REPUBLIC OF UGANDA

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT FOR THE 840MW AYAGO HYDROPOWER PROJECT

Volume 1 - Final Draft ESIA Report

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On Behalf of:

MINISTRY OF ENERGY AND MINERAL DEVELOPMENT

UEGCL Generating for Generations
UGANDA ELECTRICITY GENERATION COMPANY LIMITED

JULY 2016

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Introduction

Ayago Hydropower Station is located at NL 2°25' and EL 31°55' on the River Nile in the Murchison Falls National Park (MFNP) in Uganda, and about 340 km far from the capital Kampala. The River Nile flows into the Lake Albert at the bottom of the Great Rift Valley. The proposed dam location is upstream of the MFNP, a treasured tourist attraction in the park, and downstream of the Karuma Falls. The South bank (left) of the dam site may be accessed from Nanda (80 km from the dam site), on the Kampala-Gulu highway, or via Masindi Town which is c.130 km away. The north bank (right) of the dam site can be reached along the Karuma-Pakwach highway from the other adjoining roads.

Preliminary studies by Government of Uganda on the Ayago Hydropower project started in the 1980s. Efforts to develop Ayago hydropower project were renewed in 2009 by commissioning the Hydroelectric Development General Planning study, which recommended that Ayago be developed first among seven potential plants along the Victoria Nile. Consequently, a pre-feasibility study was conducted, and later the Japan International Cooperation Agency (JICA) study team carried out more detailed studies.

Results of the pre-feasibility study indicate that Ayago Hydropower Station is of run-of-river type and will be developed as diversion type, where the underground head power house is located on the left bank and then connected with the non-pressure long tailrace tunnel to divert water to the downstream river. The normal pool level is 852m. The proposed plant capacity is 840MW with firm power being 295.3 MW and the average annual energy output is 5184GWh. It will be installed with 6 units of 140MW water-turbine generator. The total duration of Ayago Hydropower Station construction will last five and a half years (66 months) and the power generation period will last four years and eight months (56 months). Among them, construction preparation will last 13 months, construction of main body will last 43 months and construction completion 10 months.

The Ayago plant is situated within an ecologically important area, the MFNP one of the leading tourist destinations in Uganda. Important attractions in the landscape include: Murchison Falls, the Nile Delta (these two form part of a Ramsar Site), River Nile, Buligi game tracks, Paraa (home of hippos), Kaniyo Pabidi Forest, Rabongo Forest, among others.

In August 2013, the construction MOU was signed with China Gezhouba Construction Company (CGCC) International Limited. CGGC International Ltd commissioned WSS Services Uganda Ltd as their National Environmental Consultant to undertake the Environmental and Social Impact Assessment (ESIA), and associated Environmental and Social Management Plans (ESMPs) of the Ayago Project in compliance with national permitting requirements as well as international finance requirements.

One of the key findings is that sources of nuisance noise are localized and noise levels are generally low. Elephants can however hear infrasonic calls at least four kilometers away, and noise and vibrations generated from the Project construction and operations activities may disrupt such communication. Noise and vibration are known to affect breeding behavior of amphibians.

On-site water quality measurements indicated good baseline river water quality. The range of pH measured was 6.51 – 7.91 which indicates a good environment for aquatic organisms expected in the area. The soils are classified as acrisols (Petroplinthic Acrisols) which have low productivity according to the mapping of NARO's Soils and Soils Fertility Program. Acrisols are prone to soil erosion and preventing erosion is a key precondition of working with Acrisol soils.

The vegetation is diverse including wetland, riverine forest, riverine thicket, woodland, wooded grassland, and open grassland. The floristic richness was assessed as high, with more than 550 species recorded. *Combretum collinum* subsp. *binderanum, Piliostigma thonningii* and *Terminalia glaucescens* are dominant species in the woody layer, while Hyparrhenia filipendula and Brachiaria brizantha are dominant in the herb layer. *Afzelia africana*, a globally threatened species, is common along the Nile. At least seven invasive plant species occur in the project area, the most notable ones being *Lantana camara* and *Mimosa pigra*.

At least 109 species of mammals are known to occur in MFNP and of these, 47 were registerd in the project area. These include threatened species such as the elephant and Rothschild's Giraffe, Hippopotamus, Lion and Chimpanzee. These are all important species for tourism activity.Of the known 450 birds species in MFNP, 246 (more than 50%) were recorded within the Ayago project Area. A total of 24 amphibians and 26 reptiles are known to occur within the project area.These include the CITES listed Nile Crocodile (*Crocodylus niloticus*).

A total of 15 fish species are now known from the area. These include the two globally threatened (Endangered) *Lates macrophthalmus* and *Marcusenius victoria. Oreochromis variabilis* and *Marcusenius victoriae* are endemic to the Victoria Nile and Lake Victoria and its satellite lakes while *Lates macrophthalmus* is endemic to the Lake Albert ecosystem. A total of 139 species of butterflies, 47 species of dragonflies, 31 species of dung beetles were recorded within the Project area.

Much of the land here is government land mainly occupied by the Murchison Falls National Park and the Karuma Wildlife Reserve. In pockets of community settlement, agriculture is the dominant form of land use. The population in the survey area derives their livelihood by growing ground nuts sim sim, millet, sorghum, sweet potatoes, peas, sunflower, beans, maize and cassava. There are human-wildlife conflicts with surrounding communities arising from problem animals, especially elephants, that raid crops. There are also poaching activities from these communities despite the revenue-sharing scheme in place. Excavations for archeological materials revealed lithic, pottery and cultural materials indicating a Later Stone Age (LSA) industrial complex.

