

**A scoping study of the Hydrological Systems for Lake
Edward Basin- Bwindi Impenetrable and Queen
Elizabeth National Parks, Southwestern Uganda**



*Technical report submitted to
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GVTC-ES*



**By:
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LISTS OF ABBREVIATIONS

| | |
|-------------|---|
| BINP | : Bwindi Impenetrable National Park |
| DRC | : Democratic Republic of Congo |
| FGD | : Focussed Group Discussion |
| GVL | : Greater Virunga Landscape |
| GVTC | : Greater Virunga Transboundary Collaboration |
| ITFC | : Institute for Tropical Forest Conservation |
| NEMA | : National Environmental Authority |
| QENP | : Queen Elizabeth National Park |

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EXECUTIVE SUMMARY

The Greater Virunga Landscape (GVL) is an interconnected chain of eleven protected areas (PAs) straddling the borders of Uganda, Rwanda and Democratic Republic of Congo (DRC) with endemic and endangered flora and fauna. The GVL is well known for its mountain gorillas (*Gorilla beringei beringei*). The lake Edward basin is located within the GVL and its environs receive lots of rainfall due to the forest cover of the protected areas therein. Despite this, water for local community use still remains a big challenge and is insufficient due to the uneven distribution of the water sources therein. Even with the water resources in the lake Edward Basin, the water for local people livelihood is threatened with pollutions and human livelihood activities. Deforestation on the hillsides of lake Edward for agriculture has resulted in extreme soil erosion and silting of rivers and lakes during heavy rainfalls. This was the basis of this study that was commissioned by GVTC to conduct a scoping study for the Lake Edward Hydrological basin in both Uganda.

In order to achieve the above objective of the scoping study, we used rapid and adaptive hydrological assessments and socioeconomic assessments methods around the lake Edward basin. This was done through; Assessment of existing information and data related to water resources in the region, Field visits to the developed and undeveloped water sources, onsite assessment of water source conditions, assessment of watershed conditions through assessment of the major rivers draining into Lake Edward. Furthermore, we use Focused group discussions with local leaders, water committees and park managements, reviewed documents related to water management in the regions and also carried out Key informant interviews with water management specialist (water engineers, natural resource managers at the district.

Study findings reveal that there is lack or no secondary data on water resources available at the local and district level. Where it is available the information is discrete and scanty. There is limited research on hydrological systems especially river hydrology in region. We found out that the Natural Resource and Environment offices in the region were inactive in their operations and that there was no specific water management plans as

most district development plans do not prioritize and deeply pronounce on water and environmental issues. The preliminary hydrological assessment findings reveal that despite the numerous availability of water resources in the region, the quality of the water resources is very poor as a result of human agricultural practices, waste disposal ways, mining and related climate change effects. These have resulted in polluted rivers and lakes from siltation, soil erosion and sometime flooding. Other major challenges included; Population increase and poverty, degradation of most riverbanks attributed to agriculture and limited awareness and deficiencies in law enforcement of water management laws and policies.

In conclusion, this study shows that there is dearth of hydrological systems information/data missing in the region for understanding the watershed/hydrological systems of the lake Edward water basin. This information/data is important for the sustainable management of the watershed at both policy formulation and policy implementation level.

This study proposes the following recommendations for a sustainable water management system in the region:

- Need for an in-depth study on the hydrological assessment of L. Edward basin and research uptake
- An urgent need for a harmonized approach to the exploitation of water resources at an integrated water shed management level.
- A need for stringent policies/laws and their enforcements that aim at restoring the riverbanks for major rivers crossing through agricultural areas.
- A need for other water resources such as rainwater harvesting facilities should be explored as an alternative water supply scheme to the local people. This could be coordinated and funded through GVTC with its partners in order to reduce pressure on the protected areas that might result into conflicts between PA managers and the local people.
- A need for an action research and establishment of a regional database to create a sustainable inventory of the water regimes.

1.0 INTRODUCTION

1.1 Background and Context

The scoping study aimed at exploring the hydrology and water resources of Lake Edward drainage system covering Bwindi Impenetrable National Park (BINP) and Queen Elizabeth National Park (QENP). The Lake Edward basin in Uganda is comprised of several watersheds that provide an inflow into Lake Edward. The two protected area systems in Uganda, form part of the Lake Edward drainage basin. In this scoping study, the water related issues in the Lake Edward drainage systems were broken down into Bwindi and Queen Elizabeth drainages (with some parts of Rwenzori Mountains national park forming part of the drainage). The Ugandan side of the Lake Edward has several rivers flowing into Lake Edward. They include River Ivi (tributary of Rutshuru), River Ishasha, River Ntungwa, River Ncwera, and smaller streams of Rwampunu and Nyamweru (World Lakes Database). All the rivers drain the Kigezi highlands on the eastern side of the Lake. The other main inflow into Lake Edward is River Nyamugasani, which drains the south-western end of the Rwenzori's. Because of the high human population and the use of unsustainable agricultural practices on the steep slopes, the rivers draining into lake Edward are usually turbid from heavy sediment load from agricultural runoff (Kasangaki et al., 2012). As a result the quality of water from the rivers may not be fit for human consumption.

The protected areas forming part of the Lake Edward catchment include Bwindi Impenetrable National Park, Queen Elizabeth National Park, and the Kigezi Wildlife Reserve. The protected areas all located within the Albertine Rift, are rich in both terrestrial and aquatic biodiversity including endemic species of mammals and fish. As populations around the parks continue to increase, pressures on the parks to provide a variety of resources will increase. Without the appropriate management interventions of watershed resources outside the parks, the ecosystems being protected within the parks will also be at risks from human activities. Within the lake Edward Basin, less than 1% of households have water supplied on their premises, while 16% have water within 1 km of radius (Development Consultants International, 2008).

1.2 Description of the Mission's Scope of Work

ITFC technical team led the scoping exercise to explore and analyze the hydrology of the Lake Edward region with a particular focus on the improvement of the water supply for local communities and reversing river system degradation.

1.3 Goal

1. Perform a preliminary field survey and provide an initial assessment of the hydrologic systems of the region, characterizing the threats to these watersheds and proposing strategies to minimize them.
2. Gauge the current state of available information and level of monitoring that is occurring across the landscape.
3. Identify what questions need to be answered about the area and what work needs to be completed over the next year and beyond in terms of data gathering to improve the current state of knowledge of these watersheds.
4. Evaluate the state of water resources in the region and suggest methods of improving the quantity and quality of water that is being distributed to local communities.

2.0 METHODS

2.1 Description of the Study Area

In Uganda, the scoping study aimed at exploring the hydrology and water resources of Lake Edward drainage system covering Bwindi Impenetrable National Park (BINP- Figure 1 & 2) and Queen Elizabeth National Park (QENP-) (Figure 1 & 2). The Lake Edward basin in Uganda is comprised of several watersheds that provide an inflow into Lake Edward. The two protected area systems in Uganda, form part of the Lake Edward drainage basin. In this scoping study, the water related issues in the Lake Edward drainage systems were broken down into Bwindi and Queen Elizabeth drainages (with some parts of Rwenzori Mountains national park forming part of the drainage).

