IESE) reports for each site (Summarised in Chapter 3 and 4)

- (iv) Description of the catchment physiographic characteristics, with maps and areas of delineated site catchments, reservoir storage capacities with volume-depth-surface area relationships, dead and active dam storages, catchment runoff and sediment yield, reservoir inundation areas, future water demands, IDFs. It should also include maps of the catchment and reservoir extents for the different sites, etc. (Chapter 4)
- (v) Water requirements and demands for the different multipurpose uses; delineated irrigation command areas, maps, etc.; hydropower potentials; conceptual designs; dam profiles; drawings; proposed approaches for construction and operation of the multipurpose infrastructure (distributed within Chapter 3 and 4).
- (vi) Preliminary CBA results; preliminary cost estimates. (Chapter 5)
- (vii) Ranked sites/projects (Chapter 5)
- (viii) TOR for feasibility studies for the sites (Attached in the Report Annex).

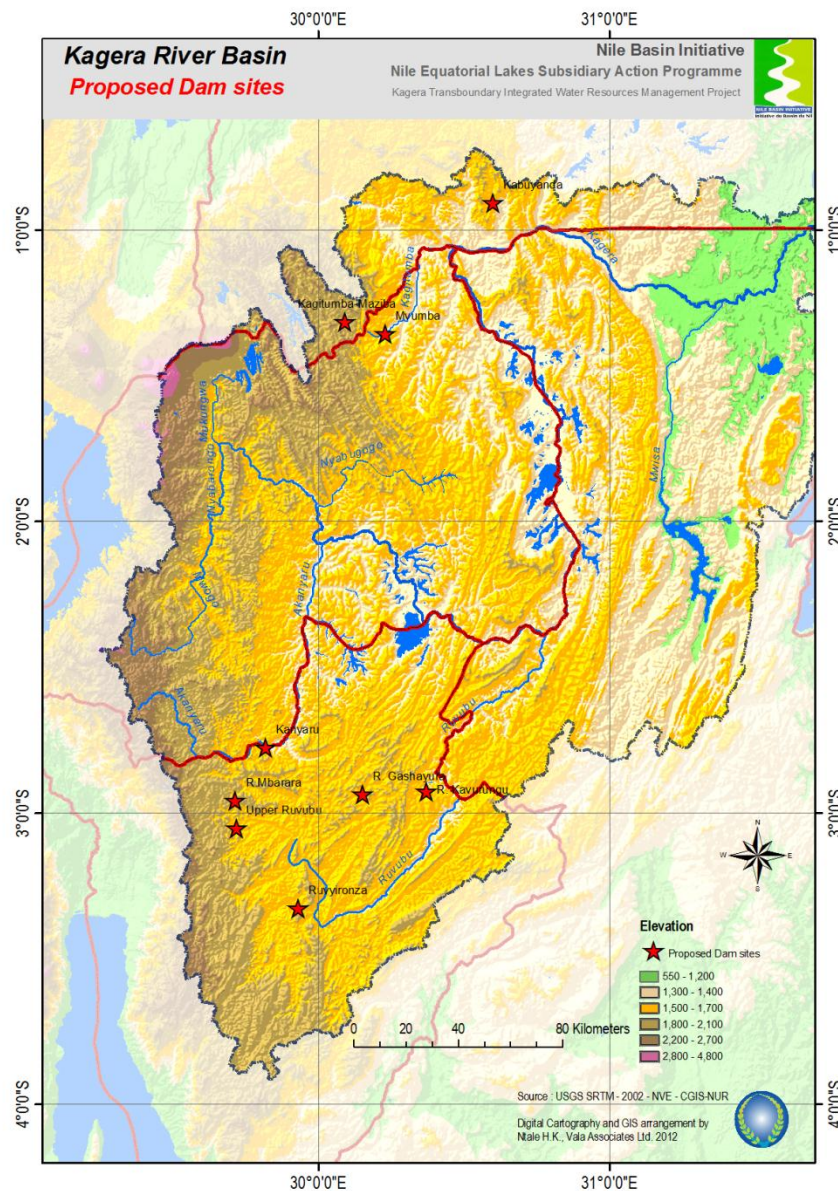


Figure 1.5-1 Location of the proposed dam sites

## **1.6 Arrangement of this report**

This report has been arranged into two volumes, Volume I and II.

**Volume I** (this report) is the main text and consists of six chapters, each addressing issues pertinent to the study as spelt out in the ToR. Chapter One gives a background, objectives and expected output of the assignment. Chapter two presents the policy and institutional setting within which the study was made. Chapter Three presents an overview of the methodology adopted for the Initial Environmental and Social Examination (IESE) assessment for the nine sites. Chapter Four details the IESE outcomes combined with the the technical assessment for each of the sites. Chapter five discussed the economic and financial considerations of the subprojects as well as the ranking criteria. Finally, Chapter Six presents the conclusions and recommendations from the study.

**Volume II** contains all the maps and AUTOCAD design drawings for the conceptual dam designs for the nine sites.

## 2 Policy, Legal and Institutional Framework

The purpose of this section is to set out the legislative, regulatory, and policy context in the three countries under which the proposed projects will be undertaken and the need for compliance. These policies, legal and institutional instruments have been summarised on countrywide basis as follows:

### 2.1 Burundi Policy, Legal and Institutional Framework

#### 2.1.1 Burundi Policy Framework

##### 2.1.1.1 Regarding Water uses in Burundi

The National policy on Water, 2001 (*“Politique nationale de Gestion des Ressources en eau et Plans d’action, Juillet 2001”*) is the main policy about the water uses. This plan focuses on access to domestic water supplies, rural hydropower development. It aims at increasing the use of water for agriculture and livestock. The Decree n°1/41 of 26th November 1992 about water sector regulation (*“Décret-Loi portant institution et organisation du domaine public hydraulique”*) considers a wide range of issues of water resources management: fisheries, water resources governance, irrigation and water supply.

The Title III, chapter 2 of the above Environmental Code, 2000 highlights the importance of meeting with water quality standards. According to the Article 52, all dams are subject to EIA procedure. The Article 53 mentioned that minimum flows have to be maintained in order to preserve the life circle and the circulation of living species in the river.

The Law dealing with public water supply, 2000 (*“Loi N° 01/014 du 11 août 2000 portant libéralisation et réglementation du secteur de l’eau potable et de l’énergie électrique”*) regulates the use of natural resources, including water management plans, water quality standards and licensing.

#### 2.1.2 Burundi Legislative Framework

##### 2.1.1.2 Regulations regarding environmental impact studies in Burundi

The main text related to environmental impact studies in Burundi is the Environmental Code *“Loi n°01/010 portant Code de l’Environnement de la République du Burundi”*- on 30 June 2000, in particular the title II, chapter 3: The Article 22 deals with environment impact assessment process. When a project is likely to impact the environment, an EIA has to be presented to the “administration in charge of Environment”; The Article 23 sets out the mandatory content of EIAs; According to the Article 27, the power of enforcement and of ensuring compliance is vested in the Ministry in charge of Water, Environment, Territory Management and Urbanism.

##### 2.1.1.3 Legislative Framework for Land Tenure Management in Burundi

The main texts about land tenure management in Burundi to be taken into account for the study are the followings:

The Land Code of the Republic of Burundi (Law No.01/008 of 01/09/1986): The procedures for resettlement are provided within the Land Code. Responsibility for resettlement lies with the Ministry of Environment & Lands, but if the land is in a wetland, the responsibility lies

with the Ministry of Agriculture. The Transitional Act of Constitution, 1998 (*Acte transitionnel de Constitution du 6 juin 1998*): the article 29 states that “every person is granted the right to property”. The 2011 Land Act (*Nouveau code foncier*) recognizes private rights to land, permits usufruct rights, leasehold and concessions. Furthermore, rights over previously titled land are recognized as private property rights and land rights acquired and held under customary law are considered as legitimate. The article 407 provides the rules for the expropriation of land. The Ministry decree n°720/304 stated on March, 20th 2008 provides guidelines for compensation based on the market value and on land for land replacement.

#### 2.1.1.4 Regulations for Land Tenure in Burundi

Burundi’s formal law recognizes state land and private land. All land that is not occupied is considered as state land by the law. According to the 2011 Land Code, unregistered customary do not have the protection of the formal law. Nevertheless registration has hardly taken place. Under customary law, land is usually held individually and household, rather than by lineage. Nowadays, most households obtained land through leasing, inheritance or purchase. Land transactions and succession are now regulated locally within families, possibly accompanied by a deed outlining the transaction which may have been witnessed by the local administration or by *Bashingantahe*, which is the customary institution in charge of village-level dispute resolution. This institution is an organized and local body of “wise men”, known for being fair and responsible. Their decisions are not legally binding, but carry social weight.

### 2.1.2 Institutional context in Burundi

#### 2.1.2.1 The Ministry of Water, Environment, Territory Management and Urbanism

The following institutions are related to environmental management in Burundi:

The Ministry of Water, Environment, Territory Management and Urbanism (*Ministère de l’Eau, de l’Environnement, de l’Aménagement du Territoire et de l’Urbanisme*) which is the key ministry dealing with environment issues in Burundi. It is given the power of enforcement of EIA process. The National Institute of the Environment and Nature Conservation (*Institut National pour l’Environnement et la Protection de la Nature*) which is responsible for, inter alia: (i) collection of data related to environmental monitoring, (ii) making sure that environmental standards concerning pollution are respected.

The Ministry of Water, Environment, Territory and Urbanism (*Ministère de l’Eau, de l’Environnement, de l’Aménagement du Territoire et de l’Urbanisme*) is also responsible for the cadastre and for titling. The Ministry of Agriculture (*Ministère de l’Agriculture*) is in charge of land use planning. The National Commission for Land and Other Properties was set up in 2006 temporarily. It is under the Office of the First Vice President. Its aims is to mediate and resolve land disputes related to refugees, to obtain compensation, to update the inventory of state-owned lands and to assist other vulnerable people to reclaim their land.

## **2.2 Uganda Policy, Legal and Institutional Framework**

### **2.2.1 Uganda Environmental Policy Framework**

#### *2.2.1.1 The National Environment Management Policy, 1994*

The overall goal of the National Environment Management Policy is the promotion of sustainable economic and social development mindful of the needs of future generations and ESIA is one of the vital tools it considers necessary to ensure environmental quality and resource productivity on long-term basis. The policy calls for integration of environmental concerns into development policies, plans and activities.

#### *2.2.1.2 The National Water Policy, 1999*

The Government of Uganda produced a National Water Policy in 1999, which emphasizes the need for participatory planning at the lowest possible level and specifically mentions the requirement for districts to set priorities, by-laws and annual development plans within policies and guidelines set by national level ministries.

#### *2.2.1.3 The National Gender Policy, 1997*

The aim of this Policy is to guide and direct at all levels, the planning, resource allocation and implementation of development programmes with a gender perspective. Its overall goal is to mainstream gender concerns in the national development process in order to improve the social, legal/civic, political, economic and cultural conditions of the people in Uganda in particular, the women.

#### *2.2.1.4 The National HIV/AIDS Policy, 2004*

This Policy provides overall policy framework for national HIV/AIDS response, and in a nutshell, it mandates sectors to mainstream HIV/AIDS into its their programmes, plans and activities hence, the need to have HIV/AIDS mitigation measures integrated into the project during its design and implementation process.

### **2.2.2 Uganda Environmental Legal Framework**

Uganda Legal section presents a summary of the legal and institutional frameworks governing the construction proposed dam project. It also summarizes the relevant lead agencies and departments that administer and monitor issues related to the proposed investment.

#### *2.2.2.1 The Constitution of the Republic of Uganda, 1995*

The importance of environment in Uganda is recognized by the Constitution of the Republic of Uganda of 1995. The Constitution provides for *inter alia*, matters pertaining to land, natural resources such as rivers and lakes and the environment. The Constitution puts upon all Ugandan's the duty to create and protect the clean and a healthy environment. In this context, an ESIA should be conducted so as to identify, assess and put in measures to ensure that, during implementation of the project the environment does not compromise the environmental and social settings for the project.



#### 2.2.2.2 *The National Environmental Act Cap 153*

Section 20 of the Act makes it a legal requirement for every developer to undertake an environmental assessment for projects listed in the Third Schedule of the Act. The activities of the planned dam project fall under those which are out of character with the surrounding and hence, require an ESIA to be conducted before implementation which therefore justifies the need an ESIA to be conducted.

#### 2.2.2.3 *The Water Act, Cap 152*

This law, consisting of 4 Parts, describes the protection and management policies of water resources such as impoundments and others. The objective of the Act is to enable equitable and sustainable management, use, and protection of water resources of Uganda through supervision and coordination of public and private activities that may impact water quantity and quality; hence the ESIA should outline such measures before project implementation is undertaken.

#### 2.2.2.4 *National Forestry and Tree Planting Act, 2003*

The National Forestry and Tree Planting Act 2003 is the main law that regulates and controls forest management in Uganda by ensuring forest conservation, sustainable use and enhancement of the productive capacity of forests, to provide for the promotion of tree planting and through the creation of forest reserves in which human activities are strictly controlled. Specifically, the Act provides for tree planting and ownership which could be undertaken in this project as part of its environmental mainstreaming.

#### 2.2.2.5 *The Local Government Act, 1995*

This Act provides the legal foundation of the Government Policy on decentralization and devolution of functions, powers, and services to Local Governments. Under this Act, district and lower local councils are given the responsibility of managing their natural resources including environment at the local government level. With reference to this project, the local governments will be involved in issues of land acquisition, compensation and environmental monitoring and compliance.

#### 2.2.2.6 *Land Acquisition Act, 1965*

This Act makes provision for the procedures and methods of compulsory acquisition of land for public purposes whether for temporary or permanent use. The Act requires that adequate, fair and prompt compensation is paid before taking possession of land and property. These are all meant to ensure that the process of land acquisition is in compliance with existing laws and that the affected persons receive fair, timely, adequate compensation.

#### 2.2.2.7 *The Land Act, 1998*

This Act provides for the tenure, ownership, and management of land in Uganda. The tenure systems are customary, freehold, *mailo* and leasehold. Section 43 of the Act



empowers the GoU to acquire land compulsorily in accordance with Article 26 (92) and Article 237 of the Constitution. However, the Constitution and the Land Act have both guaranteed security of occupancy of land to lawful and bona fide occupants.

#### *2.2.2.8 The Occupational Safety and Health Act, 2006*

The Act provides for the prevention and protection of persons at all workplaces from injuries, diseases, death and damage to property. Employers must provide for the protection of workers from adverse weather, provision of a clean and healthy work environment, sanitary conveniences, washing facilities, First Aid and facilities for meals. The Act provides for safe access to the workplaces and safe work practices which applies to this project as well.

#### *2.2.2.9 Environmental Impact Assessment Regulations, 1998*

The procedures for conducting ESIA and guidelines for ESIA practitioners and regulatory bodies are stipulated in this document. The regulations require a detailed study to be conducted to determine the possible environmental impacts, and measures to mitigate such impacts. At the end of the study, the environmental assessment report is submitted to NEMA to take a decision as to whether to approve or reject the project. The Guidelines also stipulate that the ESIA process should be participatory, that is the public should be consulted widely to inform them and get their views about the proposed investment.

### **2.3 Rwanda Policy, Legal and Institutional Framework**

This section highlights policies and laws related to Rwandan land legislation with regard to resettlement. It provides a brief overview of the Rwandan Land Policy; the provisions in the Rwandan Constitution regarding land use planning, management and tenure; the Organic Land Law; Presidential and Ministerial orders and decrees related with land expropriation, land valuation and land replacement.

#### **2.3.1 Rwanda Environment Policy Framework**

##### *2.3.1.1 National Land Policy, 2004*

The Policy is premised on the National Development Strategy of Rwanda (Vision 2020). It provides for land tenure systems, guiding principles of land management, an effective & efficient land registry, and land transactions. In order to achieve the objective of the Land Policy, a number of organic laws, decrees and orders have been and are still being prepared and promulgated to facilitate the implementation of the Rwandan Land Policy. Those that are currently in force are discussed below:

##### *2.3.1.2 National Land Policy, 2004*

The Policy is premised on the National Development Strategy of Rwanda (Vision 2020). It provides for land tenure systems, guiding principles of land management, an effective and efficient land registry, and land transactions. The Organic Law on Land and the other more

recent land legislation are a realization of the policy objectives stated in the National Land Policy.