Project positive impacts

- Employment of local communities during the pre-construction/mobilization and the construction phases.
- Employment of Ugandan nationals during the operation phase of the project.
- Local revenue generation to the communities, UWA, and the Nwoya District.
- Improved power supply to the national grid meeting the increased power demand.
- Income generation; the lands taken by the project for the transmission will be sold out to the contractor and the households that sell the land will get income through the process.

- Also the proposed large scale hydro power project will widen the tax base for the Ugandan government through the remittance of taxes to the national treasury and licenses from government.

Project likely negative impacts

- ***Land uptake for the workers camp, power house, reservoir location causing*** vegetation clearance.
- ***Access road construction causing*** vegetation clearance, which would lead to loss of plant species, possible colonization by invasive species, habitat fragmentation especially for the amphibians and crawlers (snakes, snails) that are accustomed to movement within vegetated landscapes.
- ***Influence on hydrological regime -*** Water depth upstream of the dam will increase, water flow rate in the reservoir decreasing gradually from the tail area to the upstream.
- ***Air quality -*** vehicle fumes; diesel emissions from large construction equipment and generators; emissions from storage and transfer of fuels for construction equipment; small amounts of carbon monoxide, nitrogen oxides; particulates from blasting activities; and fugitive dust from many sources such as: clearing, grading, excavating, trenching, backfilling, dumping, and truck and equipment traffic, mixing concrete, storage of un-vegetated soil piles, and drilling and pile driving.
- ***Destruction of cultural resources -*** Complete destruction of the resource if present in areas undergoing surface disturbance or excavation; degradation or destruction of near-surface cultural resources on- and off-site resulting from changing the topography, changing the hydrological patterns, and soil movement (removal, erosion, sedimentation) and unauthorized removal of artifacts or vandalism as a result of human access to previously inaccessible areas.
- ***Soil erosion -*** large quantities of excavated soil from the construction of the weir, head and tail race powerhouse and access road. The soils in the region have been characterized as Acrisols of low productivity that are highly susceptible to erosion
- ***Contamination of surface and ground waters -*** Accidental spills from vehicles and equipment with diesel engines may contaminate the water, lowering the quality and leading to suffocation of fish, and death of other aquatic organisms. Erosion leading to deposition of sediments in aquatic resources also introduced contamination into the water, increasing turbidity, suspended solids and lowering the overall water quality; waste storage areas for the construction crew may leak nutrients and biological pollutants into ground water resources.
- ***Loss of vegetation and terrestrial plants -*** construction of the Head and tail race, the power house and the waterway will inevitably be stripped of vegetation.
- ***Animal behavior and ranging alteration –*** due to severe disturbance; some animals may avoid areas frequented by people during the day and tend to feed at night, which is not their norm. This destabilizes the natural flow of ecosystem functions, and interrupts the predator-prey relationship.
- ***Influence on aquatic habitats and fish -*** water in the reservoir will increase, water level upstream the dam will rise, water flow rate will reduce, sediment deposition will be more and water transparency higher.
- ***Construction traffic and noise –*** *noisy equipment and* material haulage by heavy trucks on the main roads to the park and roads within the park with create much noise.
- ***Waste -*** Worker camps will produce solid and liquid wastes which will require treatment and safe disposal to prevent soil and water pollution.

Occupational Health and Safety Risks - handling of heavy equipment, working at height, working near waters that habour dangerous wildlife, working with fuels and other hazardous material, may cause injuries to project workers, leading to loss of limbs, and in the worst case scenario, deathchanges in water level, flow and diversion during the construction phase.increased human persence within the park, and possible increased poaching.

- Visual impacts **and its effects on tourism activity leading to** loss of tourism value by UWA and tourism investors.
- ***Health of the residents –*** *Influx of migrants will i*ncrease incidence of HIV/AIDS and malaria.
- ***Disruption of cultural norms and practices and historical relics.***

Key mitigation measures

- Avoidance of critical terrestrial and aquatic habitats and life cycle periods e.g. breeding seasons; cultural heritage sites.
- Minimizing clearing and disruption of vegetation, especially riparian, e.g. by utilizing existing transport corridors whenever possible, and control of soil erosion e.g. by lining steep channel and slopes such as use of jute matting.
- Encourage native vegetation re-growth after construction and consider the onset of the rainy season with respect to construction schedules; or undertake active restoration where necessary.
- Active management of invasive species like the *Mimosa pigra* through allowable (by UWA) practices like periodic bush burning.
- Before construction, the surface soil within the construction site should be removed and piled together, and temporary fencing and protection measures taken.
- Maintenance of sound-control devices on equipment and restriction of harmful noise to only day time and outside of breeding grounds and switching off engines when not in use.
- Observance of speed limit within the park; all workers to use protective equipment and those engaged in activities likely to raise dust will wear dust masks; water spraying – minimize dust generation and enhance protection.
- Maintenance of vegetative buffer between the water and construction works to reduce sediment/contamination.
- Fire and emergency alarm systems.
- Enhance the publicity, education and management of the construction personnel and local residents, including about HIV/AIDS and the dangers of unsafe relations.
- Structures will be painted with earthen tone colours to prevent visual blight caused by highly dissimilar buildings with the back drop of a natural setting.

Conclusion

The proposed hydropower scheme at Ayago is sensitive because of its location in one of the oldest and most important National Parks in Uganda, with many sensitive habitats and species of flora and fauna, as well as its critical role in provision of life-support ecosystem services. This EIA has ably identified and addressed anticipated biophysical and socio-economic concerns, and has proposed mitigation measures for adverse impacts. However, containment of the anticipated impacts requires that the developer carefully and diligently follows the prescribed mitigation measures. It should be absolutely necessary to adhere to the recommended environmental management and monitoring plans. Regular auditing of the project activities and review of plans should avert any unforeseen environmental and social impacts.