The Ugandan side of the Lake Edward has several rivers flowing into Lake Edward. They include River Ivi (tributary of Rutshuru), River Ishasha, River Ntungwa, River Newera,

and smaller streams of Rwampunu and Nyamweru (World Lakes Database). All the rivers drain the Kigezi highlands on the eastern side of the Lake. The other main inflow into Lake Edward is River Nyamugasani, which drains the south-western end of the Rwenzori's. Because of the high human population and the use of unsustainable agricultural practices on the steep slopes, the rivers draining into lake Edward are usually turbid from heavy sediment load from agricultural runoff (Kasangaki et al., 2012). As a result the quality of water from the rivers may not be fit for human consumption.

The protected areas forming part of the Lake Edward catchment include Bwindi Impenetrable National Park, Queen Elizabeth National Park, and the Kigezi Wildlife Reserve. The protected areas all located within the Albertine Rift, are rich in both terrestrial and aquatic biodiversity including endemic species of mammals and fish. As populations around the parks continue to increase, pressures on the parks to provide a variety of resources will increase. Without the appropriate management interventions of watershed resources outside the parks, the ecosystems being protected within the parks will also be at risks from human activities. Within the lake Edward Basin, less than 1% of households have water supplied on their premises, while 16% have water within 1 km of radius (Development Consultants International, 2008).

The study was conducted in the five districts of Kasese, Rukungiri, Mitooma, Bushenyi, Sheema, Rubirizi and Kanungu. We assessed the major rivers that flow into Lake Edward: Nyamugasani and Lhubiriha of Kasese district; Ncwera and Ntungwa that originates from Bushenyi through Mitooma (only Ncwera) and Ntungamo (only Ntungwa) to Rukungiri district; Nyamweru; Rwampunu and Kaizi that originates from Rubirizi district through Queen Elizabeth National Park (QENP). River Ishaasha that passes through Bwindi Impenetrable National Park (BINP) in Kanungu was also assessed. Both QENP and BINP are catchment areas for the Lake Edward basin. Hydrological data of the two protected areas was generated from the park offices of Buhoma (BINP) and Katunguru (QENP). This helped to contextualize the study and generate existing data available for other subsequent interventions.

We interviewed 30 key informants from the districts of Kasese, Mitooma, Rukungiri, Sheema and Rubirizi (Ref. Appendix). Eleven (11) Focus Group Discussions were conducted in Kyarumba, Nyakatonzi, Mpondwe and Karambi in Kasese district between June 16 and June 18, 2015. The study team conducted other Focus Group Discussions in Bitereko in Mitooma district on June 19, 2015; Bwambara and Rwenshama in Rukungiri district on June 20, 2015. Other Focus Group discussions were conducted between June 21 and 24, 2015 in Nkongoro Nyabihoko-Ntungamo, Kitagata-Sheema district, Kisenyi and Karinzu in Rubirizi district (Ref. Appendix). In total 110 people participated in Focus Group Discussions.



Figure 1 General Locational map of the study area in lake Edward Basin

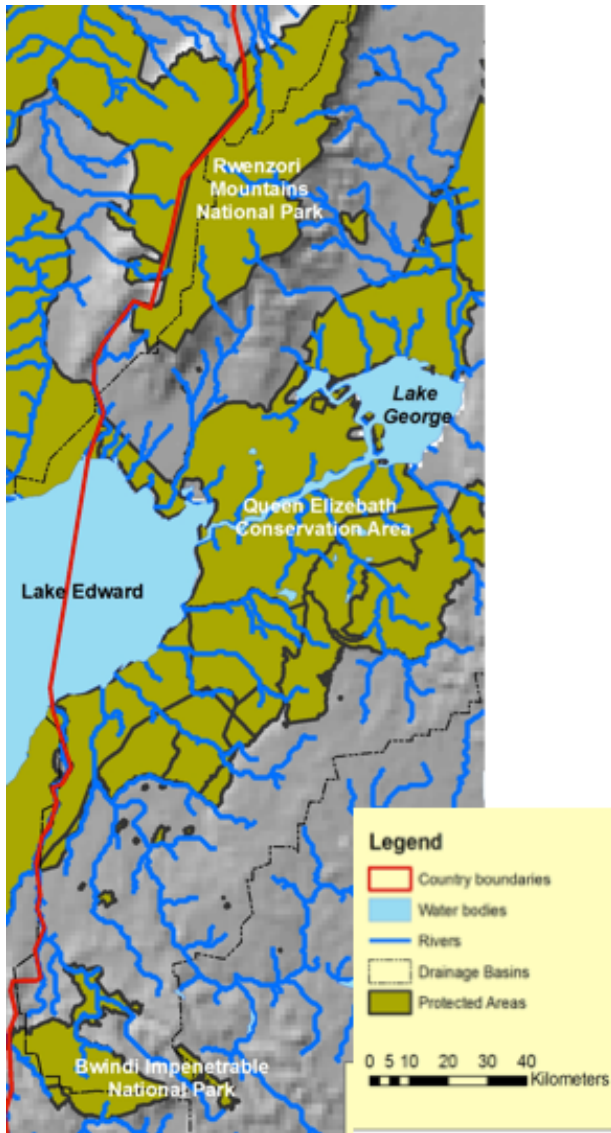


Figure 2 The Major drainage system of lake Edward Basin

2.2 Data Collection Methods

The methods for assessing water resources within the landscape took a watershed approach where different major watersheds within the landscape were identified and detailed assessments done therein. The specific methods applied are detailed below:

Hydrology assessment

- Assessment of existing information and data related to water resources in the region. This included hydrological gauging stations, weather data, water quality

and quantity. Data availability was assessed through literature review and interviews with key resource persons in the landscape.

- Field visits to the developed and undeveloped water sources- the field visits assessed water resource availability and access by the local population. The condition of the water sources was assessed onsite.
- Assessment of watershed condition. These were done based on the major rivers draining into Lake Edward (plate 1). In each of the watershed, issues of land degradation, deforestation, water pollution and nature of the terrain were assessed to aid determination of watershed conditions. Any initiatives by government and NGOs and CBOs aimed at conserving the watersheds were also identified.



Figure 3 An Assessment of the hydrological condition of River Ishasha-Uganda

A watershed approach was employed to assess the hydrological conditions of the major rivers flowing into the Lake Edward. The major rivers and their watershed were identified and assessed using an integrated landscape assessment that involved scanning the landscape for any signs of degradation in addition to visiting the rivers to assess the

condition of the banks and in-stream habitat and water quality. The assessment of the watershed was systematic following the river/watershed gradient from upstream, midstream and downstream where the river enters the lake.