### **2.3.2 Legal Framework in Rwanda**

#### *2.3.2.1 The Organic Land Law No 08/2005 of 14/7/2005*

This categorizes land via two criteria: (1) Land Use and (2) Land Ownership. Article 9 splits land use into two categories: urban lands and rural lands. Urban lands are defined as lands confined within the legal boundaries of towns and municipalities as well as lands in suburbs Volume III – Preliminary Resettlement Action Plan Page 54 and collective settlements of towns and municipalities. Any other land is rural land. Land ownership is divided into the following categories: individual owned lands and State lands (whether urban or rural). Individual land is comprised of land acquired through custom, written law, acquisition from competent authorities, purchase, gift, exchange and sharing (Article 11).

State lands are further categorized into two sub-categories: public domains and private State owned lands (Articles 12 and 13). State land for public domain includes land reserved for public use, for use by organs of state services or for environmental protection. Private state owned land consists of all other state owned land not considered to be part of public domain.

The Organic Land Law also provides two types of formal land tenure: full ownership/Freehold and long term leasehold. Following the recent privatization 09/04/2007 of State owned lands, very few land users currently hold either type of land tenure. This means that PAPs will receive compensation for individual land owned unlike in the past where land was communally owned (customary) or state owned. Therefore, the Organic Land Law recognizes existing rights, whether written or unwritten, under both civil law and customary practices through new national land tenure arrangements. Efforts are being made under the Law (Article 7) to formalize land ownership, especially those acquired through customary means.

For instance, rural populations with customary/indigenous land rights are being encouraged to register their land through decentralized land institutions like the District Land Bureau, Sector Land Committees and Cell Land Committees (*Ministerial Order N°001/2006 of 26/09/2006 determining the structure of Land Registers, the responsibilities and the functioning of the District Land Bureau*). All types of land tenure must be in compliance with the designated land use and environmental protection measures as outlined in the Land Use Master Plan (*Organic Land law NO 08/2005 of 14/07/2005, article 6*).

In addition, the present Organic Land Law sets a legal framework for property law under articles 5 and 6 which provides for full ownership of land and permits any person that owns land (either through custom or otherwise), to be in conformity with the provisions of this law. It is important to observe however that full ownership of land is only granted upon acquisition of a land title issued by the general land registrar authority. Once the efforts to provide proper land tenure documentation are completed, ownership of land without proper documents such as land title will not be deemed lawful land ownership and thus in event of circumstances like expropriation, one will not be able to benefit from a fair and just compensation package.

### 2.3.2.2 *Rwandan Constitution 2003*

Rwandan Constitution recognizes that every person has a right to private property (Article 29). Consequently, private property, whether individually or collectively owned is inviolable. Exceptionally, the right to property may be overruled in the case of public interest. In these cases, circumstances and procedures are determined by the law and subject to fair and prior compensation (Article 29). Laws on property are also found in various legal texts of Rwanda. Eligibility for compensation is also enshrined under the Rwandan constitution (Article 29) and the Expropriation Law. The two laws regulate and give entitlement to those affected, whether or not they have written customary or formal tenure rights.

### 2.3.2.3 *Ministerial Order NO 001/2006 of 26/09/2006 Determining the Structure of Land Registers, the Responsibilities and the Functioning of the District Land Bureau.*

This Order determines the structure of land registers, the responsibilities and the functioning of land bureau in each district (Article 1). However, this Order does not apply to land specified in articles 12, 14, 15 and 72 of the Organic Land Law n° 8/2005 of 14/07/2005 determining the use and management of Land in Rwanda (Article 2).

Article 3 of this Order stipulates the following land registers; Cadastral register, Short term lease and long term lease contract. Chapter 2 (Article 3-4) highlights the structures of land registers while responsibilities are stipulated in Chapter 3 (Article 5-7) of this order. According to this order, the overall responsibility of implementing the land policy lies with the Land Bureau (Article 5-7). Functioning of the land Bureau is stipulated in Chapter 4 of this order.

### 2.3.2.4 *Expropriation Law*

In addition to eligibility discussed under the Constitution above, expropriation law defines the person to be expropriated any person or legal entity who is to have his or her private property transferred due to public interest, in which case they shall be legally entitled to payment of compensation (Article 2 (7)).

Article 3 of the Expropriation Law stipulates that any individual who suffers any loss he or she should receive just compensation for it, although it is not clear what comprises fair and just compensation, this being left to the judgment of independent valuers. Article 4 of this law also stipulates that any project which results in the need for expropriation for public interest shall provide for all just compensation in its budget. Article 22 (2) of this law further indicates that through an agreement between the person to expropriate and the one to be expropriated, just compensation may either be monetary, alternative land or a building equivalent as long as either option equates to fair and just monetary compensation. Through mutual arrangement, both parties can determine the mode of payment. In case the determination of just compensation exceeds in value the alternative land given to the expropriated person, the difference will be paid to the expropriated persons.

## 2.3.3 **Environmental Institutional Framework**

### 2.3.3.1 *Rwanda Environment Management Authority*

The Government of Rwanda has undertaken strong commitment to understand its current and future environmental challenges as a necessary step in the pursuit for sustainable development. Today, to effectively manage environmental challenges such as soil erosion,

deforestation, wetland drainage, water degradation, climate change and the loss of biodiversity, GoR established Rwanda Environmental Management Authority (REMA), under Organic Law No.04/2005 of 08/04/2005 Article 64, to coordinate and oversee all aspects of environmental management for sustainable development. One of ERMA's principal functions is to oversee the conduct of EIA and take a decision on proposed development projects to be undertaken by both public and private sectors.

#### 2.3.3.2 Ministry of Natural Resources

The Ministry of Natural Resources (MINIRENA), deals with the environment; and natural resource management including water resources, forests, mining, and land management. Its role is to provide policy guidance for these sectors, ensure the protection of the natural resources and environment, and provide oversight for the Rwanda Natural Resources Authority (RNRA) and REMA.

#### 2.3.3.3 Rwanda Development Board

Rwanda Development Board (RDB) considers and approves EIAs. It is the first point of contact for a developer and should be well versed with the EIA process and the government and other agencies that need to be consulted as each case may require. REMA is the principal organ of government responsible for the environment. It retains oversight in EIA matters and takes charge of post EIA and other environmental matters.

#### 2.3.3.4 Ministry of Agriculture and Animal Resources

The Mission of Minister of Agriculture and Animal Resources (MINAGRI) is to initiate, develop and manage suitable programs of transformation and modernization of agriculture and livestock to ensure food security and to contribute to the national economy. The Vision of Minister of Agriculture and Animal Resources is to modernize Agriculture and Livestock to achieve food security.

#### 2.3.3.5 Energy, Water and Sanitation

Energy, Water and Sanitation Authority (EWSA) has as mission to create conditions for the provision of sufficient, safe, reliable, efficient, cost-effective and environmentally appropriate energy, Water and Sanitation services to households and to all economic sectors on a sustainable basis. EWSA has a vision of contributing effectively to the growth of the national economy and thereby improve the standard of living for the entire nation in a sustainable and environmentally sound manner.

## 2.4 World Bank Safeguard Policies

The Bank's categorization of projects is based on screening process in which, the proposed projects are screened to determine the appropriate extent and type of EIA to be undertaken. The Bank classifies the proposed project into one of four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. Based on these considerations, these projects fall under the Bank's Category A group and the safeguards justification is as follows:

## 2.5 Consideration of the Transboundary aspects of the proposed infrastructure

Some of the proposed dams are located at or near boundaries between countries (Uganda-Rwanda, Burundi-Rwanda) and therefore development of these sites have transboundary implications. Although there are positive examples of cross border treaties and collaboration (for example the Mekong and the Senegal River) aimed at facilitating transboundary cross-boarder water infrastructure development, the implementation and governance of transboundary infrastructure is particularly challenging. If not handled properly, the transboundary impacts of such structures may lead to cooperation deadlocks, if not of open conflicts, between countries within the Kagera basin. However, these structures can also become drivers of regional economic integration and sustainable development, especially for agriculture, energy and transport.

Infrastructure development in transboundary basins needs as a minimum, to apply the 1997 UN Convention on the Law of the Non-navigational Uses of international watercourses with particular emphasis on equitable and reasonable use of water resources and associated benefits. Investments in transboundary water infrastructure projects are only equitable and sustainable when the benefits are shared between all stakeholders including local communities alongside wider macroeconomic benefits.

Development of the transboundary infrastructure will be implemented within the NBI cooperative framework. At the minimum, the respective countries may consider avoiding wasting time trying to harmonise their national plans for the construction of the transboundary infrastructure. Instead, they should discuss and agree on one single regional plan for the construction of dams, taking into account the best location possible for a given infrastructure with targeted uses. This gives room to manoeuvre for a truly integrated approach, optimizing the balance of multiple uses of the water retained by the hydraulic infrastructures (hydropower, irrigation, inland navigation, etc.), and minimizing in the same time environmental and social externalities.

Transboundary river basin organizations are obviously the most relevant structures for the implementation of such transboundary projects which should work hand in hand with the regional economic community (EAC) and the national governments.

Table 2.5-1 Summary of the Safeguard Policies with Reference to the Planned Dam Projects

OP N°.	Summary of Safeguard policy	Its implication	Triggered/Not Triggered
OP 4.01	<b>Environmental Assessment:</b> Under the OP 4.01 category A projects are characterized based on amongst others, if such a project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. The planned works on the multi-purpose dams will likely be major and trans-boundary hence, the EIA will be required to recommend measures that will be needed to prevent, minimize, mitigate, or compensate for such adverse impacts and improve environmental performance which qualifies the projects to be Category A type.	The planned large dams fall under those projects that require an EIA to be prepared and approved before their implementation.	√
OP 4.04	<b>Natural Habitat:</b> The Bank supports the protection, maintenance, and rehabilitation of natural habitats and their functions. The conservation of natural habitats is essential for long term sustainable development.	No natural habitats will be impacted by the planned project.	X
OP 4.09	<b>Pest Management:</b> In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity.	At this stage is not known if agro-chemicals shall be applied on the project, hence this IESE study cannot commit to assess whether this safeguard will be triggered or not. This should be explored in the detailed ESIA.	X
OP 4.10	<b>Indigenous peoples:</b> These are defined to be a distinct, vulnerable, social and cultural group possessing a number of characteristics including collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.	No Indigenous People exist in the project area hence, there will be no impact and the safeguard will not be triggered.	X
OP 4.11	<b>OP 4.11 Physical Cultural Properties:</b> This policy addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance.	This IESE did not encounter any information on physical cultural resources in the area of the project. It is suggested that detailed ESIA for the project to assess this further to confirm existence of such resources.	X
OP 4.12	<b>Involuntary Resettlement:</b> This policy includes safeguards to address and mitigate these risks and recommends involuntary resettlement instruments which include a resettlement plan, a resettlement policy framework and a resettlement process framework.	The Project will involve land uptake for project infrastructure and associated facilities which makes the need for a RAP study apparent.	√

OP N°.	Summary of Safeguard policy	Its implication	Triggered/Not Triggered
OP 4.36	<b>Forests:</b> The objective of this policy is to assist borrowers to harness the potential of forests to reduce poverty in a sustainable manner, integrate forests effectively into sustainable economic development, and protect the vital local and global environmental services and values of forests.	The project will impact on Kabuyanda CFR hence; it triggers this safeguard policy instrument.	√
OP 4.37	<b>Safety of Dams:</b> For the life of any dam, the owner is responsible for ensuring that appropriate measures are taken and sufficient resources provided for the safety of the dam, irrespective of its funding sources or construction status. When the Bank finances a project that includes the construction of a new dam, it requires amongst others, that the borrower adopt and implement certain dam safety measures for the design, bid tendering, construction, operation, and maintenance of the dam and associated works.  The Bank distinguishes between small and large dams where large dams are 15 m or more in height. Dams that are between 10 and 15 m in height are treated as large dams if they present special design complexities. Dams fewer than 10 m in height are treated as large dams if they are expected to become large dams during the operation of the facility. Such large dams require amongst others, that preparation and implementation of detailed plans ensure safety aspects. The EIA is one of the tools that can therefore formulate some of the safety aspects in large dams.	All the 9 dams under this study have heights above 15 m and therefore qualify as large dams, as per OP 4.37.	√
OP 7.50	<b>Projects on International Waterways:</b> This policy applies to the following types of international waterways: (a) any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states, whether Bank members or not; and (b) Any tributary or other body of surface water that is a component of any waterway described in (a) above.	Based on this Policy provisions above, the planned dams will be on river systems that follow between Rwanda, Burundi and Uganda, they also flow through more than two states. In addition, the river systems form part of the larger trans-boundary Kagera River. This further justifies the need for an ESIA to be conducted on the proposed multipurpose dam projects	√
OP 7.60	<b>Projects in Disputed Areas:</b> Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the country in which the project is carried out and one or more neighbouring countries.	The project areas for the planned dam site are not disputed, and therefore, this policy will not be triggered.	X

## 3 Overview of the methodology adopted for the IESE of the nine sites

### 3.1 Project Approach

The study approaches employed during the IESE study included document review, reconnaissance surveys, stakeholder consultations and field observations. These approaches are further elaborated below.

#### 3.1.1 Review of Available Documents

Documents and records were reviewed to obtain existing secondary data and information relevant to the study. The major source of such information included socio-economic and investment profiles for Kagera River Basin Management Project (Kagera RBM Project), national or partner country's education, health and community development reports. Environmental and social safeguard policies Furthermore, policies of focus in the study included but were not limited to the following:

- Sida's Guidelines for the Review of Environmental Impact Assessments, 2002;
- World Bank safeguard policies;
- Uganda's EIA Guidelines, 1997 (NEMA);
- REMA's EIA Guidelines of 2006;
- Initial Environmental Examination (IEE) procedures for AfDB funded projects of 2002;
- African Development Bank safeguard policies;
- EAC Protocol on Environment and Natural Resources; and
- EAC EIA Guidelines for shared ecosystems.

#### 3.1.2 Reconnaissance surveys

Reconnaissance visits to the proposed eight dam sites were undertaken which as a vital activity of this assignment which accorded the consultant the opportunity to carefully take stock of what is on the ground, examine the extent to which water services are required, and collect all the preliminary field data from the sites. The carefully planned tour, using the checklist and plan developed at the initial analysis of maps and desk review provided the Consultant with an in-depth understanding of the social, economic, environmental and hydrologic situation on the ground, leading to an improved strategy and action plan for detailed investigations.

From the perspective of the environment and socio-economic scoping, the field reconnaissance visits have been used to gather information on ground issues that are likely to be impacted on and impact on the project intervention during its implementation. These visits were important in helping to formulate focus for subsequent and detailed Environmental and Social Impact Assessment Study (ESIA) investigations and general formulation of ToRs for ESIA as well as in ranking the sites based on a combination of factors such as social, ecological/biological and cultural, amongst others. In all, the reconnaissance surveys helped to answer the key question which is "what exists where and what is/and of what value is it and to who?". Information gathered from the field reconnaissance visits was utilized in the preparation of the preliminary description of existing environmental and social conditions at site and the characterization of the spot preliminary evaluation of the projects' potential environmental and social risks and impacts



in their areas of influence thereby leading to formulation of ways to prevent, minimize, mitigate, or compensate for adverse environmental impacts and enhance positive impacts.

### **3.1.3 Stakeholder Consultations**

The Consultant carried out consultations with the relevant stakeholders and these included the District staff, ministries, local authorities and also local people at the project sites that might be affected by the project. The local people provided information such as land tenure systems, existing conflicts in regard to natural resources, and socioeconomic information among others.

### **3.1.4 Field Observations**

Observations were made through transects walks; the consultant observed among other things housing, infrastructure, settlement patterns and other economic activities. This method was equally employed to document major vegetation and animal groups in the areas of the project.