LIST OF ACRONYMS

ADT	Average Daily Traffic
AHT	Average Hourly Traffic
AIDS	Acquired Immune Deficiency Syndrome
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
CGCC	China Gezhouba Construction Company
CGCC	China Gezhouba Construction Company
CGV	Chief Government Valuer
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
CR	Critically Endangered (IUCN Red List)
CSO	Civil Society Organizations
dB	Decibels
Dbh	Diameter At Breast Height
DD	Data Deficient (IUCN Red List)
DO	Dissolved Oxygen
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
EFR	Environmental Flow Rates
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EN	Endangered (IUCN Red List)
ERA	Electricity Regulatory Authority
ESAP	Environmental and Social Action Plan
ESIA	Environmental Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMPs	Environmental and Social Management Plans
EU	European Union
FGD	Focus Group Discussions
FSSD	Forestry Sector Support Department
GDP	Gross Domestic Product
GHG	Green House Gases
GoU	Government of Uganda
GPS	Global Positioning System
GWP	Global Water Partnership
HIV	Human Immunodeficiency Virus
HPP	Hydro Power Project
HSE	Health, Safety and Environment
IAS	Invasive Alien Species
IBA	Important Bird Area
ICOLD	Commission on Large Dams
IDPs	Internally Displaced Persons
IFC	International Finance Corporation
ILO	International Labor Organization
IRENA	International Renewable Energy Agency
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
Km	Kilo Meters

LC	Least Concern
LRA	Lord’s Resistance Army
LSA	Later Stone Age
LVBC	Lake Victoria Basin Commission
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MCC	Manual Classified Count
MCTC	Manual Classified Turning Count
MEMD	Ministry of Energy and Mineral Development
MFCA	Murchison Falls Conservation Area
MFNP	Murchison Falls National Park
MGLSD	Ministry of Gender, Labour and Social Development
MLHUD	Ministry of Lands, Housing and Urban Development
MoU	Memorandum of Understanding
MoWT	Ministry of Works and Transport
MTTI	Ministry of Trade, Tourism and Industry
MW	Mega Watts
MWE	Ministry of Water and Environment
NaFiRRI	National Fisheries Resources Research Institute
NBI	Nile Basin Initiative
NE	Not Evaluated (IUCN Red List)
NEMA	National Environment management authority
NFA	National Forest Authority
NGO	Non-Governmental Organisation
NRMM	Road Mobile Machinery
NT	Near Threatened (IUCN Red List)
Corporation	
NWSC	National Water and Sewerage Corporation
OHS	Occupational Health and Safety
ORP	Oxidative Reduction Potential
pH	Potential of Hydrogen
PPE	Personal Protective Equipment
PS	Performance Standard
PV	solar photovoltaic
RAP	Resettlement Action Plan
SHM	Stakeholder meetings
STDs	Sexually Transmitted Diseases
UBOS	Uganda Bureau of Statistics
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
ULSD	Low Sulphur Tax-Exempt Diesel
UNCCD	United Nations Convention to Combat Desertification
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNM	Uganda National Museums
UNRA	Uganda National Roads Authority
UWA	Uganda Wildlife Authority
VU	Vulnerable (IUCN Red List)
WCD	World Commission of Dams

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Ms. Edith Kahubire	Sociology	Sociologist	
Mr. Dismas Ongwen	Archaeology	Archaeology and Cultural Specialist	
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Dr. Timothy Twongo	Aquatics and Fisheries Resources Management	Aquatic Ecologist	
Dr. James Kalema	Biodiversity and Ecology	Plant Ecologist	
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Mr. Moses Masiga	Natural Resources Economics	Natural Resources Economist	

1. INTRODUCTION

1.1 BACKGROUND

Uganda is a landlocked country in East Africa, bordered on the east by Kenya, on the north by Sudan, on the west by the Democratic Republic of the Congo, on the southwest by Rwanda, and on the south by Tanzania. Uganda has a total landmass of over 241,000 sq. km (NEMA 2010), 18 percent of which is covered by freshwater bodies. Lying astride the equator, Uganda offers exceptional diversity, combining some of the best features of Africa, including the source of the River Nile (the second longest river in the World) and Lake Victoria (the second largest fresh water lake in the World). The country's geographical diversity is high. In the East, it overlaps the tropical Savannah and in the West, African rain-forest zones. Besides, there are many existing contrasting physical features, ranging from extensive plains with undulating hills to snow-capped mountains, waterfalls, meandering rivers and spectacular flora and fauna. The country is endowed with abundant renewable energy resources. These include extensive hydrological resources, favorable solar conditions and large quantities of biomass resources including residues from agricultural production.

With about 43,942 km^2 of wetlands and open water (18% of total area), Uganda is considered fairly well endowed with water resources. Major water bodies include lakes Victoria, Kyoga, Albert, George and Edward while major rivers include the Nile, Ruizi, Katonga, Kafu, Mpologoma and Aswa. Almost the whole of Uganda lies within the Nile basin, which is shared by 10 countries. Favorable atmospheric conditions and mighty river provide a high hydropower potential estimated at about 2,000 MW mainly along River Nile that can be developed to supply isolated areas or feed into the national grid. Uganda has a high hydropower, solar and biomass resource potential. Nevertheless, it has one of the world's lowest levels of electricity development. At present, just 3-5 percent of the population have access to electricity and many towns, especially in the North of the country, are without electrical power and in the rural areas only about 2 percent had access to electricity, of which less than half was provided through the national grid, the remainder coming from household generators, car batteries or Solar Photovoltaic (PV) units. Whereas with the developments in the oil sector, future additional power supply is likely to be provided from thermal powered plants using heavy oils. But in terms of cost effectiveness and environmental friendliness, Hydropower plant remains the better alternative. Therefore, carefully planned hydropower development can make a vast contribution for improving living standard in the country by not only contributing to the Treasury resources and foreign exchange earnings (power exports), but also promises to be a large source of employment for Ugandans and infrastructure development.