Socioeconomic surveys

Data was collected through Focus Group Discussions and Key informant interviews (plate 2). A total of 11 FGDs were conducted and each FGD was composed of 10 participants. In total 110 people participated in FGDs. FGDs helped to generate detailed data on historical changes, water demand, supply, perceptions on water quality and potential threats. Thirty (30) key informants were interviewed and these included; district local government staff (natural resource and environmental officers, population officers and planning staff (n=08), local leaders (n=18) and National Park staff (n=04). The integration of key Informants aimed at identifying policy related and administrative measures put in place for water resource management. They also helped share data on natural resource plans and strategies of reversing existing degradation.



Figure 4 Focus Group Discussions in Bwambara, Kasese District

3.0 STUDY FINDINGS

3.1 Status of Existing Hydrological Systems data/information

Secondary data on Lake Edward hydrology is very scanty as table 1 shows. In all the sampled districts, limited or no hydrological systems reports/data existed. Kasese district has environmental drainage maps but other districts do not. A map of the Imaramagambo Central Forest Reserve also aided to describe the rivers of Ntungwa, Ncwera, Rwampunu, Kaizi, Rwampunu and Nyamweru. The limitation of search data/information at the local government headquarters is a precursor to poor water management in the region. Without information/data on the existing water resources to the policy makers/implementers at the local government, then the sustainability of use of the water resources in the region is at stake. This will lead to poor/unsustainable use of the existing limited water resources that will compromise the water resources leading to water related conflicts in the region.

Table 1 Availability of hydrological data/information in the study area

| Parameter | QENP | BINP | Kasese | Rubirizi | Mitooma | Rukungiri | Kanungu | DRC | Data source |
|----------------------------------|------|------|--------|----------|---------|-----------|---------|-----|--|
| Water shed conditions | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Management plans, |
| Water sources | Yes | Yes | Yes | No | No | Yes | No | No | Water report |
| Hydrology of swamps | No | No | No | No | No | No | No | No | N/A |
| Erosion and Resource Degradation | No | No | No | No | No | No | No | No | N/A |
| Water resource management | No | No | No | No | No | No | No | No | N/A |
| Weather and Climate data | Yes | Yes | Yes | No | No | No | No | No | Weather monitoring data, Reconnaissance report |
| Geological maps | Yes | No | No | No | No | No | No | Yes | Geological surveys and mines, Visitor information centre |

Yes = Have the data/information, No = Have no data/information, NA = not applicable

3.2 Status of Bwindi National park's hydrological system

Bwindi Forest is an important water tower as it gives rise to several streams and rivers that drain into Lake Edward. The park's underlying geology consists of Precambrian shale phyllite, quartz, quartzite, schist and granite. The park is located at the edge of the Western Rift Valley in the highest parts of the Kigezi Highlands, which were created by up-warping of the Western Rift Valley. Its topography is very rugged, with narrow valleys intersected by rivers and steep hills. Altitude in the park ranges from 1,190 to 2,607 meters above sea level, and 60% of the park has an elevation of over 2,000 meters (6,600 ft.).

The Bwindi forest is an important water catchment area. With a generally impermeable underlying geology where water mostly flows through large fault structures, water infiltration and aquifers are limited (Guitteri et al 2008). Much of the park's rainfall forms streams, and the forest has quite a dense network of streams. The forest is the source of many rivers that flow to the north, west, and south. Major rivers that rise in the park include the Ivi, Munyaga, Ihihizo, Ishasha, and Ntengyere rivers, which flow into Lake Edward. Other rivers flow into Lakes Mutanda (Butynski, 1984).

The major rivers draining Bwindi include Ishasha with its main tributaries of Munyaga and Ihihizo, River Ivi with its main tributaries of Kashasha and Kihungye, the southern part of park is drained by Nshongyi and Ndeego streams that flow into River Ruhezamyenda originating from Lake Bunyonyi. Downstream, Ruhezamyenda flows through Lake Mutanda where it is joined by other tributaries from Kisoro to form River Kaku (Plate 3) that flows into DRC. The streams originating from Bwindi national park are generally of good water quality (plate 4) with transparency values above 120 cm and conductivity values of below 30 $\mu\text{S}/\text{cm}$. But when these streams/rivers flow into local community areas such as farmlands and settlement, the water quality declines with lower transparency and higher conductivity values (plate 4). Because of the good water quality of sources within the national park, several gravity flow schemes have been established to supply the surrounding communities with clean water. Examples of gravity flow schemes originating from Bwindi include Buhoma community scheme, Rubuguri water scheme, Banyara gravity scheme and the Ndeego gravity flow scheme. Because of the abundance of water around Bwindi National park, communities rarely enter the park to access water.



Figure 5 River Kaku as it flows through Busanza in Kisoro district, several HEP projects have been planned to be constructed on this river



Figure 6 River Ivi in Bwindi with good water quality (A), B is the same river flowing through agricultural fields with poor water quality

The physicochemical characteristics and aquatic biodiversity of major streams and rivers of Bwindi Impenetrable National park have been studied extensively (e.g. Kasangaki et al 2006, Kasangaki 2007, Kasangaki et al 2008). For example the physicochemical characteristics and benthic macroinvertebrates of rivers Munyaga, Ihihizo, and Ishasha were investigated over a ten-year period and the data is available at the Institute of Tropical Forest Conservation archives. Over 18 species of fish have been described from Bwindi rivers including those endemic to the Albertine Rift region and some that may be

new to science such as *Amphilius* sp Nov. Long-term weather data for Bwindi also exists and several automatic weather stations have been established around the park. These can be used to model the hydrology of the sub-watershed accurately.

Most of the river systems draining Bwindi are protected in the upper parts of the watershed and are therefore not impacted by human activities such as erosion and runoff from agricultural fields. However, as the rivers leave the protected area, downstream they flow through agricultural areas and are often impacted by runoff from the fields and dirt roads. As a result the water quality deteriorates as the rivers flow towards Lake Edward to the north. Other major polluters of the water sources downstream may be the agricultural chemicals used in the tea plantations where the use of fertilizers is rampant. Other disturbances on the rivers draining Bwindi may be the mini-hydro power plants such as the one on River Munyaga and another located on river Ishasha producing 6.4 megawatts of electricity.

The hydrology of the Bwindi Rivers is yet to be studied comprehensively. In addition, the microbiological and heavy metal pollution of the rivers is yet to be ascertained. These are highly recommended for a detailed hydrological assessment. The demand for water by communities around the park appears not to be high because of the abundance of surface water in streams, rivers and wetlands both within the communities and from the inside the park.

3.3 Status of Hydrological Systems in Queen Elizabeth's and Rwenzori parks

Two major rivers flow into Lake Edward via Queen Elizabeth National Park and drain the southeastern part of the Rwenzori Mountains. The two main rivers are Nyamugasani and Lhubiriha. River Lhubiriha is medium sized up to 10m width in the midslopes and flows along the DRC-Uganda border before it drains into Lake Edward. Upstream, its source is located within Rwenzori Mts National park, midstream, it flows through an intensively cultivated landscape on steep slopes where it frequently floods leading to loss of crops and human lives.