## **3.2 Approach to Technical Assessments:**

### **3.2.1 Introduction**

Assessment of the dam sites was carried out to analyse the technical options for development of the sites. The steps followed in carrying out the analysis included; (1) review of available documents; (2) field observations; (3) catchment and dam site characterisation; (4) hydrological analyses; (5) preliminary dam design and costing; (6) economic analysis and ranking of the dam sites

### **3.2.2 Review of available documents**

Review at each site was carried out of the following types of information, when available

- Previous designs on or close to the proposed sites, when available
- Review of country water policies and legal frameworks
- Review of guidelines for specific analyses like
  - Hydrological modelling
  - Dam design
  - Sediment estimation
  - Project ranking
  - Project economic analysis

### **3.2.3 Field observations**

Excursions were made to each of the 9 sites in which on-spot assessments were carried out to ascertain the following

- Suitability of site for development

- Soil types and general geology
- Dominant crops
- Extent of reservoir inundation and necessary compensation
- Catchment and dam site characterisation. The main factors considered included; (1) catchment size and physiography; (2) general geology and soils; (3) climate including rainfall, evapotranspiration, and temperature

### **3.2.4 Hydrological analyses**

These were aimed at obtaining design information based on an analysis of the hydrology of each basin. Hydrological analyses were based on (1) river flow data, for gauged basins, (2) hydrological modelling for ungauged basins. The hydrological information obtained were useful for sizing the reservoir, spillway sizing, estimation of hydropower potential, and other. Some of the statistics that were computed included;

- Mean and median flow (m<sup>3</sup>/s);
- Mean monthly and annual flow
- Design flood (T=10,000 years)
- Sediment accumulation rates

### **3.2.5 Preliminary dam design and costing**

This included the following

- Choice of dam type and sizing
- Spillway design
- Other structures; power station, intake structures, power canals
- Estimation of irrigation command area, water supply area
- Costing based on unit rates used for similar projects in the region

### **3.2.6 Economic analysis and ranking of sites**

The sites were ranked based on multi-criteria analysis using attributes like reservoir capacity, storage/earth ratio, water use benefits of created and/or boosted irrigated agriculture and hydropower generation, cost of sub-projects, and environmental attributes

An economic analysis was carried out basing on assumptions about discount rate, project economic life and commodity prices

## 4 IESE and Technical assessment of the dam sites

This chapter outlines the findings from the IESE and technical assessment of the nine sites. For each site, the physical environment profile is discussed followed by the ecological and baseline social environment findings. A discussion of the technical assessment of the site follows, which includes the site hydrology; an appreciation of the water uses (irrigation, water supply and hydropower where applicable) and a summary of the site specific dam design elements. The discussion of each site ends with an outline of the estimated project costs.

### 4.1 Kabuyanda Dam Site

#### 4.1.1 Physical Environment Profile

Kabuyanda Dam Site is located on River Mishumba, at coordinates  $-0^{\circ} 54' 26.04''$  (South) and  $30^{\circ} 35' 58.14''$  (East), where it leaves the Rwoho Central Forest Reserve towards the communities and flows towards Kikagate areas in Isingiro district, Uganda. Figure 4.1-1 and Figure 4.1-9 below show the geographical location of the site and the details of the proposed reservoir.

The mean catchment slope is about 27.8% but the steepest slopes may be higher than 110%. The catchment elevation ranges between 1345 m asl at the dam site to 1843 m asl while the mean is 1585 m a.s.l.

The constructed reservoir could be utilized for multipurpose uses that include water supply, and irrigation needs. The area to be inundated by the Kabuyanda reservoir is completely un-inhabited. In this regard, there are likely to be minimal compensation costs associated with the Kabuyanda dam/reservoir project.

##### 4.1.1.1 Climate

Available data indicates that the basin receives a mean annual rainfall of 1004 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 September and November but can sometimes extend to December. The maximum rainfall is received in April and averages 140 mm while maximum rainfall in the short rainy season is received in November and averages 138 mm. July is the driest month, receiving only 22 mm of rainfall. The mean annual potential evaporation is 1219 mm and varies over a narrow range between 113 mm in March and 84 mm in May. The mean monthly temperature ranges between  $20^{\circ}\text{C}$  in July and  $23^{\circ}\text{C}$  in April.

##### 4.1.1.2 Temperature

Average daily temperature for Mbarara and Isingiro areas based on the Mbarara regional Meteorological station for the period 1960-1993 was a minimum of  $13.7^{\circ}\text{C}$  and a maximum of  $26.6^{\circ}\text{C}$ . Analysis of the trend showed an increase of about  $2^{\circ}\text{C}$  over the period. The temperature for Kabuyanda site and Rwoho Central Forest Reserve is expected to be slightly different due to differences in altitude. The strongest winds blow during the months of June and August and are from the South and East.

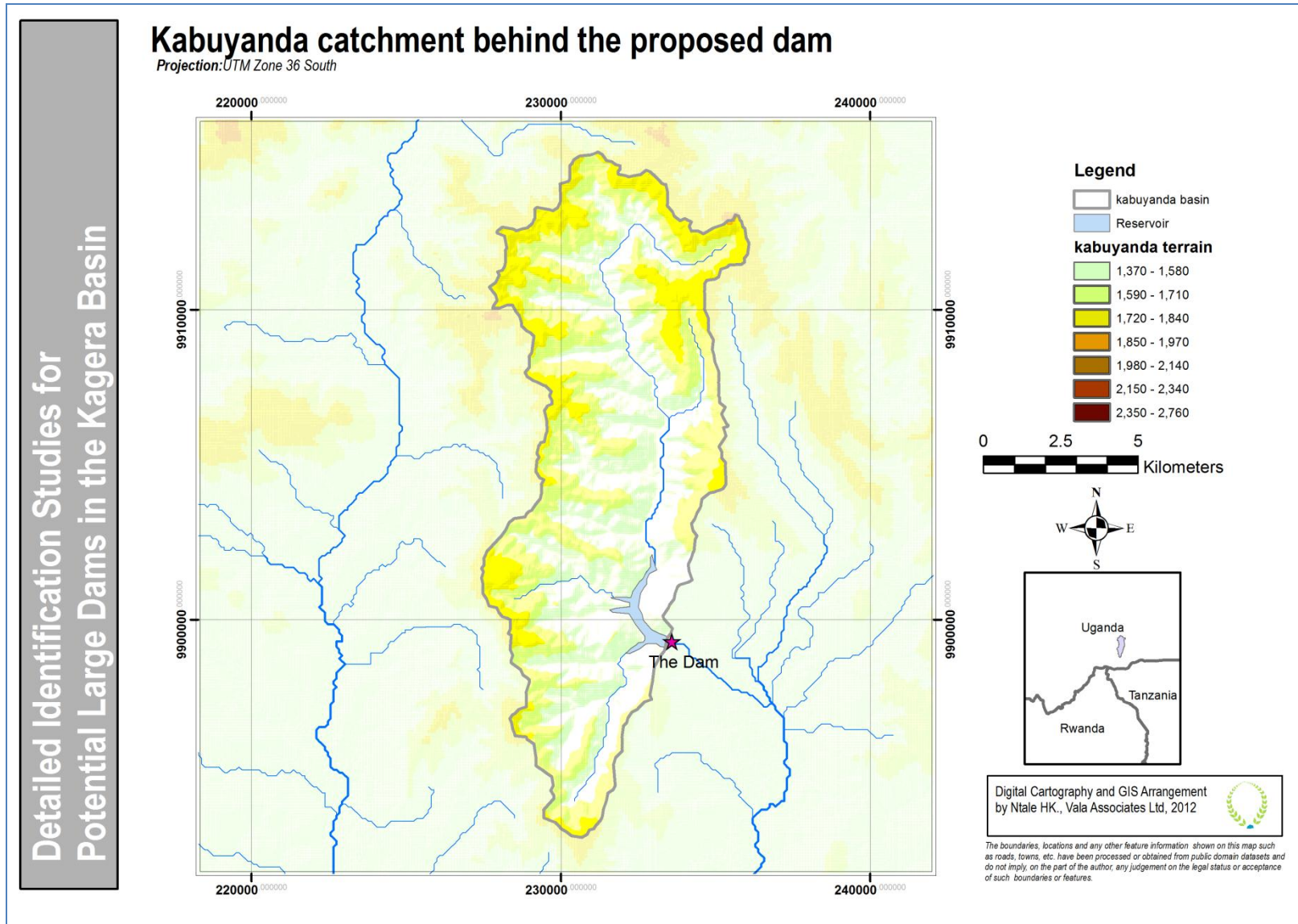


Figure 4.1-1 Kabuyanda Site location

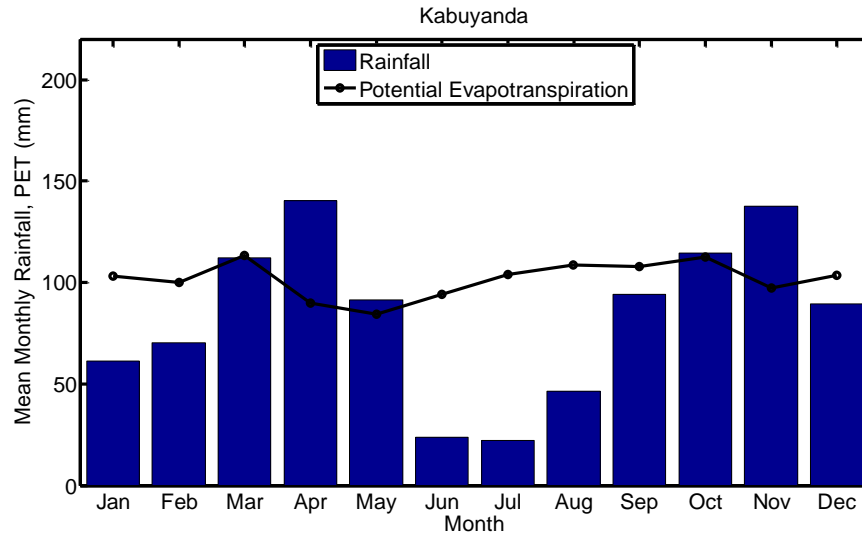


Figure 4.1-2 Kabuyanda catchment mean monthly rainfall and potential evaporation

4.1.1.3 Geology of the Dam site

The geology of the project area is said to be part of Southern Ankole geological system which is entirely dominated by ancient (Precambrian) metamorphic rocks of the Toro and Karagwe-Ankolean Systems, which are intruded by slightly younger granitic rocks (Figure 4.1-3). The tightly folded Toro System is overlain uncomfortably by the Karagwe-Ankolean System. The granitic rocks intruded the Karagwe-Ankolean at the time of fold formation and were typically emplaced in the cores of major anticlines. The geological map indicates that Toro System rocks only occur beneath the first two km of the project road and typically comprise mica schists, but these rocks were not seen in outcrop close to the project area.

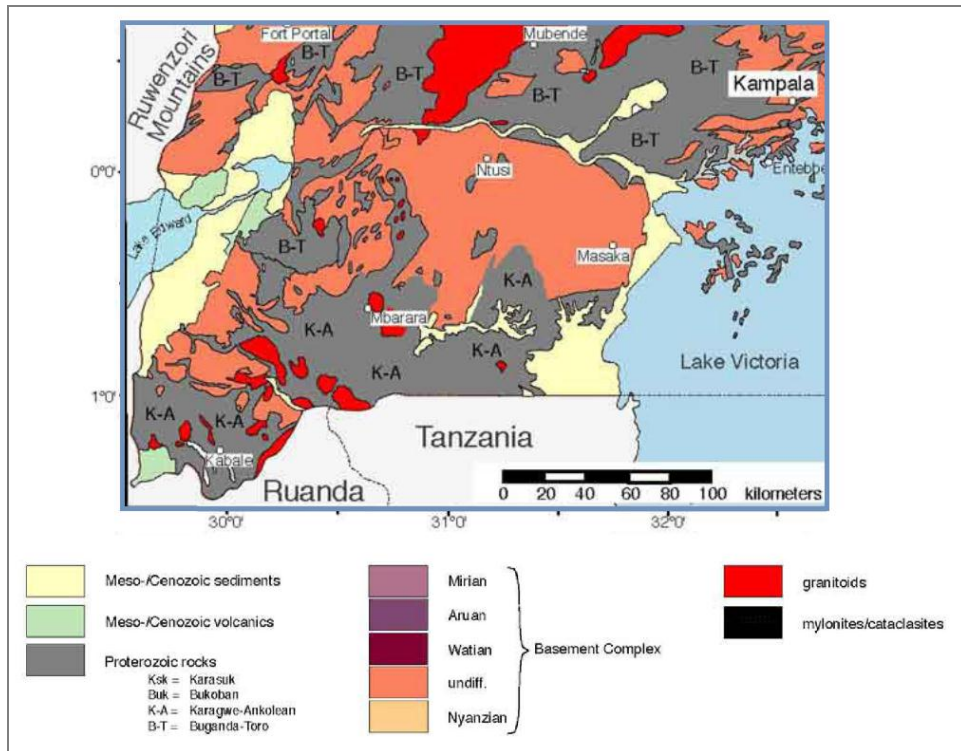


Figure 4.1-3 Geological Map of South Western Uganda (Source: ESIA Ishaka-Kagamba Road Project, 2010-UNRA)

The underlying rock is mainly the Precambrian rock, which is described in four types:

- (i) The Buganda Toro system – age dating over 1800 million years;
- (ii) Wholly granitized or high to medium grade metamorphic formation (Northern part of District);
- (iii) The Karagwe–Ankolean System (southern and north western) age dating varies from 1300-1400 million years; and
- (iv) The Granitoid and highly granitised rock (south of district).

## 4.1.2 Ecological Environment

### 4.1.2.1 Rwoho Central Forest Reserve

The planned project site lies within the Rwoho Central Forest Reserve which itself is within a mosaic natural vegetation characterized by riparian forest, bare hilltops with sparse woody plant cover and artificially planted trees of *Pinus caribaea*, *Pinus ocarpa* and *Eucalyptus sp.* Rwoho forest reserve still exhibits its original native vegetation predominantly covered with *Albizia grandbracteata*, *Rhus longiflora*, *Prunus africana* and *Erythrina abyssinica*. The mid altitude forest is on the fringes of the bare Mbarara hill tops and Oruchinga Valley to the south east draining to Kagera river.

Grasses and shrubs cover the slopes and peaks of the hills. A total of 179 species in 56 families with 7 Albertine rift endemic plants (*Oxyanthus troupinii*, *Elatostema monticola*, *Zanthoxylum gilletii*, *Pavetta oliveriana*, *Peddiea rapaneoides*, *Macaranga capensis*, and *Peddiea rapaneoides*) have been recorded in the Rwoho Forest. The dominant plant families in the areas are reported to include Poaceae with 19 species encountered, Asteraceae 18, Euphorbiaceae 17 and Fabaceae 12 species. A variety of woody forest plants exist in the remnant riparian forest patches that has been greatly exploited by the local communities in dire need for grazing land, building material, hunting and non-timber forest product exploitation of some species for animal and human consumption. The bear hilltops that have been highly degraded by grazing are supporting grassland and vegetation, which is predominantly covered with short grass, shrubs and fire resistant species.

### 4.1.2.2 Categorization of Rwoho Central Forest Reserve

Rwoho Central Forest Reserve is categorized as a secondary conservation forest in the National Forestry Nature Conservation Master Plan. There are no red-list species in the area. Of the 65 forests investigated in Uganda, Rwoho ranks 41st in overall biodiversity importance. Rwoho has one tree species unique to Uganda (*Terminalia laxiflora*) and one tree species endemic to the Albertine Rift (*Grewia pubescens*).

Furthermore, there are a number of restricted range species that only occur in less than 5 forests in Uganda, but also in other forests in the East African region. In the area also two mammals and one butterfly which are regional endemics, and 5 trees/shrubs, one small mammal and 8 butterflies of restricted range were found. In the table below the main results of the conservation value assessment are presented.

For the reforestation activities the following tree species are being used:

- 75 % *Pinus caribaea* var. *hondurensis*
- 20 % *Maesopsis eminii*
- 5 % *Prunus africana*

*Pinus caribaea* is widely tested in Uganda and adaptable to a number of site conditions. *P. caribaea* was introduced to Uganda around 1960. Experiences with native tree species are limited in East Africa but the natural occurrence of *Maesopsis eminii* and *Prunus africana* in Rwoho is indicating that the prevailing site conditions are favourable for these tree species. However, due to limited information on tree growth performance and pest problems, in particular with *Prunus africana*, further increasing the proportion of native tree species would increase the project risk.

#### 4.1.2.3 Clean Development Mechanism (CDM) Project in Rwoho Central Forest Reserve

The small-scale CDM A/R project is part of a project cluster of 5 similar projects aiming to provide a new financing mechanism to overcome the current barriers to establish timber plantations in Uganda and to allow communities to benefit from the CDM. The project area is part of the Rwoho Central Forest Reserve, a gazetted woodland reserve (Figure 4.1-4). In total the reserve covers an area of 9,100 ha, of which 50 % is available for reforestation activities. Of the 50 km of external boundary about 9 km follows streams while 41 km is an artificial boundary maintained as a planted cutline with earth corner cairns and boundary-directional trenches. The reserve lies on top of a large flat-topped ridge running from North to South. In total the project activities cover an area of 341.9 ha within Rwoho Central Forest Reserve (NFA planting area: 319.2 (93 %), community planting area: 22.7 ha (7 %). The Reserve covers in total an area of 9,100 ha. Based on conservative estimates, with a 22 years rotation cycle for all tree species, the project is anticipated to produce 29,269 tCO<sub>2</sub>-e.