1.2 Proposed Ayago Project

Ayago Hydropower Station is located at NL 2°25' and EL 31°55' on the River Nile in the Murchison Falls National Park in Uganda, and about 340 km far from the capital Kampala. Flowing westwards from Lake Kyoga to the west of the East African Great Rift Valley, the Nile River goes through a graded reach between multilevel riffles and falls and finally flows into the Lake Albert at the bottom of the Great Rift Valley. The proposed dam is located at the upstream of the Murchison Falls and the downstream of the Karuma Falls. As a main stream, the Ayago River flows into the Nile River at about 3.3km downstream of the proposed Ayago Dam.The south bank (left) of the dam site can be accessed from Nanda, close to Karuma on the Kampala-Gulu highway, or via red earth roads or passable vehicle roads from Masindi Town. Nanda is about 80km from the dam site, while Masindi is about 130km away. The north bank (right) of the dam site can be reached quite easily along Karuma-Pakwach highway from the other adjoining roads.

1.2.1 Previous studies on ayago hydropower project

The preliminary work on Ayago Hydropower Station started in the 1980s when NORCONSULT Company compiled the first feasibility study report for Ayago Hydropower Station. In the Hydroelectric General

Planning Report completed in 1997 by Kennedy & Donkin, five potential hydropower plants (Bujagali, Kalagala, Kamdini, Ayago and Murchison) were planned between Lake Victoria and Lake Albert on the Nile River.

In November 2009 the Ministry of Energy and Mineral Development of the Government of Uganda renewed efforts to develop Ayago hydropower project by commissioning the Hydroelectric Development General Planning Study which put forward that the main stream of the Victoria Nile River would be developed by 10 cascades. After comprehensive comparison of the seven proposed cascades from technical, economic, environmental and social aspects, it was recommended that Ayago Hydropower Station should be developed first. The pre-feasibility study of Ayago Hydropower project was therefore conducted as part of the Hydropower Development Master Plan. In preparation for detailed feasibility study of the project, additional site investigations were carried out by the JICA Study team.

1.2.1.1 Cascade Development of Victoria Nile

The Victoria Nile River is a major river in Uganda that starts from the northern estuary (near Jinja) of Lake Victoria in the south and flows in the northwestern direction of the country into the northern estuary through Lake Kyoga. It has a total length of 416km. Due to the regulation of Lake Victoria, changes of the annual flow is small and ranges between 602 and 741m^3/s. The upstream section passes through the plateau, and the downstream section consists of steep and faulted valleys, as well as many falls and torrents, where the Owen Falls Hydropower Plant is situated. It is navigable from Namasagali to Masindi Port; and there is a trumpet-shaped swamp delta at the estuary.

The Victoria Nile River can be generally divided into 4 sections: the upstream section from Lake Victoria to Isimba covering a total length of about 40km; the midstream section from Isimba to Karuma through Lake Kyoga, covering a total length of about 280km; the downstream section is from Karuma site to Murchison, covering a total length of about 80km; the outmost downstream section covers a length of 30km. Based on the master plan for hydroelectric development of the Republic of Uganda, the main stream of Victoria Nile River can be developed from the upstream to downstream with a cascade of 10 hydropower plants that include “Nalubaale – Kiira – Bujagali – Kalagala – Isimba – Karuma – Oriang – Ayago – Kiba - Murchison with a total installed capacity of 3600MW. Nalubaale, Kiira and Bujagali have been put into operation while the other 7 cascades are under planning. Figure 1 shows cascade hydropower planning of Victoria Nile.

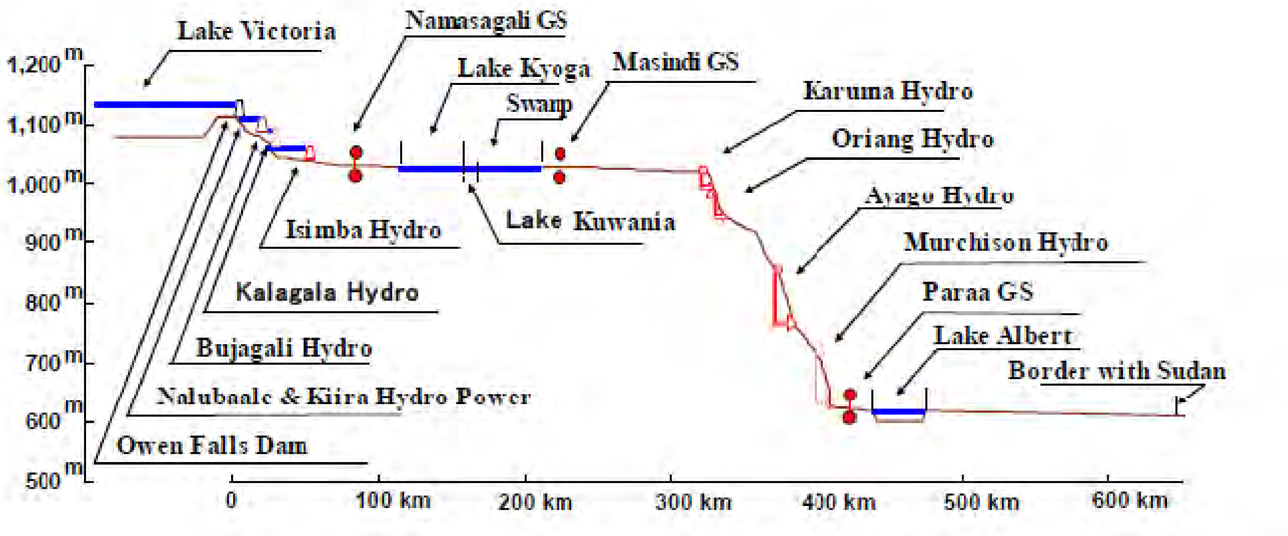


Figure 1: Cascade Development for Main Stream of Victoria Nile River (showing Distance from the lake and elevation above sea level)