Human activities along the river such as cultivation and washing clothes may be impacting the water quality and aquatic biodiversity of the river (Plate 5). Further downstream before the river enters Queen Elizabeth National Park, the river flows near the Bwera-Mpondwe border town where is heavily polluted by urban activities such as motor vehicle washing, open urination and defecation. Being a transboundary river, management of the water resource in the river may be challenging, as it will require the consultation of authorities in both DRC and Uganda. On the Ugandan side of the river, the upstream part of the river is already harnessed for a gravity flow scheme and there are plans for the expansion of the system according the Kasese District Natural Resources Officer, Mr Joseph Katswera. There is there're an urgent need for a harmonized approach to the exploitation of the water resources within the river to avoid over-exploitation and to curb the rampant pollution especially from urbanization.



Figure 7 Water use of river L'hubiriha at the Uganda-DRC border. Note the turbid water from activities upstream

The other major river originating from the Rwenzori Mountains is river Nyamugasani that is a medium sized river of up to 25m width in its mid-slopes. The river is characterized by the presence of heavy boulders in its upper reaches and its water may be described as black because of the humic acids coloration probably because its source is located in the alpine bogs of mountain Rwenzori (Plates 5 & 6). The water quality in the upper reaches can be described as good since human activities along its banks are minimal. Downstream, the river is degraded by cultivation and human settlement along its river banks. Destruction of riparian vegetation along its banks has worsened the impact of flooding resulting into loss of human life and property. For example the recent floods of May 2015 caused massive damage to property and infrastructure such as roads were damaged. Downstream the river is an important resource for pastoralists who water their animals at the river. This has often resulted in conflicts with protected area authorities as pastoralists sneak and graze inside Queen Elizabeth National Park. There have also been cases of crocodile attacks on livestock and humans as they water their animals. The Nyamugasani River is already being explored for hydropower generation with two mini-hydro power plants already planned. With all the planned activities and the high demand for water from Nyamugasani River, there should be a coordinated approach to the management of its waters to avoid over-exploitation and to restore the already degraded upper catchment areas. River flooding is an urgent problem that needs attention from water resource managers.



Figure 8 Nyamugasani river, the proposed location of a weir for the HEP plant. Note the pristine nature of the river upstream compared to the flood prone downstream areas (figure 9 below)



Figure 9 Boulder deposition by the recent floods in Nyamugasani river

The south-eastern part of Lake Edward is supplied by three major river systems thus, Rivers Nwera, Ntungwa and Ishasha. Other small streams draining into Lake Edward include Nyamweru, Rwampunu, and Keizi all originating from southern Maramagambo forest.

River Nwera is a medium sized river (Plate 7) whose source is in Mitooma district (Bushenyi previously) from an urban wetland at about 1500m altitude. The upper catchment of Nwera is relatively well vegetated and thus its water quality/clarity appears natural. However, the river gets progressively turbid as it flows downstream and by the time it enters QENP, the river is heavily laden with sediment and the colour of water is brown. The degradation downstream may be mostly from agricultural runoff. Downstream the river is an important water source for wildlife such as buffaloes that are often sighted wallowing in the river. The river often breaks its banks leading to damage of the bridge along the Katunguru-Ishasha road. Sediment carried downstream may be impacting the aquatic biota within the stream and the Lake Edward ecology.



Figure 10 River Nwera with slightly turbid water in the upper catchment area

River Ntungwa also called Mitaano upstream, originates from a wetland in Mitooma district but flows downstream through Rukungiri district and further downstream it forms a boundary between Kanungu and Rukungiri districts. It is a medium sized river but progressively increases in size downstream as is joined by other tributaries. The water quality in its upper reaches is relatively good, but deteriorates downstream from anthropogenic influences such as agricultural runoff, sand mining and stone quarrying, and road constructions. As a result of these human activities, the water flowing through QENP is usually turbid throughout the year. River Ntungwa could be the largest contributor of sediment to Lake Edward from the Uganda side of the lake. The ecology of river Ntungwa is yet to be studied to assess the impacts of human activities on the important resource for both upstream and downstream communities. A detailed assessment of water quality, aquatic biodiversity, water demand and supply along the river gradient is highly recommended.

River Ishasha is the most studied river in terms of water quality and aquatic biodiversity (Kasangaki 2007 and Mbalassa 2008). Fish species richness along the river ranges from about 3 species in the upper reaches to about 31 species downstream. The forested upper reach in Bwindi National park is home to an Albertine Rift endemic fish species *Varicorhinus ruwenzori*. The river is an important source of water and fish along its gradient. The main source of river Ishasha is in the Kigezi highlands wetland of Hakagyezi that is heavily impacted by wetland reclamation. As a result water flowing down the river is usually silt-laden.

The scoping exercise identified prevailing issues of land degradation and pollution of water sources in the Edward basin that will require instituting of soil and water conservation measures through training, capacity building and sensitization. In addition, it is anticipated that by strengthening the capacity of the relevant government institutions responsible for environmental management within the rivers and their catchments, they will be able to properly monitor the condition of land and water resources for the purposes of sustainably developing these resources.

3.4 Historical Trends and Changes in the Water Regimes

There are major changes that have taken place on major rivers that flow into Lake Edward. The notable changes include; water levels, flooding, water quality and manmade activities taking place on the rivers. Results from FGDs, key informant interviews and observations showed reduction in water levels of the major rivers visited and Lake Edward (Table 2). This was the same along the river gradient and the lake shores. These changes have taken place in the recent past and were attributed to global climate variations. There was however a few documented data to validate what was generated from primary sources. Furthermore, there were manifestations of changes in the invasion of exotic species and absence of indigenous species on all river banks. Most respondents in both Key Informant Interviews and Focus Group Discussions attributed these changes to human activities such as over cultivation on river banks, deforestation and wetland degradation. These have been facilitated by a rapid growing population and increased agricultural activities along gradient. The most affected has been River Nyamugasani and Ncwera. Other specific cases noted on River Lhubiriha and Ntungwa were increased turbidity and changes in the river course.