The project allows the involvement of private and community-based tree planting initiatives with different investor shares. Due diligence, monitoring, validation and verification costs are shared among the project cluster. Based on a successful implementation of this first pilot cluster, it is planned to extend the portfolio across the country clustered in a number of deforested public forest reserves and target regions.

In the project the NFA is the main investor being responsible for 93 % of the investor shares and proportional area. The NFA is dominating this first project cluster considering that it is currently the only organization in Uganda able to provide confidence to international investors in this new investment concept and being able to provide the expected guarantees to replace the emission reductions in case the project activities may fail. The Co-investor is the community groups, like the Rwoho Environmental Conservation and Protection Association (RECPA), with currently 250 members that are interested in tree planting. Many of the members already have a track record planting trees. Community groups will manage the remaining 7 % of the project area. In subsequent project activities the investor share of communities and/or private enterprises will be gradually increased considering the learning curve and the available track record from the first project cluster.



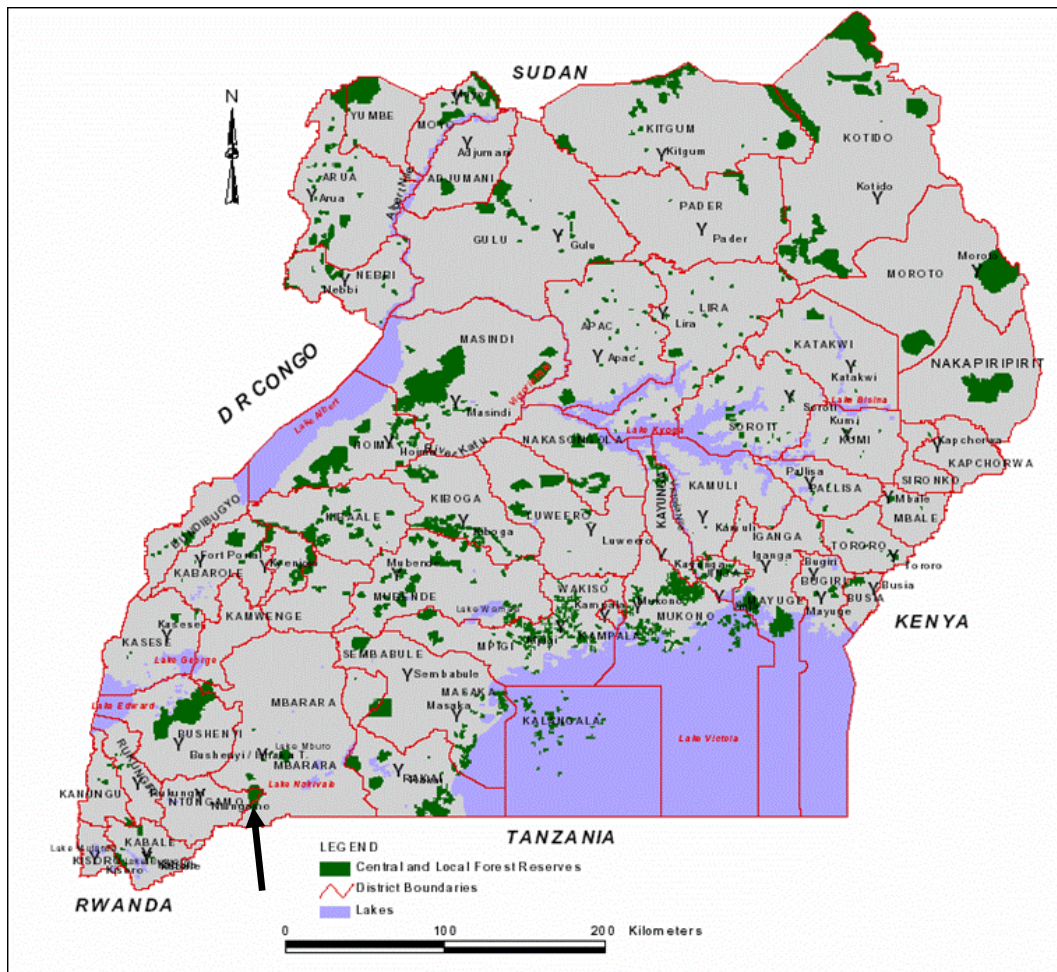


Figure 4.1-4 Map of Uganda with all Central Forest Reserves. Dark arrow shows location of Rwoho CFR (Source: NFA, 2006)

Community groups will receive the payments for each tCO<sub>2</sub> sequestered at a price stipulated in the Emission Reductions Purchase Agreement between the buyer and the NFA. Detailed rights and responsibilities are regulated in Community Forest Management Agreements and a Tree Farming License (see attached documents). The NFA will provide seedlings and technical advice to community groups. In return they will be in charge to protect the plantations from fire and the remaining patches of natural forests.





Plate 4.1-1 Papyrus section on the River. Note the pine trees on the background. Communities harvest papyrus for handcrafts from this part of the River.



Plate 4.1-2 White arrows shows part Rwoho CFR planted with Pines and is likely to be inundated once the dam is constructed.



Plate 4.1-3 Sections of the neighboring communities with bananas

### 4.1.3 Baseline Social Environment

#### 4.1.3.1 Population

The population in the district has nearly doubled in a period of 20 years implying that there is increased pressure on natural resources in order to improve on the quality of life and standards of living of the people. Rapid population growth slows down economic progress and lowers standards of living in a family. These manifests itself in form of scarcity of basic needs of man like education, Health, Infrastructure such as transport and communication systems, water and sanitation; and land for crops and livestock production (Mbarara, DSOER 2004).

Poor management of solid waste, land degradation and loss of soil fertility and erosion leading to low agricultural production are some of the key issues concerning population and social development in Mbarara district and Rwoho and Bugamba Forest management area in particular.

#### 4.1.3.2 Population characteristics

The population characteristics in the project area can be summarized in Table 4.1-1 below: The area is basically inhabited by Banyankole, Bakiga and some Banyarwanda. The current population around the reserves of Rwoho and Bugamba is 141,383 distributed in four sub counties of Mwizi (26,136), Bugamba (28,822), Rukoni (44,401) and Kabuyanda (42,024).

#### 4.1.3.3 Socio-economic Activities

Agriculture is the mainstay of the District economy, as 92% of the rural population depends on agriculture for livelihood and income and crop farming is a predominant activity engaging two thirds of the population and can be easily noted as one drives through the



Rwampara and Isingiro hills. Poor agricultural practices on fragile mountains and hills have increased incidences of soil erosion. During the discussions, it was revealed that there are seasonal wildfires started by cattle keepers and subsistence farmers especially during the dry season, this could spread and damage forest plantation.

Table 4.1-1 Kabuyanda Population Characteristics

Parameter	Parameter Value
Birth rate	55 per 1000
Death rate	20 per 1000
Growth rate per annum	3.2%
Density	138 per sq Km
Total fertility	7.8
Infant mortality rate	87 per 1,000 births
Literacy rate	53%
Sex ratio	47.3%
Proportion of National population	4.4%
Life expectancy at birth	47%
Maternity mortality rate	504/100,000
Adolescent pregnancy rate	38%
HIV / AIDs prevalence rate	10%

(Source: DSOER, Isingiro 2009)

The villages on the fringes of the project area are mostly isolated agricultural villages. Subsistence farmers whose main activity is cultivation of bananas inhabit them. Petty trade is common within the neighbourhood of the project area and several small shops/kiosks were sited in the villages. According to the population and housing census of 2002, the average monthly house income in nominal values was estimated at Uganda Shs 127,700 and crop farming was the major source of income much of which is spent on foods and beverages. rent fuel and power. The majority of the population IS engaged in private economic activities. The district economic status indicators are as follows:

- *Per capita* income estimated at Uganda shillings 540.000 (US \$ 350)
- Major cash crops: Bananas, beans maize, coffee fruits and vegetables;
- Major cash livestock and live stock products. Cattle, goats, chicken milk, eggs, hides and skins;
- Major cash services: Human transport, private-education and health/medical services, trade and commerce; and
- Industries: - metal fabrication, wood works, saw milling, grain milling, treatment of hides and milk processing.

#### 4.1.3.4 Land tenure and land use

Land tenure system fall under the following categories as stipulated in the Constitution of Uganda 1995.

- Customary tenure:- Common tenure in the district. The land under this tenure is entrusted to a household whose head of the household normally subdivides it among his children.
- Freehold land- is basically Government owned.
- Leasehold: Most of leasehold are granted for development purpose like agriculture development and setting up of the institutions.

The Rwoho and Bugamba CFRs management plan will be implemented within the Central Forest Reserves which fall under Freehold Government land held in trust by the Uganda Land Commission. The dominant land use within the management area is forestry. Outside the management planning area it is agricultural activity including cultivation of crops and keeping of livestock.

#### 4.1.3.5 Economic activities

According to the population and housing census of 2002, the average monthly house income in nominal value was estimated at Uganda Shs. 127,700 and crop farming was the major source of income of the population is engaged in private we economic activities. The district economic status indicators are as follows:-

- Per capita income estimated at Uganda shillings 540,000 (US \$ 350)
- Major cash crops: Bananas, beans, maize, coffee fruits and vegetables.
- Major cash livestock and livestock products: cattle, goats, chicken, milk, eggs, hides and skins.
- Major cash services: Human transport, private-education and health/medical services, trade and commerce.
- Industries: - metal fabrication, wood works, saw milling, grain milling, treatment of hides and milk processing.

Agriculture is the back bone of the district economy, as 92% of the rural population depends on agriculture for livelihood and income and crop farming is a predominant activity engaging two thirds of the population. Poor agriculture practices on fragile mountains and hills increased incidences of soil erosion.

#### 4.1.3.6 Rangeland Management

Rangeland distribution is mainly in Kazo Nyabushozi, Bukanga, Isingiro and Kashari countries, which are within the cattle corridor. Pastoralist practice communal grazing and keeps many animals exceeding the carrying capacity of the area resulting into over grazing leading to land degradation.

#### 4.1.3.7 Education

The district has 629 government aided primary schools and 212 private owned. It has 41 government aided secondary school and 49 private owned. There are 2 universities; Mbarara University of Science and Technology and Bishop Stuart University Kakoba. There was one National Teachers College (Kakoba, 3 primary school Teachers College, 3 technical schools and 2 farm schools).

#### 4.1.3.8 Energy

The district energy sources are mainly woodfuel, petroleum products, electricity and renewable resources like solar energy and Biogas Woodfuel accounts for 95% of the total energy used in the district. This has resulted into a lot of deforestation and loss of tree cover. The increased demand for wood fuel is due to slow adoption of Biogas and solar energy technologies and high cost of petroleum products and slow rate of rural electrification and increased tariffs on electricity.

#### 4.1.4 Hydrology of the site

The physical environment of the site (i.e. climate) has been discussed in section 4.1.1.1 above. Hence the discussion of the hydrology in this section shall limit itself to the analyzing the site runoff properties, reservoir sizing as well as preliminary investigation of the associated sediment transport

##### 4.1.4.1 Previous studies

Ntale (2011) considered some aspects of the Kabuyanda site in the study report titled "Rapid identification and assessment of potential sites for multipurpose storage reservoirs", a report prepared for the Kagera River Basin Project.

##### 4.1.4.2 Alternative developments

It should be appreciated that there are three rivers that flow into the Kabuyanda valley, River Mishumba being the largest. For complete control of the waters flowing into the valley, the other smaller rivers could either be dammed at the entrance into the flat depression (Figure 4.1-1) or alternatively they could be diverted into the primary irrigation canal to serve the command area. Therefore, if the decision to develop this dam is taken, it should be implemented, taking into consideration the whole Kabuyanda valley water system requirements and control.

##### 4.1.4.3 Runoff

Flow at the proposed dam site is not gauged. However, hydrological modeling using regionalized parameters shows that between years 1956 and 2000, the daily flow at the dam site ranged between 0.1 m<sup>3</sup>/s on 7-May-1967 and 10.6 m<sup>3</sup>/s on 12-Sep-1982 and averaged 0.6 m<sup>3</sup>/s (Figure 4.1-5). The mean flow has an exceedance probability of 27% while the median flow is 3.7 m<sup>3</sup>/s.

The mean monthly total flows vary between 0.7 Million m<sup>3</sup> (Mm<sup>3</sup>) in July and 1.5 Mm<sup>3</sup> in April (Figure 4.3-3). A secondary peak flow of 2.4 Mm<sup>3</sup> occurs in November. The total annual flow averages about 19 Mm<sup>3</sup>.

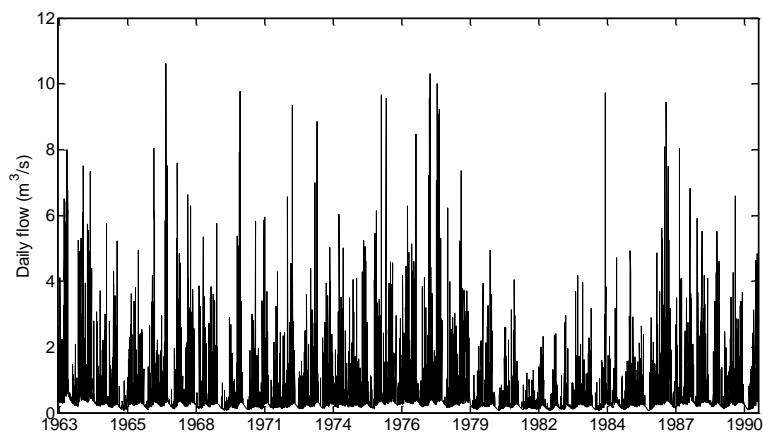


Figure 4.1-5: Daily flow variation: Kabuyanda

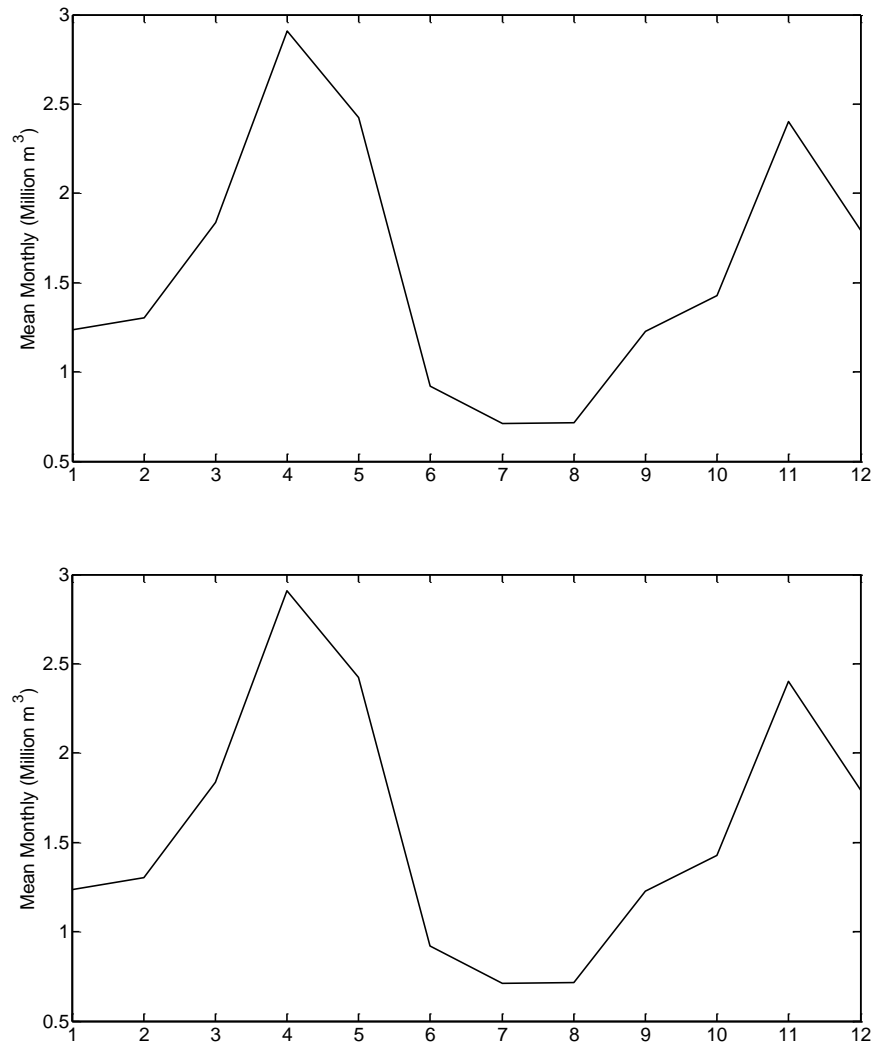


Figure 4.1-6 Kabuyanda Mean monthly flow variation

4.1.4.4 Reservoir

Using a 30m digital elevation model (DEM) of the area, reservoir elevation-area and elevation-volume curves were prepared and are shown in Figure 4.1-7 and Figure 4.1-8 respectively. The figures show that the inundation area and volume of reservoir increases steadily with elevation up to an elevation of 1400 m asl. The limiting parameter to the reservoir size is the quantity of available water. After computation of the available runoff at the site, it was decided to fix the ratio of the runoff to the volume of the reservoir to no less than 1.1. Taking this ration and dead storage into consideration, a reservoir elevation of 1363.2 m asl was recommended for this proposed dam site. Figure 4.1-1 shows the Volume – Area relationship for the dam site. The reservoir fetch is about 2.8km.