1.2.1.2 Development Type of Ayago Hydropower Project

The results of pre-feasibility study on Ayago Hydropower Station indicate that Ayago Hydropower Station is of run-of-river type and will be developed as diversion type, where the underground head power house is located on the left bank and then connected with the non-pressure long tailrace tunnel to divert water to the downstream river; the normal pool level is 852m. The proposed plant capacity is 840MW with firm power being 295.3 MW and the average annual energy output is 5184GWh.

1.2.2 Project Parties

In 2008, the Government of Japan, through the Japan International Cooperation Agency (JICA), in collaboration with the Government of Uganda, began new preparations for fresh enviromental impact assessments and International bidding for a contractor and commitment as a lead funding source for the project. In April 2013, the Government of Uganda awarded the US$1.9 billion construction contract to Mapa Construction and Trading Company Inc., a Turkish infrastructure construction company. However, in August 2013, that award was rescinded and the construction contract was awarded to China Gezhouba Construction Company (CGCC) International Limited.

CGGC International Ltd has commissioned WSS Services Uganda Ltd as their National Environmental Consultant to undertake the Environmental and Social Impact Assessment (ESIA), and associated Environmental and Social Management Plans (ESMPs) of the Ayago Project in compliance with national permitting requirements as well as international finance requirements. CGGC International Ltd. undertook the feasibility study for Ayago Hydropower Station from August 2013 to April 2014.

Compliance with Ugandan and International lender legislation and guidelines for environmental and social performances will be the key responsibility of the Developer (MEMD) through its implementation agency (UEGCL). The Developer and a stakeholder wide monitoring group comprising technical staff from government institutions (NEMA, MEMD, UEGCL, UETCL, ERA, MWE, DWRM, DWD, MoWT, MoGLSD, UWA, MTTI, NFA, FSSD, The National Fisheries Resources Research Institute (NaFIRRI), Ministry of

Lands, Housing and Urban Development etc) and Civil Society will monitor compliance of the Contractor.

1.3 Purpose of this Report

The ESIA was conducted in order to:

i. develop detailed analysis of the key national and international legislation under which the proposed project will profess compliance;
ii. highlight the existing baseline of the proposed project site
iii. identifyany significant impacts that the proposed project may pose to the environment;
iv. analyze the significance of the adverse environmental impacts and propose suitable and adequate preventive or mitigation actions;
v. formulate an environment management and monitoring plan for the implementation of the mitigation actions during the construction, operation and decommissioning phases;
vi. promote improved social and environmental performance through the effective use of management systems.

Environmental Impact Assessment (EIA) procedures in Uganda are stipulated in the Environmental Impact Assessment Regulations (National Environmental Management Authority (NEMA, 1998), Guidelines for Environmental Impact Assessment in Uganda (NEMA, 1997) and the Draft EIA Guidelines for the Energy Sector (NEMA, 2014). The overall EIA procedures consist of Screening, Environmental Impact Study and Decision (Figure 2). Stakeholder meetings (SHM) are required throughout the study period, from the Scoping, through the EIStudy, to the project implementation and entire lifecycle. The ESIA process followed the procedure laid forth by the EIA guidelines of 1997, capturing key requirements set forth by NEMA. The Environmental and social considerations/safeguard policies of international financial institutions were also reviewed.