Table 2 Summary of specific changes in the water sources

| Rivers | Natural changes | Man made changes | Restoration efforts |
|-------------------|---|--|----------------------------|
| River Nyamugasani | <ul style="list-style-type: none"> • Increased water turbidity • Reduction in water quantity • Flooding changes from 10 years in 1980 to 5 years in 1990 and after every 1 year from 2001 • Landslides occurrence | <ul style="list-style-type: none"> • Unstable water banks • Population increase • Increased water usage for cattle • Sand mining • Hydro power generation • Water supply schemes | None |
| River Lhubiriha | <ul style="list-style-type: none"> • Increased water turbidity • Reduction in water quantity • Change in river course | <ul style="list-style-type: none"> • Unstable water banks • Cultivation of cotton near river banks • Rural Hydro power scheme • Clearing of natural trees on river banks | None |
| River Ntungwa | <ul style="list-style-type: none"> • Increased water turbidity • Flooding occurrence every year • Changes in water color • Change in river course • Changes in aquatic plants and animals | <ul style="list-style-type: none"> • River bank degradation • Clearance of water catchment areas • Superstition changes of a ghost on the river banks | None |
| River Nwera | <ul style="list-style-type: none"> • Increased | <ul style="list-style-type: none"> • Clearance of | None |

| | | | |
|----------------|--|---|-------------------------|
| | <p>water turbidity</p> <ul style="list-style-type: none"> • Flooding occurrence every year • Change in river course • Changes in aquatic plants and animals | <p>river banks</p> <ul style="list-style-type: none"> • Increased populations | |
| River Kaizi | <ul style="list-style-type: none"> • Too much reduction in water levels | <ul style="list-style-type: none"> • No man made changes noticed and mentioned | None |
| River Rwampunu | <ul style="list-style-type: none"> • Flooding changes • Water level reduction • High turbidity | <ul style="list-style-type: none"> • Population increase • Degradation of river banks | None |
| River Nyamweru | <ul style="list-style-type: none"> • Flooding changes • Water level reductions • High turbidity | <ul style="list-style-type: none"> • Population increase • Degradation of river banks | None |
| River Ishasha | <ul style="list-style-type: none"> • Flooding changes • Water level reductions • High turbidity | <ul style="list-style-type: none"> • Population increase • Degradation of river banks | None |
| Lake Edward | <ul style="list-style-type: none"> • Crocodiles invention • Water level reduction • Increased turbidity | <ul style="list-style-type: none"> • Increased fishing activity | Reallocating crocodiles |

3.5 Water Demand and Supply

The demand for water around both Bwindi and Queen Elizabeth landscape is high compared to the available water supply. Water demand around Queen Elizabeth National Park is however higher compared to that around Bwindi Impenetrable National Park. The Northern side of Queen particularly Kasese district has high water demand compared to

the Southern side of Rubirizi, Mitooma, Bushenyi and Rukungiri (Table 3). During FGDs, participants attributed this to a rapid population growth rate in Kasese district compared to other districts. This affects the state of major rivers that flow into Lake Edward. Most people depend on these rivers for domestic chores such as bathing and washing clothes, livestock, arable farming and fishing. This increases pressure on the existing water sources. Government has also tapped water schemes from these major rivers for community water supply and hydro power generation.

It was however established that, impact assessments in terms of water quantity are not always done before installation of huge investments such as hydro power generation and gravity water scheme supply. The most affected is river Nyamugasani and Lhubiriha in Kasese district where hydro power generation may threaten water quantity. There are minimal strategies put in place to explore alternative sources of water supply. Participants in the scoping exercise revealed that there are no rain harvesting strategies due to limited sensitization and civil society work to aid this technology. There are no boreholes and protected springs around rivers Nyamugasani and Lhubiriha. This continues to put pressure on the rivers which are seen as major sources of water. In the southern side of QENP, there is evidence of water streams and swamps which provide alternative water supplies. Gravity water schemes, boreholes and rain harvesting technologies are also minimal. There is limited work of Non-Governmental Organizations (NGOs) to aid water supply. This has made most people fetch water direct from unprotected streams and springs.

From preliminary insights, local people believe more in the use of river water for household use than other water sources especially water from Lake Edward. For instance the Banyabutumbi of Rwenshama fishing ground believe more in river water. This was attributed to historical and cultural beliefs on river water for healing and worship. Other people in other places believe in its natural scent and taste compared to lake water that is salty. Most people do not boil water believing that its natural scent will go. This has increased health risks and disease burden as reported in the Focus Group Discussions with health personnel.

Table 3 Categorization of rivers, water use and supply

| Rivers | Population | Water use | Water supply |
|-------------------|--|--|--|
| River Nyamugasani | <ul style="list-style-type: none"> • 500-1000 households upper stream in Kyarumba and Kyondo Sub Counties • Middle stream serves Nyakatonzi community pastoralists • Most settlements are closer to the river • Most households have scarce land for cultivation and encroach on river banks | <ul style="list-style-type: none"> • Domestic chores • Arable farming use through irrigation • Livestock use • Fishing • Sand mining on river banks • Brick making | <ul style="list-style-type: none"> • Water canal • Mini-irrigation schemes by Kasese district • 4 small gravity water schemes by Compassion International, Kyarumba catholic church, Government and Save the children |
| River Lhubiriha | <ul style="list-style-type: none"> • Serves communities on Uganda and DRC side • Most people using the river are on Uganda side • Settlements in Uganda are closer to the river | <ul style="list-style-type: none"> • Domestic chores • Washing bays for cars and motorcycles • Fishing | <ul style="list-style-type: none"> • Bwera urban water supply • Rural hydro power system • Irrigation schemes • Africa Development Bank water scheme that will serve Katwe-Kabatooro Town Council |
| River Ntungwa | <ul style="list-style-type: none"> • Serves districts of Bushenyi, Ntungamo, | <ul style="list-style-type: none"> • Domestic chores • Livestock farming | None |

| | | | |
|----------------|--|--|--|
| | Kanungu and Rukungiri | <ul style="list-style-type: none"> • Arable irrigation • Fishing | |
| River Nwera | <ul style="list-style-type: none"> • Serves communities of Bushenyi, Mitooma and Rukungiri | <ul style="list-style-type: none"> • Domestic chores • Livestock farming • Arable irrigation • Fishing • Gold mining • Worship sites for Abanyabutumbi | Gravity water scheme in Rwenshama fishing ground |
| River Kaizi | <ul style="list-style-type: none"> • Serves a few pedestrians in Rukungiri district due to its seasonality and low coverage | <ul style="list-style-type: none"> • Drinking by pedestrians | None |
| River Rwampunu | <ul style="list-style-type: none"> • Serves communities of Rubirizi and Rukungiri | <ul style="list-style-type: none"> • Domestic chores • Tea irrigation | None |
| River Nyamweru | <ul style="list-style-type: none"> • Serves communities of Rubirizi and Kisenyi fishing ground (Rukungiri) | <ul style="list-style-type: none"> • Domestic chores • Fishing • Tea irrigation | Gravity water scheme in Kisenyi |
| River Ishasha | <ul style="list-style-type: none"> • Serves districts of Kanungu | <ul style="list-style-type: none"> • Domestic chores • Fishing • Arable farming | |
| Lake Edward | <ul style="list-style-type: none"> • Serves the fishing community on Lake Edward | <ul style="list-style-type: none"> • Fishing • Domestic chores | Gravity water scheme at Kisenyi |

The demand for water on river Nyamugasani is high. There is a high population upstream and midstream. The Sub Counties of Kyarumba and Kyondo are highly populated. The middle stream serves communities of Nyakatonzi, Lake Katwe and Lake Katwe Town Council. The downstream of river Nyamugasani is also over populated. This indicates high demand for water. The major water uses identified by participants in Focus Group Discussion were domestic and agricultural purposes. Generally people's demand for water is too high compared to the available supply. There is a multiplicity of water use. It was observed through the landscapes that there are few other water sources apart from the existing rivers and their tributaries. From all the FGDs and key informant interviews, there is general consensus among the stakeholders from Kasese district that access to water for local communities is a challenge compared to the districts of Rubirizi, Mitooma and Rukungiri. Measures to address this challenge ought to be sought to reverse the negative impact to the parks.