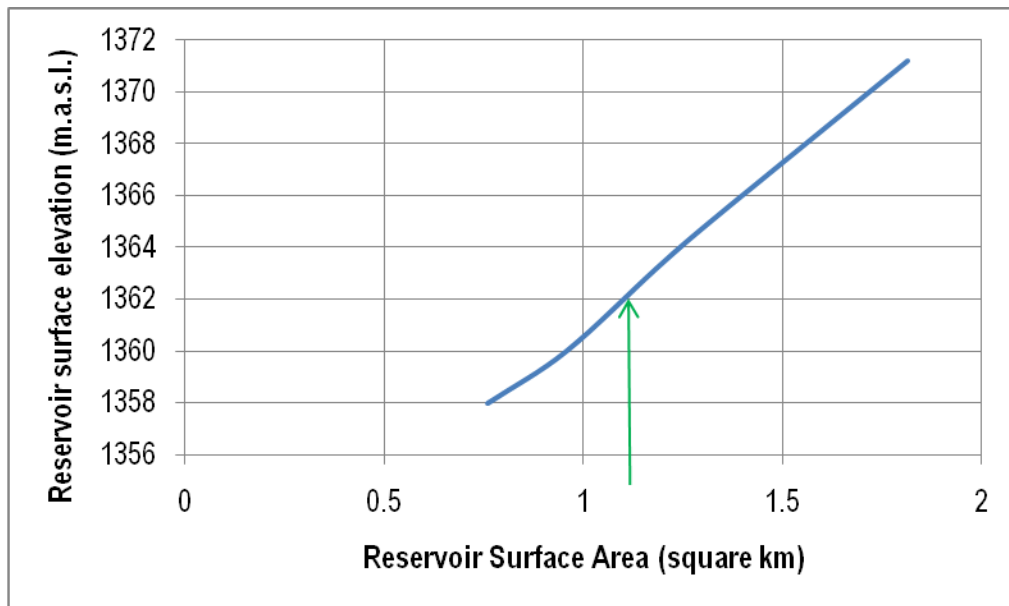


Figure 4.1-7: Plot of Kabuyanda reservoir surface elevation versus reservoir surface area

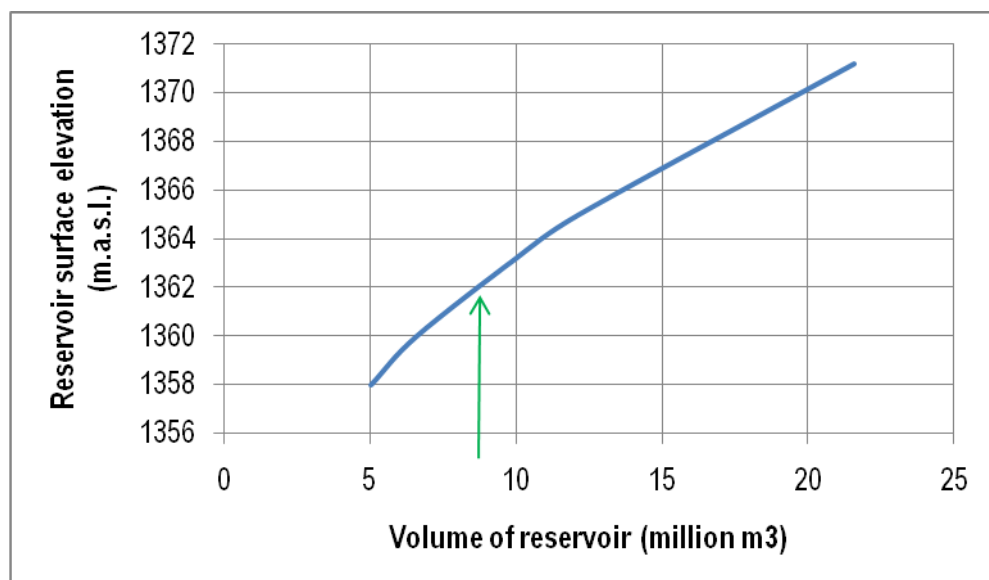


Figure 4.1-8: Plot of Kabuyanda reservoir surface elevation versus reservoir volume

A reservoir elevation of 1363.2 m asl will inundate 1.183 km<sup>2</sup> of land and will have a total volume of 10 million cubic meters of water. The reservoir fetch will be approximately 2.3 km along the main river. Kabuyanda reservoir **would not require any resettlement of people.**

#### 4.1.4.5 Reservoir evaporation

Being an open water body, the reservoir evaporation rates would be expected to be close to the potential evapotranspiration rates. Table 4.1-2 shows the daily and monthly potential evaporation rates estimated from data at 1 meteorological stations located close to the Kabuyanda dam site.

Table 4.1-2 Daily and monthly potential evaporation rates

Month	Daily Evaporation	Monthly Evaporation (mm)
Jan	3.3	103
Feb	3.6	100
Mar	3.7	113
Apr	3.0	90
May	2.7	84
Jun	3.1	94
Jul	3.4	104
Aug	3.5	109
Sep	3.6	108
Oct	3.6	113
Nov	3.2	97
Dec	3.3	104
Annual	3.3	1219

#### 4.1.4.6 Sediment transport

This study shall use an empirical sediment assessment methodology first proposed by Lawrence et al. (2004) which was based on a study they undertook on sediment deposition in 14 dams in East and Southern Africa. Lawrence et al. (2004) estimated sediment yields by first carrying out a rapid catchment characterization procedure which included scoring qualitative factors describing soil type, crop cover, and signs of erosion. Lawrence et al. (2004) then combined the qualitative factors with quantitative information on slopes, rainfall and catchment area in the following simple predictive function calibrated using measured catchment sediment yields:-

$$S_Y = 0.0194 \text{ Area}^{-0.2} * \text{MAP}^{0.7} * \text{Slope}^{0.3} * \text{SASE}^{1.2} * \text{STD}^{0.7} * \text{VC}^{0.5}$$

Where

$S_Y$  = Sediment yield (t/km<sup>2</sup>/year)

Area = Catchment area (km<sup>2</sup>)

MAP = Mean annual precipitation (mm)

Slope = River slope from the catchment boundary to the dam

SASE = Signs of active soil erosion (Score from catchment characterization)

STD = Soil type and drainage (Score from catchment characterization)

VC = Vegetation condition (Score from catchment characterization)



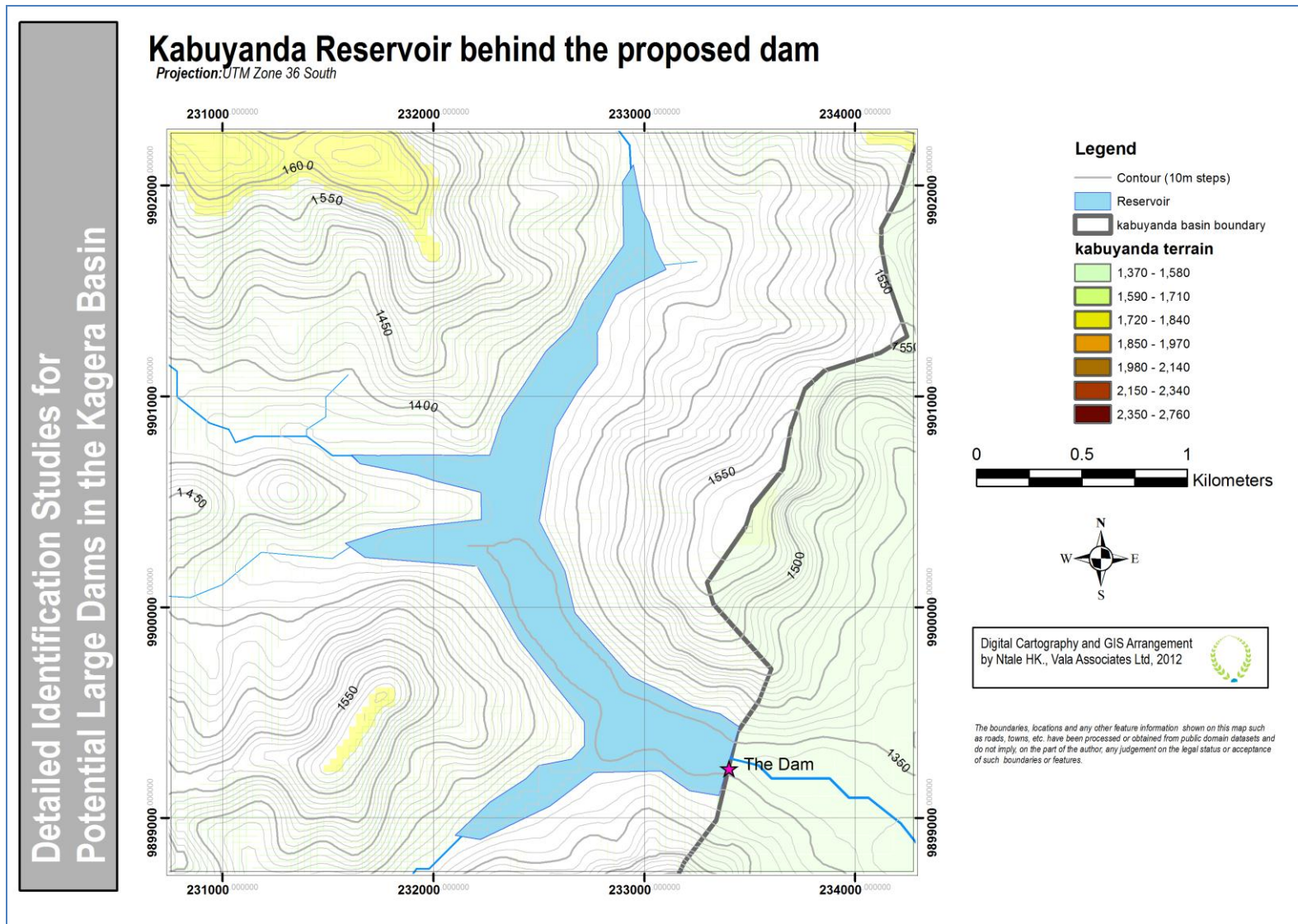


Figure 4.1-9 Kabuyanda Reservoir at 1362m above sea level

It should be borne in mind that the catchment characterization represents a “snapshot” of conditions in the catchments on a single visit. In light of the high standard errors associated with sediment measurement, and some other potentially large sources of error, the values obtained from this study are only indicative. It is the understanding of the consultant that more rigorous methods will be adopted during feasibility studies of the project to obtain more accurate sediment yields information. However, this will only be possible if sediment data collection is embarked on right now, so that by the time the feasibility study is carried out at least there will be some data with which to calibrate and validate the numerical model outputs.

Using the approach suggested by Lawrence et al (2004), sedimentation yields for the Kabuyanda catchment contributing to the dam site was established to be 672 t/km<sup>2</sup>/yr. The dead storage properties of the dam are shown in below:

Table 4.1-3 Kabuyanda Sediment Properties

Site Name	Kabuyanda
Reservoir Volume (Mm <sup>3</sup> )	10
Catchment area (km <sup>2</sup> )	109
SY (t/km <sup>2</sup> /yr)	672
Assumed Sediment density (t/m <sup>3</sup> )	1.1
Dead Volume (Mm <sup>3</sup> )/yr	0.03
Dead storage after 50 years (Mm <sup>3</sup> )	1.45
Percentage of Reservoir filled with sediment after 50 years	14%

#### 4.1.4.7 Floods

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

- i). Selection of the maximum 24-hour flows from the modeled flows
- 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 4.1-4)

Table 4.1-4: Flood estimates for the Kabuyanda Project

Return period, T (years)	Flood magnitude (m <sup>3</sup> /s)	Risk of failure for a 50 year design life (%)
50	14.2	63.6
100	15.7	39.5
200	17.1	22.2
500	19.1	9.5
1000	20.6	4.9
10000	25.7	0.5

#### 4.1.5 Irrigation and command area

The Kabuyanda site is very suitable for irrigation immediately downstream of the dam. There is intensive mixed farming in the Kabuyanda valley. Availability of water all year around would enable the valley residents to engage in more profitable agriculture. The irrigation command area for Kabuyanda is about 1283 ha (Table 4.1-5). This is the area that can directly be irrigated by the reservoir. However, some more 2920 ha of irrigable land are available and may be irrigated if other feeding rivers are diverted into the primary irrigation canals. The command area can support 2500 farmers and provide food for about 12,700 people. The annual water demand for irrigation is about 6.4 Mm<sup>3</sup>.

Table 4.1-5: Irrigation command area for Kabuyanda

District	Sub-County	Area (ha)
Isingiro	Kabuyanda	931
	Kikagate	352
<b>Total</b>		<b>1283</b>

#### 4.1.6 Water Supply

The total population that can benefit from water supply from the Kabuyanda project in 2012 and 2062 was estimated at 69,753 and 336,934 people respectively (Table 4.1-6). The annual water demands are 0.8 Mm<sup>3</sup> and 2.9 Mm<sup>3</sup> for 2012 and 2062, respectively.