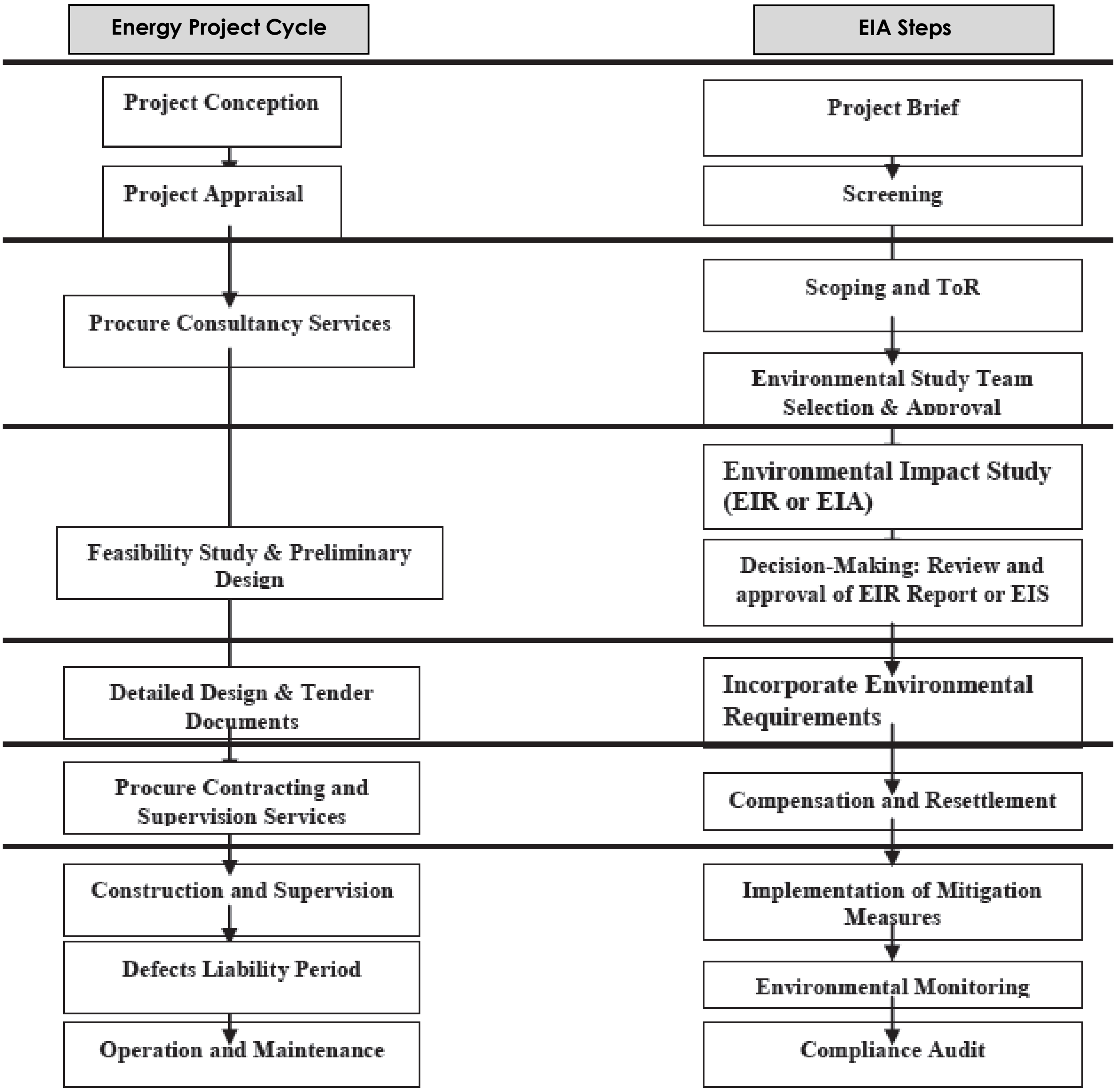


Figure 2: ESIA flow process for Energy Projects

*(**Source:** Environmental and Social Imapct Assessment Guidelines for energy projects in Uganda (NEMA, 2015)*

1.3.1 Scope of Work

The nature and scope of the ESIA included a detailed description of the elements of the construction and operation phases of the Ayago HPP. A detailed review of the legislation, policies and standards that are relevant to hydropower developments and the sustainable use of River Nile for various purposes, in particular, electricity generation, has been made. The review entailed specific requirements for ESIA and a scope of field studies required. The report also provides baseline information on the biophysical and social environment within the project area, including but not limited to: topographic conditions, hydrology and hydraulic conditions, biodiversity surveys (including flora and fauna studies), water quality geological characterizations and stakeholder consultations.

The ESIA report identified the nature of all environmental and social impacts that the hydropower plant and ancillary developments/operations would generate. This includes elaborating the source of the impacts, receptors, describing in detail social impacts and impacts on the ecosystems and wildlife in the National Park and those specifically on the River Nile. The ESIA identified prevention measures and proposed mitigations based on recommendations from similar projects and professional opinion from the consultant. The process developed an Environmental Management and Monitoring Plan (EMMP) highlighting the mitigation measures of the negative environmental impacts and provides monitoring indicators upon which the developer can assess the success of the proposed actions.

1.3.2 Structure of the Report

This ESIA report is organised as follows:

Table 1: Organisation of the Report

Chapter Number	Title
	Executive Summary
Chapter 1	Introduction
Chapter 2	Project Description
Chapter 3	Methodology for undertaking the ESIA
Chapter 4	Policy, Legal and Institutional Framework
Chapter 5	Biophysical and Socio-economic Baseline
Chapter 6	Public Consultation and Involvement Process
Chapter 7	Alternatives Analysis
Chapter 8	Impact Assessment and Mitigation Measures
Chapter 9	Environmental Management and Monitoring Plan

2. PROJECT DESCRIPTION

2.1 Introduction

This Chapter provides a description of the Project location, a description of the key components which make up the hydropower scheme, description of the project layout, summary of the key project activities during both the construction and operation phases, and final project programme. Additional technical details such as scheme drawings are available in the feasibility report.

2.2 Project Location

Ayago Hydropower project site is along River Nile, located at NL 2°25' and EL 31°55' in the Murchison Falls National Park in Uganda, about 340km from the capital Kampala (Figure 3). Flowing westwards from Lake Kyoga to the west of the East African Great Rift Valley, the Nile River goes through a graded reach between multilevel riffles and falls and finally flows into the Lake Albert at the bottom of the Great Rift Valley. The proposed project site is located at the upstream of the Murchison Falls and the downstream of the Karuma Falls. As a main tributary, the Ayago River flows into the Nile River at about 3.3km downstream the Ayago Dam site.