3.6 Major water use and management threats

Major rivers flowing into Lake Edward and used by the local people face both natural and man-made hazards and threats (Table 4). The threats to these rivers can be attributed to both climate change and human activities taking place along riverbanks. The rivers draining the Rwenzoris are threatened by the mining activities of the Kilembe Mines, open sanitation such as washing clothes and bathing from the river. The other major challenge to the rivers in general is washing of vehicles next to the rivers near urban centers. This was the case on River Rubiliha on the DRC-Uganda border and other urban centers. The general threats to rivers in the basin include siltation as a result of agricultural intensification, cultivation along riverbanks and overfishing within the rivers (Table 4). Climate variability (melting of snow on the rwenzoris and heavy rainfalls) is also affecting the water regime within the rivers resulting in frequent floods in some rivers such as Nyamugasani.

From the interviews, it was noted that Lake Edward is threatened by overfishing especially on the DRC side of the lake where there is breakdown in law and order. The water quality is also polluted especially near fishing villages where sanitation facilities

are rudimentary or nonexistent. Participants in FGDs and key informants indicated that water levels have reduced in the recent past. The major rivers affected included; Nyamugasani, Lhubiriha, Rwampunu, Ishasha and Kaizi. Rivers such as Ntungwa and Nyamweru have had changes in turbidity and change of river course. Flooding was reported to be common on River Nyamugasani, Lhubiriha, Ntungwa and Ncwera (Plate 8). This affects human lives and farming activities closer to the riverbanks. Flooding of these rivers was attributed to climate change caused by poor farming methods, degradation of river banks and natural state of these rivers. Human activities were ranked the most factors responsible for flooding and erosion. Landslides are so evident which have increased water turbidity. It was evident that there are no mitigation measures put in place to reverse the situation. All in all, the major threats to the water regimes were; poor cultivation methods along the river banks and water diversion on the southern side of QENP.

Table 4 Major rivers in Uganda, their threats and mitigation measures

| Rivers | Threats | Mitigation measures |
|--------------------------|---|---------------------|
| River Nyamugasani | <ul style="list-style-type: none"> • Copper mining especially Kilembe mines • Over cultivation of water banks • Washing bays for cars and motor cycles • Illegal water diversion - upper stream | None |
| River Lhubirha | <ul style="list-style-type: none"> • Human interaction such as stepping inside the river at Mpondwe and Kisenyi • Washing inside the river in Karambi and Mpondwe • Washing bays which intoxicate water quality with oil and other chemicals | None |
| River Ntungwa | <ul style="list-style-type: none"> • Over cultivation on river banks especially rice growing • Over fishing • Road construction -Kagamba • River silting • Deforestation of natural trees • Charcoal burning | None |
| River Newera | <ul style="list-style-type: none"> • Over cultivation on river banks • Over fishing • River silting | None |
| River Rwampunu | <ul style="list-style-type: none"> • Water diversion to tea farms • Cultivation on river banks | None |
| River Kaizi | <ul style="list-style-type: none"> • Seasonality especially in dry spells-Climate change?? | None |



Figure 11 Field team talking to the community members on human threats to water at R.Ntungwa and R.L'hubiriha

3.7 Water related health hazards and challenges

The limited protective measures on major rivers have resulted into challenges affecting the settlements and people living near them. From the interviews and field observations, it was noted that flooding and poor water quality is a major health risks and disease burden in the region. There are increased water borne diseases especially in communities at Rwenshama and Kisenyi fishing grounds where water is consumed directly from the rivers and lake. Flooding has also increased the prevalence of mosquitoes and eye related diseases. Flooding was reported common at River Nyamugasani, Lhubiriha, Ntungwa and Ncwera. Common diseases mentioned include; Malaria, Typhoid, Bilharzias, river blindness, dysentery and Cholera. It was reported in Kisenyi and Rwenshama that Cholera has hit the area twice (in 1978 and 2000). Malaria was reported as a common

occurrence especially in the wet season across all the communities that participated in the scoping exercise.

Interview and field observation further indicate that across all communities visited, residents do not treat water and a few boil it for drinking. The only treatment was for the erected gravity water schemes in Kasese district and at Kisenyi and Rwenshama fishing ground. The lack of water treatment has a health implication to the population. Cases of child and maternal mortality were reported to be high mainly attributed to water quality challenges. This is connected to malaria and water borne diseases as a result of poor waste disposal and poor water management systems. A case in point at Rivers, Nyamugasani, Lhubiriha and Ncwera, there was evident of poor waste disposal into the rivers. The toilets and latrines in the nearby trading centres have their outlet disposals on the rivers which increases water contamination. This affects water quality yet people collect water direct from these rivers for drinking and other domestic chores.

3.8 Efforts to Mitigate Water related hazards

For both QENP and BINP, there are no major water management strategies put in place to reverse the degradation of major rivers or water usage and supply. There are no water management committees with exception of Kisenyi gravity water schemes. In Kisenyi fishing ground, a water management committee comprised of 10 people is in place. The purpose of the committee is to oversee water usage and maintenance of water supply. It was established that residents pay a small fee of 200 UGX per jerrican of water. This money is meant to aid maintenance of the water supply. If this water management approach is replicated across all communities using water, it could be a measure of maintaining water quality.

District water management was found to be inadequate. Most natural resource offices were inactive with scanty data on natural resource management. District natural resource and environment offices are understaffed (average 1 staff per office) yet the mandate to manage and govern natural resources in the 5 districts visited is enormous. Even the little staff employed to take up natural resource tasks were ill-equipped claiming of underfunding to undertake the proposed activities. The district development plans that

were reviewed pronounced little on natural resource systems and management. This has resulted into ineffective natural resource management in all offices visited. In all the 5 districts, Kasese was fairly active compared to other districts.



Figure 12 Gravity water management at River Newera, Rwenshama fishing village

3.9 Stakeholders involved in water Management

From the interviews with the local people and local government leaders, a number of stakeholders involved in water management were identified as table 5 shows. The stakeholders ranged from International donors, national government organizations, local governments and local community Based organizations (Table 5).