Table 4.1-6: Potential water supply beneficiaries for Kabuyanda

District	Sub-County	Population (2012)	Population (2062)
Isingiro	Kabyanda	33,420	161,431
	Kikagate	9,869	47,670
	Nyakitunda	4,206	20,315
Ntungamo	Rukoni	22,259	107,518
<b>Total</b>		<b>69,753</b>	<b>336,934</b>

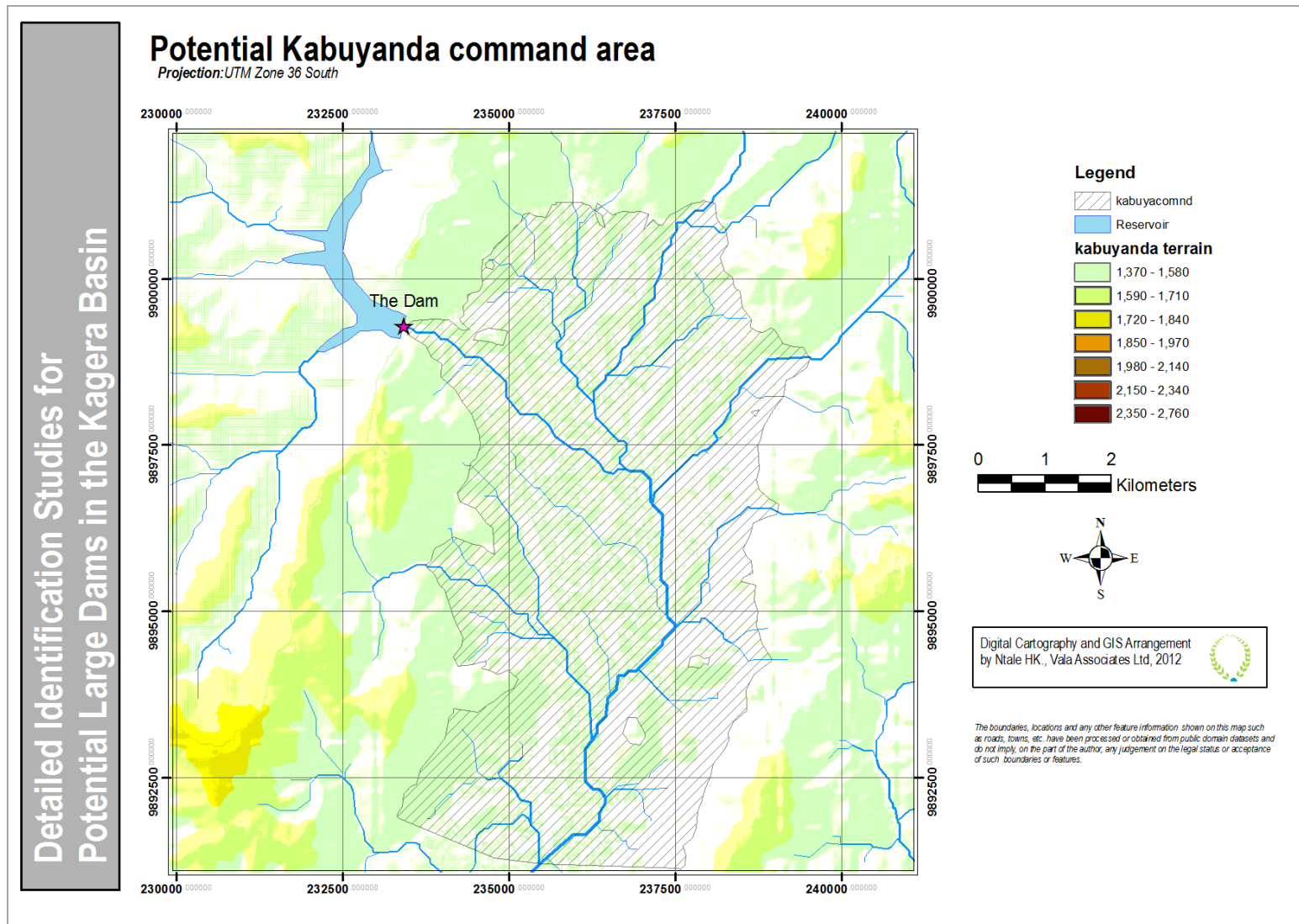


Figure 4.1-10 Kabuyanda command area

## 4.1.7 Dam Design elements

### 4.1.7.1 General

Owing to the nature of the river cross-section at the proposed dam site as wide valley, an earth dam is proposed. The dam will have a base elevation of 1347.2 m asl while the crest elevation will be 1364.7 m asl. The dam crest will be 350m long. An Ogee type spillway is included within the design to be located on the right side of the dam. The spillway crest elevation will be 1362.7 m asl while the spillway crest length will be 15 m.

### 4.1.7.2 Dam Type

The dam at Kabuyanda has been designed as an earth dam with a roadway on top.

Table 4.1-7: Kabuyanda dam design

Variable		Units	Value
Dam location			<b>Kabuyanda</b>
Dam type			Earth Dam
Reservoir base elevation		m asl	1345.2
Reservoir top elevation		m asl	1362.7
Reservoir depth at above dam base (Hnet)		m	17.5
Free board (Flood control pool + 3% of dam height)	Flood control pool (flood height above spillway crest): 1.5m 3% of dam height (for wave action, etc): 1.5m	2.5	m 2.5
Dam height H		m	20.0
Crest elevation		m asl	1365.2
Spillway crest elevation		m asl	1362.7
Crest length		m	350
Top width (7-12 m depending on dam height)		m	7

### 4.1.7.3 Construction materials

A full investigation of the availability of good quality construction materials will be carried out at the feasibility stage. From the reconnaissance it was established that there is plenty of good red earth soil within the dam environs which could be used to construct the dam. 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.



#### 4.1.7.4 Spillway

The spillway will be of the side channel type. It will be located on the right side of the dam. Table 4.1-8 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 4.1-8: Spillway design parameters

Variable	Units	Value
Return period	years	10,000
Spillway crest elevation	m asl	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

#### 4.1.7.5 Hydropower

The proposed hydropower station at the Kabuyanda site has the potential to produce 1.0 GWh of energy per year which is enough to supply about 1,000 houses and over 6,000 people.

#### 4.1.8 Project costs

The estimated costs for the Kabuyanda project total to 13.2 million US dollars as broken down in Table 4.1-9 below. It is interesting to note that despite the site being primarily being motivated by irrigation and water supply needs, some hydropower can be produced at the site as well.

Table 4.1-9 Kabuyanda Project costs

No	Item	Units	Quantity	Rate (USD)	Amount (USD)
<b>1.0</b>	<b>PREPARATORY WORKS</b>				
	Mobilisation and demobilisation	Lumpsum	1	800,000	800000
	Permanent access	km	10	100,000	1000000
	Temporary access	Lumpsum	1	100,000	100000
	River diversion during construction	Lumpsum	1	500,000	500000
	Resettlement and compensation	ha	118	2,500	295000
	<b>Subtotal</b>				<b>2695000</b>
<b>2.0</b>	<b>MAIN DAM</b>				
	Excavation, loose	m3	48000	15	720000
	Excavation, rock	m3	12000	22	264000
	Foundation preparation	Lumpsum	1	300,000	300000
	Dam earthworks - random fill	m3	120000	15	1800000
	Dam earthworks - impermeable core	m3	80000	20	1600000
	<b>Subtotal</b>				<b>4684000</b>

<b>3.0</b>	<b>SPILLWAY, INTAKE</b>				
	Excavation, loose	m3	1000	15	15000
	Excavation, rock	m3	3500	22	77000
	Concrete Spillway	m3	4200	200	840000
	Concrete intake	Lumpsum	1	250,000	250000
	Penstocks, 2No @ 0.2 m2 steel	m	100	500	50000
	Other civil structures	Lumpsum	1	200,000	200000
	<b>Subtotal</b>				<b>1432000</b>
<b>4.0</b>	<b>POWER STATION</b>				
	Excavation, loose	m3	3000	15	45000
	Excavation, rock	m3	2000	22	44000
	Reinforced concrete power station	m3	2500	350	875000
	Other civil works	Lumpsum	1	100,000	100000
	<b>Subtotal</b>				<b>1064000</b>
<b>5.0</b>	<b>MECHANICAL AND ELECTRICAL WORKS</b>				
	Turbines and miscellaneous mechanical equipment	Lumpsum	1	350,000	350000
	Generators, transformers and miscellaneous electrical equipment	Lumpsum	1	200,000	200000
	Gates for intake, outlet	Lumpsum	1	75,000	75000
	Switchyard	Lumpsum	1	100,000	100000
	<b>Subtotal</b>				<b>725000</b>
	<b>TOTAL, CONSTRUCTION COST</b>				<b>10600000</b>
	ADMINISTRATION AND ENGINEERING		0.1		1060000
	CONTINGENCIES		0.15		1590000
	<b>CAPITAL COST (WITHOUT VAT)</b>				<b>13250000</b>

#### 4.1.9 Anticipated Impacts and Mitigation Measures for the Kabuyanda Project

##### 4.1.9.1 Positive Impacts

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

- The dam will likely facilitate cultivation of crops to be done throughout the year and that will guarantee household income for the communities and also food security;
- Proposed watershed management practices once instituted will likely improve the settings around the project;
- There will be improvement of access roads easier transportation of machinery and equipment to the site and such roads will benefit the communities;
- The dam project can generate some indirect benefits such as induced developments such restaurants and accommodation facilities to serve the workers thereby leading to the development of the area;
- Adjacent communities especially the women are likely to start some businesses such as sale of food to the workers thereby earning some additional income to supplement their domestic needs;
- Apart from irrigation needs, if well managed, the dam can be used for aquaculture by the community;
- There will be improved supply of water for both domestic and livestock purpose

- It will also support cattle production and associated dairy products through improved water supply
- During construction phase, the communities will get benefits in terms of employment.

#### 4.1.9.2 Negative Impacts

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

- The entire catchment of the dam as well as the planned reservoir lie in the Rwoho Central Forest Reserve. It is advantageous to have a catchment that is a forest reserve; however, the idea that the water reservoir is within the Forest reserve as well may be seen to be consuming the original gazetted function of the land.
- The project will take up 118 ha (out of the 9100 ha of the entire NFA CDM site or 1.29 of the total gazetted land). Although this is a small percentage, it might have a negative impact on the communities who are already participating and anticipating to benefit from the CDM project;
- Impacts on the papyrus stand on the river thereby affecting communities who are benefiting from the local crafts out of papyrus reeds;
- The dam will take up access road that passes through the planned site thereby denying communities access route to the neighbouring villages;
- 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;
- 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;
- Loss of water resources through evaporation will be a minor impact as the net losses due to evaporation could likely be low as compared to annual inflow;
- Due to the change of the hydrology of the River, the aquatic environment as well as the wetlands near the Project area should be taken in consideration during the ESIA;
- Pollution of water sources from loose soils, and agro-chemical residual impacts;
- HIV/AIDS from the workforce and the communities is likely to be an issue during construction phase of the dam;
- Potential equipment related concerns in terms of oil spillages, used batteries and oil filters as well as used tyres all these are anticipated to occur in the camp site; and
- Water diseases through establishment of the dam could increase such as malaria; bilharzia should be studied during the ESIA.

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 4.1-10 below:

Table 4.1-10 Key impacts and mitigation measures for the planned Kabuyanda site



Nº.	Project Impact	Mitigation measures
01.	Potential conflict with CDM site	Details of the project to be shared with NFA so as to work out the optimal site for the dam and associated reservoir to minimize impacts on the CDM project site.
02.	Impact on banana and coffee shambas thereby impacting on livelihoods and sources of incomes for the communities	Compensation of the Project Affected Persons be undertaken by the project
03.	Impact on community water source downstream of the site	Alternate source of water for the communities need to be located during dam construction.
04.	The dam site will take up a community road that passes through the site	Alternate route for the community will be set up by the project.
05.	Land uptake through construction of the dam and access roads, camp sites, etc	Compensation for land uptake after Resettlement Action Plan (RAP) studies.
06.	Concerns relating to management of cut to spoil materials	Disposal sites for cut to spoil have to be approved by the Supervising consultant.
07.	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
08.	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.
09.	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.
10.	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.
11.	Soil erosion concerns which will likely arise through loose soil materials causing sedimentation	Soil control measures have to be instituted during works implementation.
12.	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.
13.	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.
14.	Human waste management especially in irrigation fields and workers camp sites.	Measures for human waste management to be instituted on the sites.
15.	Noise and vibrations	Noise from equipment and the workforce

Nº.	Project Impact	Mitigation measures
16.	HIV/AIDS from the workforce and the communities	<p>Contractors to work with HIV/AIDS service providers to sensitize communities on HIV/AIDS.</p> <p>Furthermore, the project should work out HIV/AIDS mitigation measures with the district leadership and the health department so that there should be an HIV/AIDS programme dedicated to the project. This is important in that, the project will affect social dynamic of the areas, hence there will be induced developments and population influx which all will have impacts on the communities with reference to HIV/AIDS prevalence.</p> <p>In all, the detailed ESIA should investigate this issue and propose appropriate mitigation measures.</p>
17.	Air Quality concerns	Dust suppression measures will be instituted to ensure air quality levels are kept appropriate.
18.	Crime rate possible increase	Working together with the police and law enforcement agencies in the areas of the project to control crime in the areas.
19.	Impacts on socio-cultural sites	During the IESE studies, there were no site of socio-cultural values in the project proximity. It is proposed that, detailed ESIA should further investigate this aspect and come up responsive mitigation measures to mitigate this concern.
20.	Impacts on biodiversity areas of high conservation concerns (Important Bird Areas-IBAs, national and central forest reserves etc).	Working with NFA to work out appropriate

## 4.2 Kagitumba-Maziba Dam Site

### 4.2.1 Physical Environment Profile

The site for the proposed Kagitumba dam is located on River Nyakizumba near Maziba Town in Kabale District, Southwestern Uganda. The coordinates of the proposed dam site are  $-1^{\circ} 18' 54.36''$  (South) and  $30^{\circ} 5' 25.26''$  (East.) as shown in Figure 4.2-1. Upstream of the dam site, Kagitumba River flows in a south-easterly direction. At Maziba Town, the river makes a 90 degree turn and flows in a north-easterly direction to the proposed dam site. At the 90 degree bend, the river is joined by two smaller tributaries and flows for about 1.2 km to the proposed dam site. The river continues in north-easterly direction for a further 9 km before turning sharply to flow in a southerly direction. The slope of the river upstream of the dam is about 1% while the slope downstream is about 10% and contains some rapids.

The primary purpose of the dam is hydropower production while a secondary purpose would be irrigation. Owing to the many settlements in the river valley including major Towns like Maziba, Kanjobe and even Kabale Town, the site presents challenges to any plan that involves a large reservoir, However, the terrain of the area allows for a significant head of over 240 m if the power station is located at Kahondo close to the Rwanda border. Irrigation potential on the Uganda's side is quite limited because of the steep terrain while increasing the command area into Rwanda would result in complications related to managing trans-national irrigation schemes.

#### 4.2.1.1 Topography

The topography of the project area can be described as mostly rolling (57%) and flat (39%) with mountainous terrain. The deep valleys between the hills occasionally have a combination of seasonal and permanent streams most of these drain eastwards towards the L. Victoria system.

#### 4.2.1.2 Geology

The geology of the project area is similar to that of the Kabuyanda site which is discussed to some length in section 4.1.1.3 above. From 1:100,000 maps, it can be inferred that the geology of the area consists of the Southern Ankole geological system which is entirely dominated by ancient (Precambrian) metamorphic rocks of the Toro and Karagwe-Ankolean Systems, which are intruded by slightly younger granitic rocks

#### 4.2.1.3 Soils

Most of the soils in the project areas are a mix both clay sandy loams with little differentiation into clearly defined horizons. The soils, especially those found in the valleys occur in clay sediments and dominantly darkish in colour. On tops of the some ridges, the soils are red loams. In some areas, the soils are of ferralitic type and at a final stage of weathering with little or no mineral reserve left. Other types include lithosols, alluvial and lacustrine sands and alluvial clays. Lithosols and humus loams are the dominant uplands while the grey sandy soils derived from hill wash or river alluvium, grey clays of the valley bottoms and lacustrine sands dominate the lowlands.

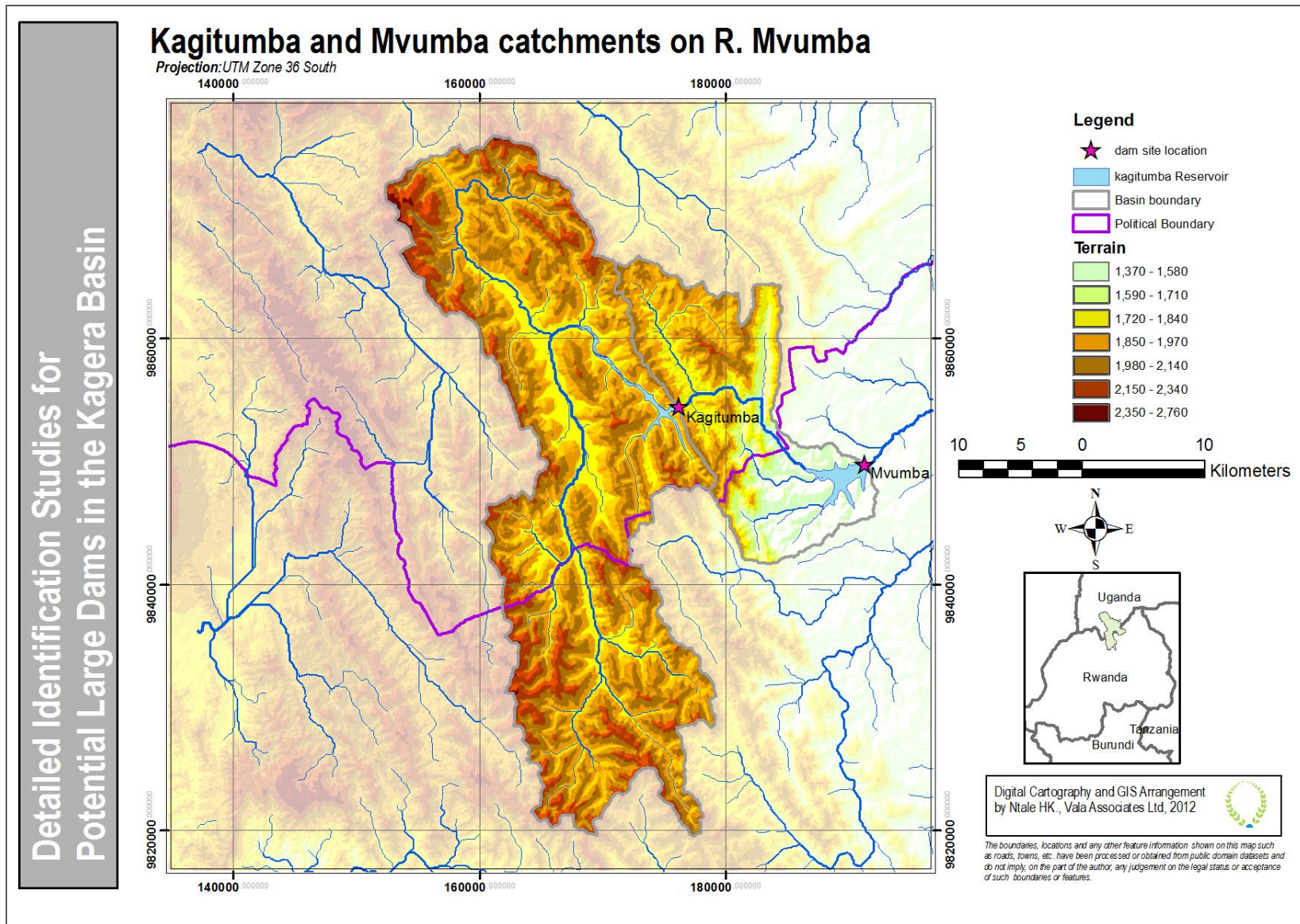


Figure 4.2-1 Kagitumba Maziba Catchment

#### 4.2.1.4 Climate

The climate of the project area falls under Kabale climatic zone which once Sir Winston Churchill described Kabale as “The Switzerland of Africa” due to the great diversity of topography, landscape and vegetation. The scenery before Kabale progressively becomes dramatic with deep steep slopes. These physical features have a role in the modification of Kabale climate which is generally cool. Kabale climate is generally considered to be semi-temperate i.e. neither hot nor cold. It's neither hot nor cold. Its Annual maximum temperature is 24.2°C while the annual mean minimum temperature is 12.1°C. The climate of Kabale can be classified as cool and humid which is primarily due to the altitude. However, there are reports from the area that show temperatures have arisen in recent years. This is possibly attributable to deforestation and extensive swamp reclamation. The region shows a bimodal rainfall pattern with rains coming from March to June and September to December. The rainfall amounts vary a great deal in space and time ranging from annual means of 1,000 to 1,500 mm.