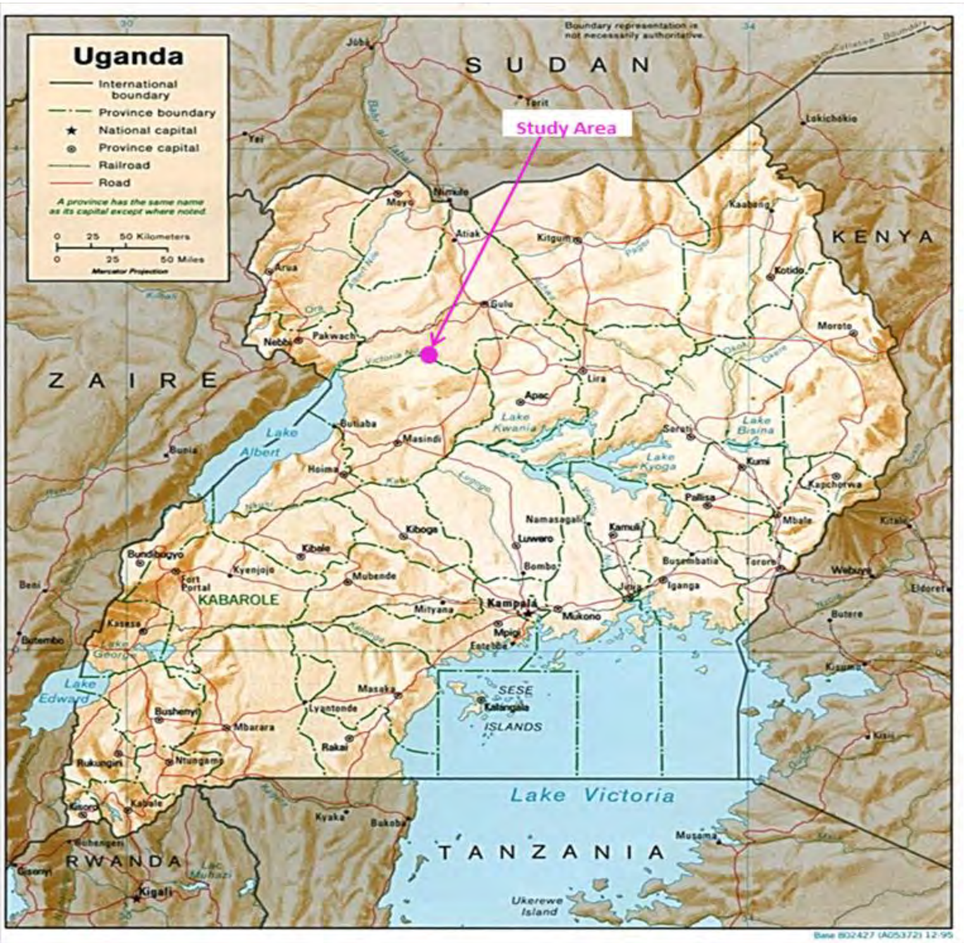


Figure 3: Location Map of the Project Area

The south bank (left) of the dam site can be accessed from Nanda which is close to Karuma on Kampala-Gulu Highway, or via red earth roads or passable vehicle roads from Masindi Town. The distance between

Nanda and the Ayago dam site is about 80km while Masindi and the dam site are about 130km apart. The north bank (right) of the dam can be reached quite easily from Karuma via Chobe Lodge and along Karuma-Pakwach Highway from other branch roads (Figure 3).

2.3 Project Site Characteristics

Table 2 presents the characteristics of the proposed Ayago Hydropower Project.

Table 2: Characteristics of Ayago Hydropower Project Site

1	**LOCATION**	
	Country	Uganda
	District(s)	Kiryandongo and Nwoya
	Village	Ayago
	Airport	Entebbe -370km (via Kampala)
	Road	From Kampala-340km
	Latitude (N)	2°25'
	Longitude (S)	31°55'
2	**METEOROLOGY**	
	Maximum Rainfall	2000mm
	Minimum Rainfall	900mm
	Average Maximum Temperature	28°C (at Kampala)
	Average Minimum Temperature	17°C (at Kampala)
3	**HYDROLOGY**	
	Catchment Area	346,000 sq.km

2.4 Area Geology

The common rock types are generally of Precambrian origin and include; Biotite Gneiss, Granitic Gneiss, Amphibolite Gneiss & Quartzite. In geological logs of the exploratory boreholes, the rock type has been described as biotite gneiss only. Close observations of the exploratory borehole core photographs indicate clearly the presence of: Residual weathered profile: Regolith & saprolite underlain by Amphibolite Gneiss, Granite Gneiss & porphyritic granite.

2.5 Project Layout

The recommended layout of Ayago hydropower station at this stage is that the plant is located on the left bank of upper dam site, the diversion and power generation structure is deployed on the left bank, the overflow and water retaining structure are deployed on the river bed, the fishway is deployed at the central island. The dam adopts concrete gravity dam, the elevation of dam crest is 857m, the Maximum dam height is 24m, and the total length of dam crest is 595 m.

The overflow and water retaining structure include (in turn from left to right): non overflow dam on left bank 70m, scouring sluice with 3 holes 54m, rolling dams with 13 holes on left bank 182m, the left non overflow dam at central island 75m, the right non overflow dam at central dam 50m, rolling dam with 7 holes on right bank 104m, non overflow dam on right bank 60m.

The diversion and power generation structure is deployed on the left bank, adopting diversion type first underground plant deployment with total installed capacity 840MW and 80 m rated head. It is installed with 6 units of 140MW water-turbine generator. Main buildings include water intake, diversion tunnel, main plant and erection yard, main transformer hole, outlet shaft, operating corridor room of tail water sluice, tail water tunnel, exit of tail water, take-off-yard abov e ground, traffic tunnel, ventilating shaft and off-site drainage system etc.

2.6 Design of Main Structure

2.6.1 Scouring Sluice

Scouring sluice with three holes are deployed at left river bifurcation, the elevation of dam crest is 857m, the elevation of foundation surface is 833m, the length in dam axis direction is 54m, the length of water flowing direction is 25m, the size of single hole is 10mX5m (width X height), the elevation of hole bottom is 837m, the width of sluice pier is 4m, adopting pier parting.