Table 5 Stakeholders involved in water management around the lake Edward basin of Uganda

| Name of the stake holder | Scope of operation | What they are involved in | Challenges |
|---------------------------------|--|---|--|
| DANIDA | Kasese district | <ul style="list-style-type: none"> Funding Ministry of Water and Environment for community water supply | <ul style="list-style-type: none"> Low water quantity and frequent flooding of River Nyamugasani Tenure of operation |
| Compassion International | Kyarumba Sub County | <ul style="list-style-type: none"> Gravity water scheme | <ul style="list-style-type: none"> Limited funding |
| Catholic Church Kyarumba | Kyarumba Subcounty | <ul style="list-style-type: none"> Water tank construction | <ul style="list-style-type: none"> Limited funding |
| Save the children | | <ul style="list-style-type: none"> Tapping water from Mubare and Kyangamiya | <ul style="list-style-type: none"> Limited funding |
| United Nations | Mpondwe boarder | <ul style="list-style-type: none"> Constructed the new bridge at Mpondwe boarder on River Lubhiriha | <ul style="list-style-type: none"> Was a onetime project |
| National Forestry Authority | Whole of Uganda | <ul style="list-style-type: none"> Managing community forests and private nurseries for trees | <ul style="list-style-type: none"> Human activities on river banks Political and economic influence |
| Uganda Wildlife Authority | Lake Edward Basin (Bwindi, Queen Elizabeth and Rwenzori) | <ul style="list-style-type: none"> Natural Resource protection | <ul style="list-style-type: none"> Limited funding Climate change |
| Central Government of Uganda | Albertine Rift | <ul style="list-style-type: none"> Funding Coordination role Water treatment at Kisenyi Relief aid after flooding | <ul style="list-style-type: none"> Corruption Wide scope and mandate |
| Kasese Local Government | Kasese district | <ul style="list-style-type: none"> Disaster relief during flooding of River Nyamugasani | <ul style="list-style-type: none"> Limited funding Corruption |

| | | | |
|----------------------------|--------------------|--|--|
| | | <ul style="list-style-type: none"> • Gravity water scheme | <ul style="list-style-type: none"> • Constant natural disasters in the district • A wide mandate • Economic investments that compromise Natural Resource Management |
| Rubirizi Local Government | Rubirizi district | <ul style="list-style-type: none"> • Passing and enforcing environmental ordinances | <ul style="list-style-type: none"> • Limited funding and corruption |
| Rukungiri Local Government | Rukungiri district | <ul style="list-style-type: none"> • Gravity water scheme • Funding • Sensitization and awareness | <ul style="list-style-type: none"> • Limited funding • Inactive Natural resource office • Poverty levels in the district |
| Mitooma Local Government | Mitooma district | <ul style="list-style-type: none"> • Provision of gravity water scheme and springs • Land use planning | <ul style="list-style-type: none"> • Limited funding • Corruption • Limited prioritisation of environmental issues |
| Kanungu Local Government | Kanungu district | <ul style="list-style-type: none"> • Gravity water scheme • Community awareness and sensitization | <ul style="list-style-type: none"> • Limited funding • Delays in capitation grant disbursements • Limited community support |
| NEMA | Whole of Uganda | <ul style="list-style-type: none"> • Environmental management • Awareness raising | <ul style="list-style-type: none"> • Human activities and resentment |

| | | | |
|--------------------------------|-----------------|--|--|
| | | <ul style="list-style-type: none"> • Conducting Environmental Impact Assessment | <ul style="list-style-type: none"> • Political and economic influence |
| LAVEMP (Egyptian organization) | Kasese District | <ul style="list-style-type: none"> • Awareness raising on Natural Resource Management • Water installation | Limited funding and time scope |

4.0 GENERAL CONCLUSION

As this study shows there is dearth of hydrological systems information/ data missing in the region for understanding the watershed/hydrological systems of the lake Edward water basin. This information/data is important for the sustainable management of the watershed at both policy formulation and policy implementation. This is despite the fact that the lake Edward basin is endowed with diverse water resources. The only limitation to these water resources is the way they are distributed for availability to the local people. As such the local people have adapted various coping methods of accessing the water resources for household use. The watershed, if not planned and sustainably managed is under threat of human activities resulting from agriculture and other forms of pollution. Climate change too has impacted on the availability of these water resources to the local people. In order to understand the hydrological systems and its management in the region, there is need for a detailed assessment studies to be carried out as was done recently for the Virunga region. This information/data would be crucial for park managers, local governments and other organizations working in the region to conserve the biodiversity therein. Such detailed study would help negate the anticipated water based conflicts by the provision of adequate and well-timed information to policy makers and implementers in water resource management.

5.0 RECOMMENDATIONS AND ACTION FORWARD

5.1 Administrative

There is need for stringent policies that aim at restoring the riverbanks for major rivers that cross through both PAs. The district natural resource and environment offices should

be planned for and funding increased to address river degradation and silting. It was established that districts of Kasese, Rubirizi, Mitooma, Rukungiri and Kanungu have not made deliberate planning for the river system regeneration. This would entail integrating natural resource issues in the general Financial Year plans and budgets.

Ordinances and Bye-laws ought to be made for more protection and management of the hydrological systems. Implementation of the formulated by laws should involve all local leaders in communities where the river systems pass.

River bank restoration should be made a deliberate strategy in order to reduce river degradation. This can be done through planting natural trees on the river banks and sensitizing the masses on proper farming methods such that further degradation of river banks is mitigated.

Sensitization campaigns should be done through the community development and natural resource offices. This should focus on precautions for natural resource management and water regime restorations.

5.2 Inventory

It was established that there is scanty data on the hydrological system of QENP and BINP. Studies on river systems have not been given much attention. Different districts that participated in this scoping exercise should do an inventory of their hydrological systems which should be periodically updated for management decisions and action.

We recommend for a more in-depth analysis of the hydrological system of Lake Edward landscape to analyze the water regimes, water quality and quantity assessment. There is need for soil erosion and flooding modeling in order to design interventions to reverse the effects on ground. A database for the landscape should be designed to keep data for subsequent research and decision making.

We also recommend inter-district and inter-regional dialogues to discuss and document water management systems and reversals to river degradation.

More research should be encouraged on river systems to increase the scope of data needed for natural resource management. This can be done by funding masters and PhD studies in the landscape. Research stations such the Institute of Tropical Forest Conservation (ITFC) should aid the increased understanding of the hydrological systems in the Albertine rift.

5.3 Suggestions for planning and water supply schemes

Water supply schemes to communities which boarder with the rivers and Lake Edward should be installed. This would entail erecting more gravity water schemes to reduce pressure on the river system which comes with water contamination. Rain water harvesting can be explored as an alternative water supply scheme. It is a local technology where rain water is collected from the roofs which drain to a collection vessel through down-pipes. Studies such as Gould and McPherson, 1987; Schiller and Latham, 1987 and UNEP 1982 on rain harvesting technology indicate that it can be an alternative source of water in water constraint areas.