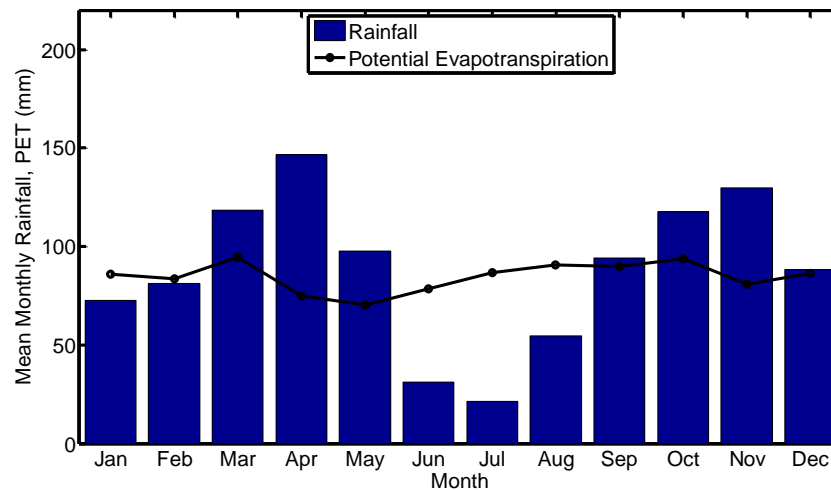


Figure 4.2-2 Kagitumba catchment mean monthly rainfall and potential evaporation

Available data indicates that the basin receives a mean annual rainfall of 1054 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 September and November but can sometimes extend to December. The maximum rainfall is received in April and averages 147 mm while maximum rainfall in the short rainy season is received in November and averages 130 mm. July is the driest month, receiving only 20 mm of rainfall. The mean annual potential evaporation is 1016 mm and varies over a narrow range between 95 mm in March and 70 mm in May. The temperature ranges between 15°C in July and 19°C in April.

#### 4.2.1.5 Vegetation

On the site there are trees and general vegetation which are not of conservation significance. The site is largely dominated by grass communities and agro-biodiversity in terms of crops such as bananas, beans, and sorghum. However, downstream of River is dominated by *Acacia gerrardii* (Plate 4.2-1) which at some sections forms closed canopy. Along the river are sections paddocked farmlands for cattle grazing (Plate 4.2-2). It is



important to note that, there are no forests or protected areas within the immediate the vicinity of the project.



Plate 4.2-1 Sections of the River Nyakizumba with some relic riverine forest patches of *Acacia* and Elephant grass



Plate 4.2-2 Grazing lands along sections of the River Nyakizumba

## 4.2.2 Social Environment Profile

This section presents preliminary socio-economic assessment, and the current project socio-economic baseline which is a summary of the situation formed through a combination of secondary data and stakeholder consultations.

### 4.2.2.1 Population and Demography

The population increase in the Kabale district is the result of natural increases due to high fertility levels and fairly high annual growth rates. Between the 1980 and 1991 intercensal period, the growth rate was 2.1 % per annum against the national average of 2.5%. There has been a tremendous increase in the districts' population density. According to the 1991 census, the population density for Kabale was 250 persons per sq. kilometre, compared to 199 persons per sq. kilometre in 1980. However, population densities in Kabale are actually higher than the figures quoted above if one considers the population figures and the available arable land. It is assumed now that, the rural population density per sq. kilometre of cultivated land was estimated to be 620 inhabitants. High densities have resulted in a drastic decrease in farm size, or land per capita, and as a consequence land shortage has resulted.

### 4.2.2.2 Age Distribution

A large number of young population combined with high illiteracy levels make available unskilled labour. From Figure 4.4 it is clear that almost half 49% of the population are youth, while young children aged below 9 years also take up 28% of the population in the project area. This may imply that the contractor may not have to import manual labour from elsewhere.

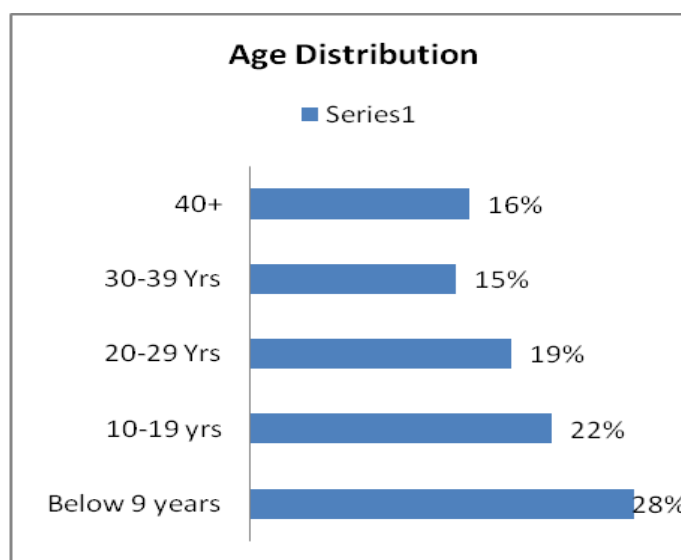


Figure 4.2-3 Age Distribution in the Kagitumba project area

### 4.2.2.3 Religion

In matters concerning religion in the area study, there are notably four main religions that the people subscribe to i.e. Islam, catholic, protestants and the Pentecostals/evangelicals.

The Protestants and the Catholics share up 83% of the population; the 19% comprise the evangelicals (Pentecostals) and the Muslims (Figure 4.2-4).

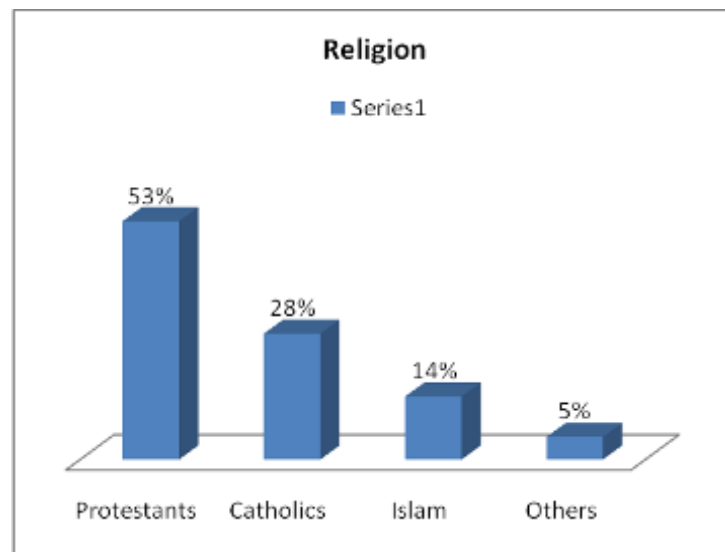


Figure 4.2-4 Religious groups in the Kagitumba project area

#### 4.2.2.4 Land tenure and land use

Different land tenure systems operate in Uganda namely customary, freehold, mailo land and leasehold. The 2002 census classified land tenure as; customary, free hold, mailo land, leasehold and others (Figure 4.2-5).

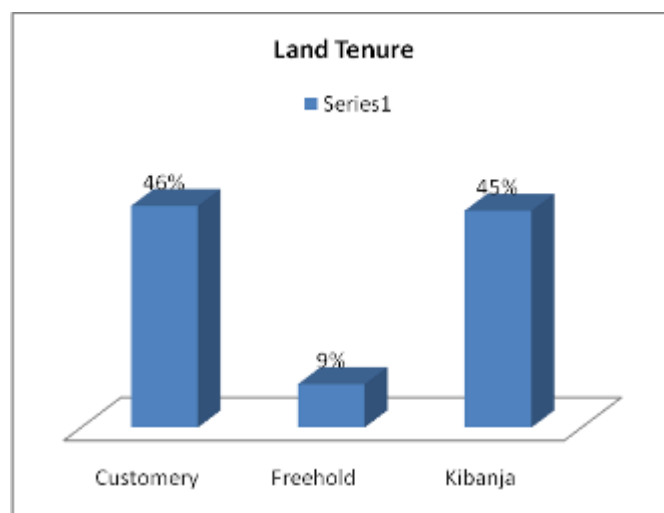


Figure 4.2-5 Land tenure modes in the Kagitumba project area

#### 4.2.2.5 Economic activities

Subsistence farming is the major source of livelihood employing 82% of the population in Kabale. In the project area 68% of the population reported that agriculture was their main source of income. Agriculture is followed and supplemented by employment income, family support and other family enterprises most of which are undertaken near and along the road



especially in the merging trading centres. Owing to the poor conditions of the main and feeder roads, farmers and traders are facing increasing costs of bringing agriculture inputs to farmers and outputs to the markets.

Livestock such as goats, cows, and poultry is sold to earn income. Communities are also engaged in retail and wholesale businesses majorly in items like: alcohol, garments, building materials, cosmetics, beverages and food items. Others earn through rentals, bars and restaurants, money exchange, charcoal sales and bricks. Fishing is also undertaken in some sections of R. Nyakizumba basically for domestic needs.

However, there are few government employment opportunities in the area and so many of the people are self-employed some with shops (retail and wholesalers), others deal in produce like beans, maize that they sell in Rwanda. Tailoring is also another job that is mostly done by the women.

#### 4.2.2.6 Health

The health scenario in the project area is characterized by high prevalence of communicable diseases, emergence of diseases due to lifestyle, inadequate availability of drugs and dilapidated health infrastructure. Data from Kabale District Five Year District Development Plan for 2010-2015 shows malaria as the leading cause of morbidity and mortality in the district. HIV/AIDS has remained a big threat to the district despite the interventions used to reduce its spread and effects. Understaffing and under funding of the department have continued to affect the quality of health care due to heavy workloads, inadequate equipment and frequent stock outs of essential drugs and supplies. Poor community health seeking behaviour and practices due to negative cultural beliefs and practices, limited access of health services more especially in hard to reach areas are the major cause of poor health care in Kabale areas.

Table 4.2-1 Disease Burden for Ten Top Diseases Reported in 2010/11

Diagnosis	0-4 Years (%)	5 Years and over (%)
Malaria	69	60
RTI No- Pneumonia-Cough or Cold	42	31
Intestinal worms	9	5
Diarrhoea Acute	6	2.1
Skin diseases	5	3
Pneumonia	4	1.6
Eye Conditions	4	2.0
ENT Conditions	2	
Diarrhoea Persistent	0.4	
Urinary Tract Infections	0.2	2.2
Sexually Transmitted Infections		3
HIV/AIDS		2.4
<b>Total's</b>		

Source: DDP, Kabale District 2008-12

#### 4.2.2.7 Prevalent diseases

Similar to the district statistics, malaria is the commonest disease in the planned dam project area with 58% of the respondents reporting so. Other diseases include: diarrhea, RTIs, intestinal worms and measles (Figure 4.2-6)

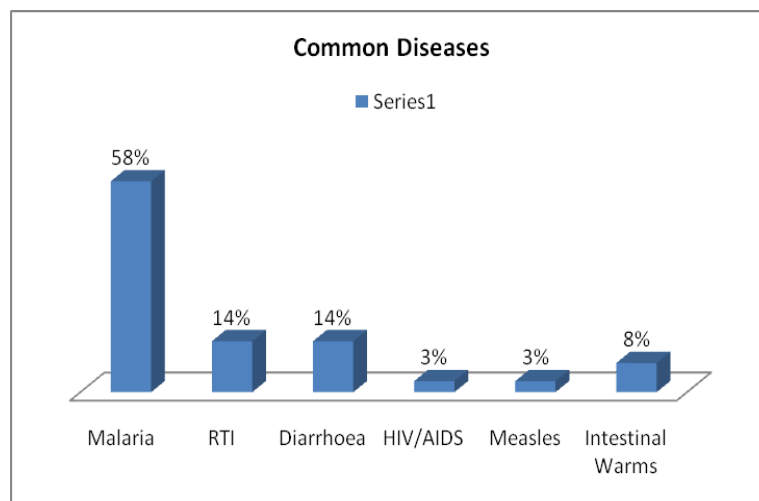


Figure 4.2-6 Common Diseases in the Kagitumba project area

#### 4.2.2.8 Water and sanitation

Access to safe water and good sanitation are very crucial to the health of the population. Use of unsafe water sources coupled with poor sanitation poses one of the greatest threats to health. Hence universal access to safe water and sanitation is a key priority of the Government of Uganda. The 2002 Census showed that 61% of the households had access to safe water sources compared to 26% in 1991, representing a 35% point increase. Despite the improvement, the current levels are still below the PEAP targets of 100% and 90% for urban and rural areas respectively by 2007/08 and the MDG target of 80% for all areas by the year 2015.

The main water sources in the area are largely supplied through gravity water schemes which are only available to few people near the road where the water pipe is located, there are few people who are able to connect water to their homes but the majority of them just buy at a cost of 50 shillings per 20 litre jerrican in the villages and trading centres and those who cannot afford simply fetch water from the nearby R. Nyakizumba. Others collect pond water which is sometimes shared with livestock.

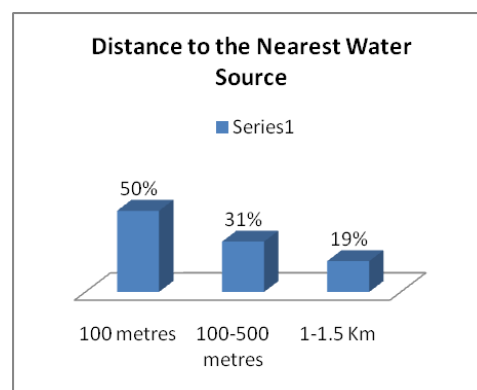
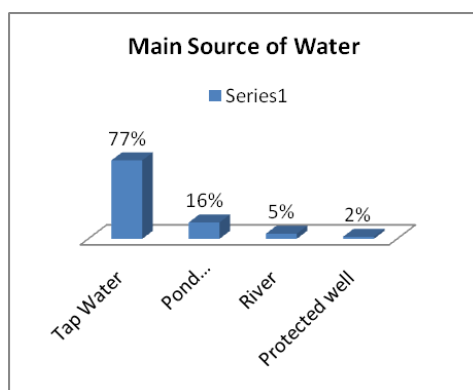


Figure 4.2-7 Summaries of water information in the Kagitumba project area



Plate 4.2-3 Some of the water sources shared by communities and livestock

#### 4.2.2.9 Energy

It is estimated that, about 77% of the population in the project area use fuel wood as their major source of energy. Fuel-wood collection, like is the case of water, women and children are responsible for fuel wood collection from an average distance of 2 kilometres. Because of the dangers involved in fuel wood collection, coping mechanisms in some communities include consumption of one meal a day, which has negative implications for the nutritional status of households. Clearing of vegetation for purposes of improving the main road may aggravate the existing fuel wood shortage with serious implication on school attendance and gender poverty.

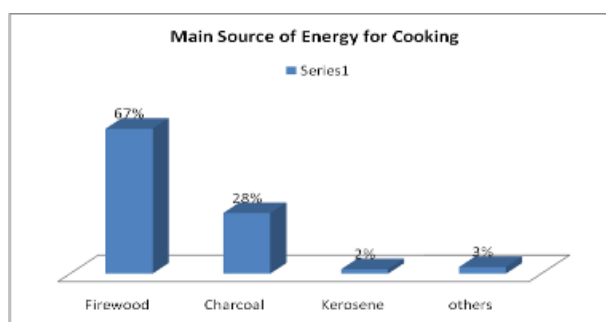


Figure 4.2-8 Main sources of energy for cooking, Kagitumba project area

#### 4.2.2.10 Gender Analysis

Both male and female were seen to be participating in economic activities however, discrepancies were observed in the different jobs done by each group. The male tend to dominate the transport business of drivers, riding motor cycles (*boda-bodas*), bicycles, and money changing. The females are mainly involved in tailoring, shop keeping and working in restaurants. At household level, the male take the lead in decision making and the women are responsible for the household chores as reported by participants in the focus group discussions. But in terms of leadership and office jobs both were seen to participate. The contractor of the OSPB project need to take maximum care when recruiting at the time of construction by making sure that the females get jobs in their area such cooking for the

workers. The community also requested that the project takes into account the different needs of men and female in terms of provision for facilities.

#### 4.2.2.11 Archaeology and physical cultural resources of the area

From preliminary consultations with the communities, the proposed project site does not have any cultural sites. However, the communities bury their relatives in their homesteads not in clan burial grounds as in central Uganda. The implication of this is, the homesteads have graveyards which are scattered out. Therefore, implications of the project on the physical cultural environment will be minimal and incidental and is to be reported to the relevant departments at the district.

- Proposed integrated watershed management measures will likely bring about improved environmental management in and around the wider watershed areas of the project;
- Some local can benefit from sale of local construction materials to the project such as sand and other fill materials;
- It is expected that, delivery of social services will likely improve once electricity is in place. Immunization, education and security will likely improve in the areas;
- The electricity to be generated will likely induce other developments in the area in the long run;
- Access routes for transportation of equipment and, project machinery will be improved thereby benefitting the locals;
- ;
- Social issues regarding land availability and subsequent compensation aspects will likely be crucial for the success of the project in view of scarce land in the areas of the project; and

#### 4.2.3 Alternative developments for the Kagitumba site

The two alternatives to exploiting the hydropower potential of Kagitumba site are

- (i) Construction of the power station 600 m downstream of the proposed dam location. This would provide for an additional head for power generation of about 40 m.
- (ii) Construction of the power station 9 km downstream at Kahondo, 2 km from the Rwanda-Uganda border. This would provide for an additional head for power generation of about 240 m.

The topography between the dam site and Kahondo is conducive as it would provide a head of over 240 m which would result in a significant increase in the amount of power that can be generated. Therefore, the viability of the second alternative of constructing the power station 9 km downstream of the proposed dam site has been assessed in this study

#### 4.2.4 Previous studies

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

- Nile Basin Initiative, (2010). - Development of Kagera Integrated River Basin Management and Development Strategy (KIRBMS) by SWECO international carried out on behalf of NELSAP. The primary objective of the consultancy is to

develop an integrated river basin management and development strategy for the Kagera basin.

- Feasibility study for the rehabilitation of SHPP Maziba, Efficient and Sustainable Energy Supply in Uganda, a report by Lahmeyer International GmbH, 2010
- Nyagatare Water Resources Assessment Project by M&E Associates in association with Real Contractors S.a.r.l on behalf of Government of Rwanda. The objective of the study was to carry out a prefeasibility study on the development of storage for various water uses along River Muvumba/ Kagitumba.

## 4.2.5 Hydrology

### 4.2.5.1 The catchment

The catchment area of the basin upstream of the dam site is 712 km<sup>2</sup> and is shared between Uganda (62%) and Rwanda (38%). The topography of the catchment is shown in Figure 4.2-1. The elevation of the riverbed at the dam site is about 1700 m asl. The river valley cross-section is bowl-shaped. On the right bank of the river, the flanks rise at a slope of about 11% for a distance of about 61 m before rising more sharply at a slope of 49%. A similar variation is seen on the left bank with the flanks rising at a slope of about 12% for a distance of 66 m before rising more sharply at a slope of 52%.

The catchment has a length of 57 km and an average width of about 13 km (Figure 4.2-1). The mean catchment slope is about 31% but the steepest slopes may be higher than 80%. The catchment elevation ranges between 1770 m asl at the dam site to over 2400 m asl while the mean is 2002 m a.s.l.

### 4.2.5.2 Alternative developments for the Kagitumba site

The two alternatives to exploiting the hydropower potential of Kagitumba site are

- (iii) Construction of the power station 600 m downstream of the proposed dam location. This would provide for an additional head for power generation of about 40 m.
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### 4.2.5.3 Runoff

Data from the nearby Nyakizumba gauging station shows that, between years 1956 and 2000, the daily flow at the dam site ranged between 0.8 m<sup>3</sup>/s on 15-July-1999 and 44 m<sup>3</sup>/s on 14-May-1979 and averaged 4.5 m<sup>3</sup>/s (Figure 4.2-9). The mean flow has an exceedance probability of 27% while the median flow is 3.7m<sup>3</sup>/s.

The mean monthly total flows vary between 26.4 Million m<sup>3</sup> (Mm<sup>3</sup>) in May and 7.5 Mm<sup>3</sup> in August (Figure 4.2-9). A secondary peak flow of 13.3 Mm<sup>3</sup> occurs in November. The total annual flow averages about 150 Mm<sup>3</sup>.

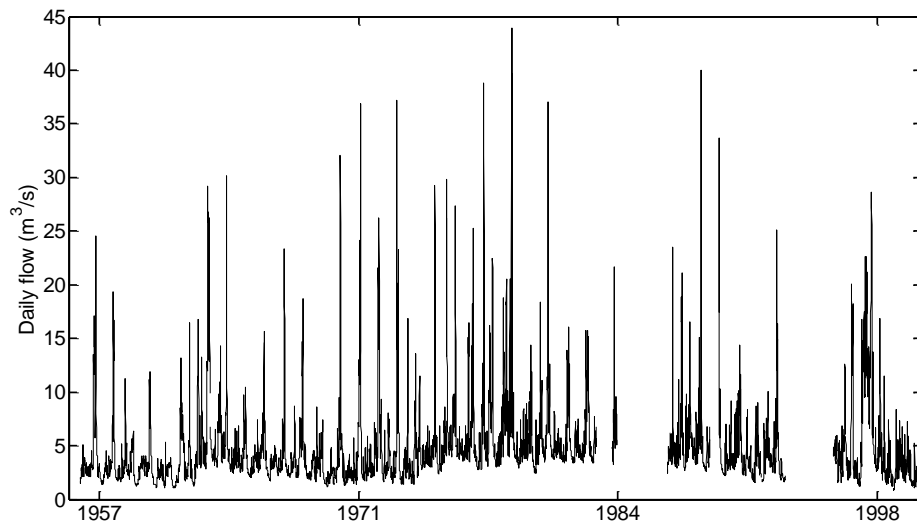


Figure 4.2-9: Daily flow variation, River Nyakizumba

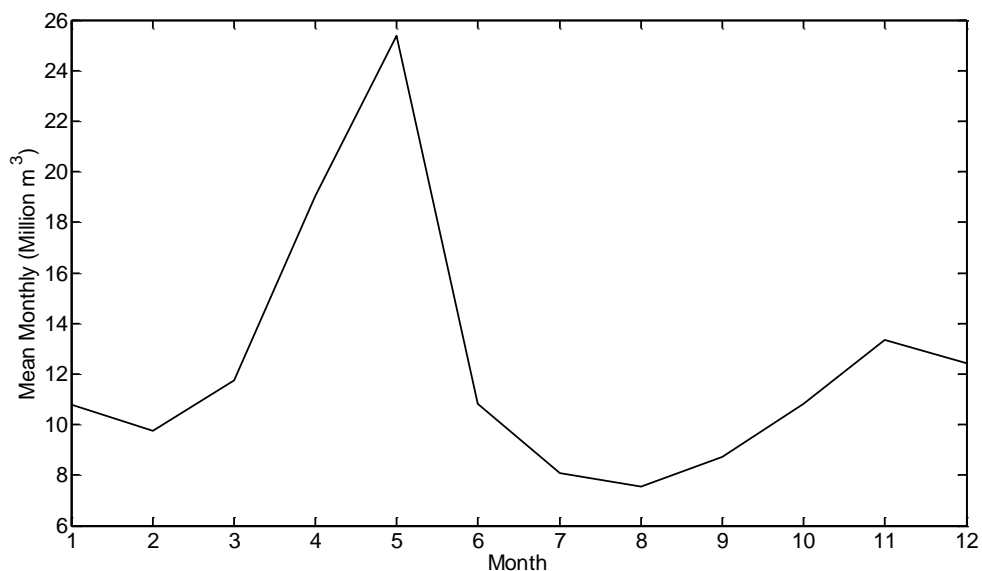


Figure 4.2-10 Mean monthly flow variation, R. Nyakizumba

#### 4.2.5.4 Reservoir

Using a 30m digital elevation model (DEM) of the area, reservoir elevation-area and elevation-volume curves were prepared and are shown in Figure 4.2-11 and Figure 4.2-12 respectively. Figure 4.2-11 shows that the inundation area increases sharply with elevation up to an elevation of 1801 m asl. After this, the curve is much flatter meaning that small increases in elevation result in large increases in inundated area and maybe unviable. From this point of view, therefore, the maximum viable elevation to which the reservoir can be raised is 1801 m asl. However, an elevation of 1801 m would inundate some densely populated areas close to Kabale Town. The KIRBMDS report gives a maximum elevation of the Kagitumba reservoir as 1793 m asl. This is probably based on the rationale that the lowest elevations in and around Kabale Town are around 1795 m asl.

However, the numerous settlements are located within the areas that would be inundated by a reservoir at elevation of 1793 m asl. Setting the required reservoir volume can be based on the required storage to offset the deficit between inflow and outflow during the driest months. Dry months in the area range between 3 and 4 months during which river flows can drop to 20-30% of the mean flow. A total of two months storage was set as the minimum that should be met by the reservoir by the Kagitumba reservoir. Taking dead storage into consideration, a reservoir elevation of 1787 m asl would be sufficient to meet this requirement at the proposed dam 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.

A reservoir elevation of 1787 m asl will inundate 224 ha of land and will have a total volume of 25 million cubic meters of water. The reservoir fetch will be 9 km along the main river while the fetch along the two tributaries will be about 2.5 km upstream of their confluence with the main river at Maziba Town (Figure 4.2-13). The average width of the reservoir will be about 200 m. The Kagitumba-Maziba reservoir would result in resettlement of about 751 people (Table 4.2-2)

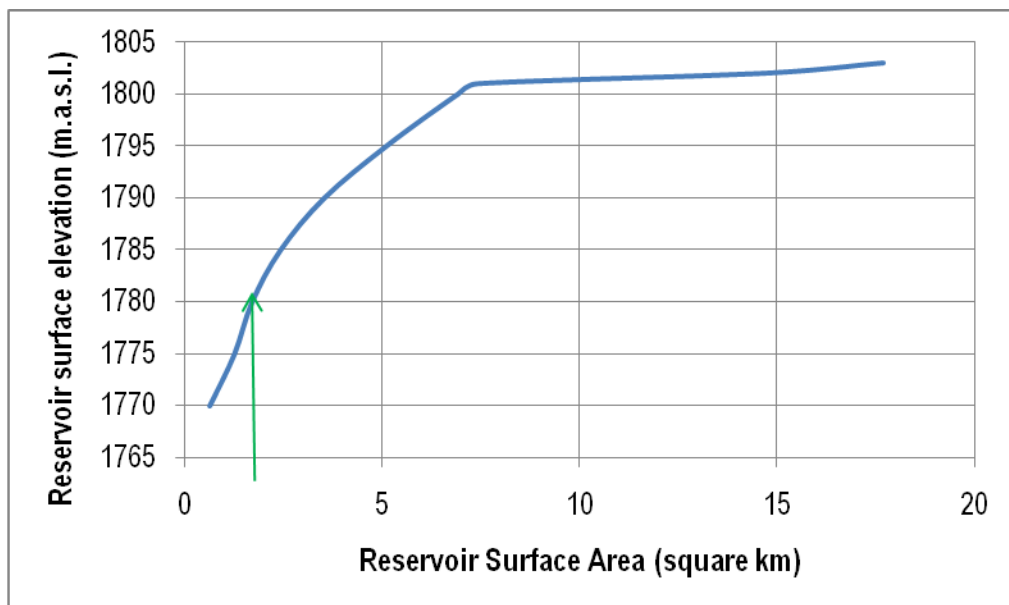


Figure 4.2-11: Plot of reservoir surface elevation versus reservoir surface area, Kagitumba project



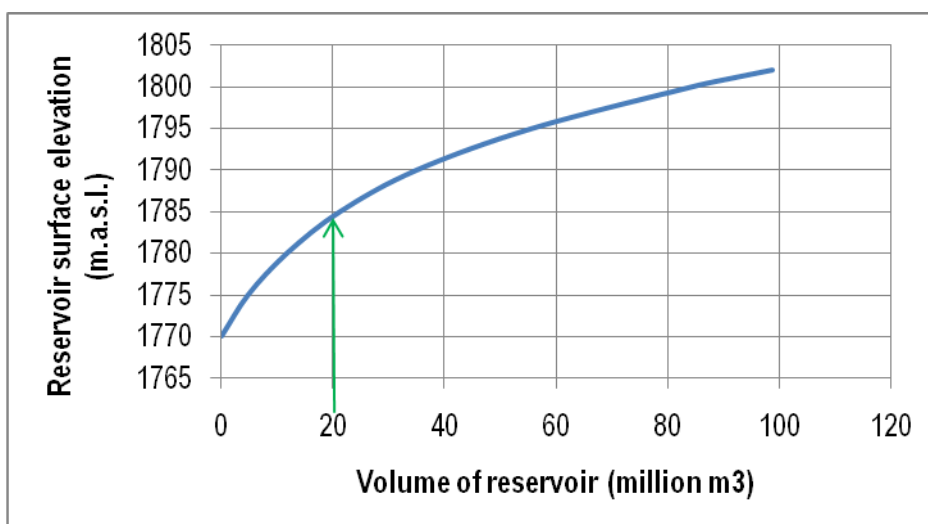


Figure 4.2-12: Plot of reservoir surface elevation versus reservoir volume, Kagitumba project

Table 4.2-2: Land area to be inundated by the Kagitumba-Maziba reservoir and the affected population

County	Sub-county	Land area (km <sup>2</sup> )	Population (2012)
Ndorwa	Buhara	1.6	425
	Kyanamira	0.9	272
	Maziba	0.4	54
<b>Total (reservoir inundation)</b>		<b>2.8</b>	<b>751</b>

#### 4.2.5.5 Reservoir evaporation

Being an open water body, the reservoir evaporation rates would be expected to be close to the potential evapotranspiration rates. Table 4.2-3 shows the daily and monthly potential evaporation rates estimated from data at 2 meteorological stations located close to the Kagitumba dam site.

Table 4.2-3 Daily and monthly potential evaporation rates, Kagitumba project

Month	Daily Evaporation	Monthly Evaporation (mm)
Jan	2.8	86
Feb	3.0	83
Mar	3.0	95
Apr	2.5	75
May	2.3	70
Jun	2.6	79
Jul	2.8	87
Aug	2.9	91
Sep	3.0	90
Oct	3.0	94
Nov	2.7	81
Dec	2.8	86
<b>Annual</b>	<b>2.8</b>	<b>1016</b>