Before hydropower generation, Environmental Impact Assessments should be done to avoid reduced water levels in case water quantity is not sufficient. This should be done hand in hand with the district water office, natural resource and environment offices to access water quantity and quality.

5.4 Conservation efforts surrounding the parks

Memoranda of understanding should be done to allow regulated access and reduce on illegal activities especially in BINP and QENP. There were documented illegal activities in connection to fetching water from PAs. Regulation is vital to reverse the trend. Alternative water sources should be developed to reduce pressure and demand for water inside the two Protected Areas.

5.5 Future role of GVTC

We recommend an action research and establishment of a regional database to create a sustainable inventory of the water regimes. GVTC through its partners should take up a role of supplying water to the most affected communities to reduce pressure on the two protected areas. Exploration of the rain harvesting technology should be done to reduce full dependence on only river water systems. GVTC should explore possibilities of working with development partners in the landscape to increase water supply in the area.

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6.0 APPENDIX

6.1: FOCUS GROUP DISCUSSIONS CONDUCTED

| Dates | Place | River system | District |
|---------------|------------------------|------------------------------------|-----------------|
| June 16, 2015 | Kyarumba | Nyamugasani | Kasese |
| June 17, 2015 | Nyakatonzi | Nyamugasani | Kasese |
| June 17, 2015 | Mpondwe | Lhubiriha | Kasese |
| June 18, 2015 | Karambi | Lhubiriha | Kasese |
| June 19, 2015 | Bitereko | Ncwera | Mitooma |
| June 20, 2015 | Bwambara | Ntungwa | Rukungiri |
| June 20, 2015 | Rwenshama | Ncwera | Rukungiri |
| June 21, 2015 | Nkongoro- Nyabihoko | Ntungwa | Ntungamo |
| June 23 | Kitagata | Ntungwa | Sheema |
| June 24, 2015 | Kisenyi | Nyamweru | Rubirizi |
| June 24, 2015 | Karinzu | Rwampunu, Nyamweru and Kaizi | Rubirizi |

6.2 RESOURCE PERSONS INTERVIEWED

| No. | Place | Position/Department | District/Location |
|-----|-----------------------------|--|-------------------|
| 1 | Joseph Kasweera | District Natural Resource Officer | Kasese |
| 2 | George Karende | District Engineer | Kasese |
| 3 | Patrick Syayipuma | Assistant Engineer | Kasese |
| 4 | Joseph Mumbahya | Sub County Chief-Kyarumba-Kyondo | Kasese |
| 5 | Queen Asiimwe | District Community Development Officer | Kasese |
| 6 | Wilfred Bwambare | Opinion leader-Mpondwe | Kasese |
| 7 | Mzee Irumba | Opinion leader-Nyakatonzi | Kasese |
| 8 | Richard Wamara | District Councilor-Nyakatonzi | Kasese |
| 9 | Rumago | UNRA | Kasese |
| 10 | Masereka J | Ag. Conservation Area Manager | QENP |
| 11 | John Fisher Bainomugisha | Ag. Community Conservation Warden | QENP |
| 12 | Bazil Mugumya | Opinion leader-Kanyabwanga | Mitooma |
| 13 | Canon James Mutazihana | Opinion leader-Bitereko | Mitooma |
| 14 | Mzee Dezi Zoreka | Opinion leader-Kanyabwanga | Mitooma |
| 15 | Jackson Bwogi Turyatamba | Forest Ranger | Mitooma |
| 16 | Suzan Mpumwire | Natural Resource Office | Mitooma |
| 17 | | District Planner | Mitooma |
| 18 | Lukwago S | District Natural Resource Officer | Rukungiri |
| 19 | Wilson Tuhamy | District Statistian | Rukungiri |
| 20 | Wilson Kamukungwe | ACAO | Rukungiri |
| 21 | Gad Zirihiihi | Opinion leader | Rukungiri |
| 22 | Isaac Tinyinekabi | Parish counselor-Rwenshama | Rukungiri |
| 23 | John Kato Owarwe | Cultural chief-Abanyabutumbi | Rukungiri |

| | | | |
|----|-----------------------|------------------------------------|-----------|
| 24 | John Kateera | Chairman LC1-Newera Rwenshama | Rukungiri |
| 25 | Ephraim Natukunda | Chairman LC1-Nkongoro Nyabihoko | Ntungamo |
| 26 | Hamid Butini | Chairman LC2-Kisenyi | Rubirizi |
| 27 | Vincent Baguma | Water technician-Kisenyi | Rubirizi |
| 28 | Joseph Rubinga | Karinzu /Imaramagambo CFR | Rubirizi |
| 29 | Lawrence Byamukama | Karinzu/Imaramagambo CFR | Rubirizi |
| 30 | George Bembereza | Opinion leader-Mubande Ndekye | Rubirizi |

6.3 FOCUS GROUP DISCUSSION GUIDE WITH THE COMMUNITY

1. What has been the trend and changes of water systems in this area (probe historical natural and manmade changes)
2. Talk about the current state of water sources (identify number of water sheds, where they are, their sources, water points both developed and un developed, conditions etc)
3. What are the current demands of water for domestic use, livestock, arable farming and institutions?
4. What information is available on water studies? (Probe research done, assessment reports, baseline studies etc)
5. What is your perception on the quality and quantity of water in this community?
6. Who is involved in water management (Govt and NGOs/CBOs) and what are they involved in? (fill the stakeholder matrix)
7. What affects water quality and quantity in this area? (Probe natural and manmade threats)
8. What have been the effects of water quality and scarcity? (Probe health challenges, income and expenditure etc)
9. What are the methods used to improve water quality in this Lake Edward region?
10. How productively do people utilize water in this area (probe potential water utilization projects/benefits from the current water supplies)
11. What would you want to see done for proper water supply and management in this area?

6.4. INTERVIEW GUIDE FOR KEY INFORMANTS

1. What is your position in this organization?
2. How long have you worked in this institution/organization?
3. What has been the trend and changes of water systems in this area (probe historical natural and manmade changes)
4. Talk about the current condition of water sources (identify number of water sheds, where they are, their sources, water points both developed and un developed, conditions etc)
5. What are the current population demands of water for domestic use, livestock, arable farming, development projects and institutions?
6. What information is available on water studies? (Probe research done, assessment reports, baseline studies etc)
7. What is your perception on the quality and quantity of water in this community?
8. How has the quality and quantity of water affected community welfare? (Probe health related issues, household income and expenditure etc)
9. Who is involved in water management (Govt and NGOs/CBOs) and what are they involved in? (fill the stakeholder matrix)
10. What affects water quality and quantity in this area? (Probe distractions natural and manmade)
11. What are the methods used to improve water quality in this Lake Edward region?
12. How productively do people utilize water in this area (probe potential water utilization projects/benefits from the current water supplies)
13. What management challenges do you see in water issues in this area?
14. What areas of research do you think need to be studied?
15. What would you want to see done for proper water supply and management in this area?