2.6.2 Rolling Dam

The Rolling dam with 13 holes and rolling dam with 7 holes are respectively deployed in left river bifurcation and right river bifurcation, the elevation of top crest of rolling dam is 852m, the elevation of highway bridge top is 857m, the elevation of foundation surface is 840m, the length in dam axis direction is 182m, the length in water flowing direction is 25m. The net width of each hole of rolling dam is 11.5m, adopting span parting.

2.6.3 Dam Section of Non Overflow Dam

The proposed dam site has two river bifurcations on left and right, each river bifurcation with two sections of non overflow dam; they are respectively, the left bank non overflow dam of left river bifurcation 70m and left non overflow dam of central island 75m; right non overflow dam of central island of right river bifurcation 50m and non overflow dam of right bank 60m. The elevation of dam crest of non overflow dam is 857m, the elevation of foundation surface is 833m -848m, the upstream surface of dam is vertical, and the slope of downstream dam is 1:0.8.

2.6.4 Fishway

The Fishway is deployed on the Central Island with total length of 620m. Main structures include fishway inlet, fish pool, and fishway outlet. There are maintenance gates of upstream outlet, flood-proof Watergate and maintenance gate of downstream inlet in turn from upstream to downstream. The downstream inlet of fishway is about 96m away from dam axis, the net width is 2.5m, the elevation of bottom plate top is 838 m, and the elevation of top of side wall is 846m. Fish pool adopts overall U type structure, the width of foundation surface is 5.5m, the width of groove is 2.5m, width of each side wall is 1.5m, between both sides of side walls is connected by 50cm×50cm pull rod. Length of single fish pool is 3.0m, the bottom slope is 1:40, and one rest pool with flat base in 6m length is set in every 10 fish pool interval. The upstream outlet is about 48m away from dam axis, the net width is 2.5m, the elevation of bottom plate top is 850.00m, and the elevation of side wall top is 857.00m.

2.6.5 Headrace Channel and Intake Tower

The headrace channel close to the flush gate is located on the left bank of the Nile and the upstream of dam, and forms a 93° angel with the dam axis; there is a gully about 38m outside the opening line of the right side of headrace channel. The excavation elevation of channel bottom is 835.50m; the maximum excavation width is about 147.6m and the flow of entire intake is 1140.24m3/s.

The intake tower is of a bank-tower reinforced concrete structure; the tower top and dam top share the same elevation - 857.0m; the elevation of top surface of base slab is 837.00m and its thickness is 3m and the corresponding elevation of foundation surface is 834.00m.

The front width of the intake tower is 147.6m, arranged in 6 sections; a single tower is24.6m wide and 22m tall and permanent joints are set between all towers. The length along the forward flow is 18m and trash rack, trash rack section and trumpet section are arranged in sequence.

The trash racks are vertical movable trash racks and 4 rack holes are set on each one, and the dimension of hole is 4.9m x 13m (W x H). One bulkhead gate and one service gate are set in the gate section and the hole dimensions are respectively 7.2m x 7.9m and7.2m x 7.2m; the bulkhead gate is opened and closed by a gate hoist on the tower top at the hydrostatic state and the service gate is opened by a hydraulic hoist on the tower top under hydrostatic state and closed under hydrodynamic state.

One traffic bridge is built behind the tower to connect with the slope road so as to meet the transportation requirements and it serves as a traffic channel for transportation of mechanical equipment and personnel during the operation period.

2.6.6 Headrace Tunnel

The Headrace tunnel adopts single machine and single tunnel, 6 tunnels are deployed in parallel, and the spacing of axis is 22.6m. On the plane it adopts straight line deployment, the axis of inlet is vertical to water inlet tower, the axis of outlet is vertical to main plant, on the facade it is composed of upper flat section (including transition section), upper curved section, shaft section, lower curved section and lower flat section, pressure adjusting well is not equipped, and the radius of upper and lower curved section is 20m. The central elevation of upper flat section is 841.30m, the elevation of central line of lower flat section is the same with the installation elevation of water turbine, it is 754.00m, and the length of single headrace tunnel is about 190m. The tunnel adopts circular section; the diameter of the hole is 6.6m.

The surrounding rock of headrace tunnel is mainly dominated by hard biotite gneiss, the upper flat section to shaft section adopt reinforced concrete, the general construction thickness is 60-120cm; the lower curved section and lower flat section of the tunnel are constructed by steel plate, the construction thickness is 80cm.

2.6.7 Main Powerhouse and Erecting Yard

The longitudinal axis of underground powerhouse is nearly vertical to the dam axis and is 130m away from the rear edge of intake tower and the rock covering on the underground powerhouse is about 75m deep. The installation elevation of the hydropower station is temporarily set as 754.00m; the elevation of top plate of tailwater pipe bottom is set as 737.40m; the ground elevation of generator layer is set as 768.00m and the elevation of vault is 792.60m.

The spacing of generator sets in the main powerhouse is24.6m and the total length is 147.6m; the span of the main powerhouse: 23.3m above780.00m elevation and 21.5m below 780.00m elevation.

The main erecting yard located on the right end of main powerhouse is close to #1 generator and is 38m long; the auxiliary erecting yard located on the left end of the main powerhouse is close to #6 generator and is 16m long. The erecting yards share the same span with the main powerhouse and the same ground elevation with the generator layer.

2.6.8 Tailrace Tunnel and Bulkhead Gate Chamber

(1) Design of tailrace tunnel

The tailrace tunnel is comprised of tailrace adit tunnel and main tailrace tunnel. One tailrace adit is arranged for one generator and is a pressure tunnel and the tunnel axis is vertical to the axis of main powerhouse; the spacing of tunnel axis is 24.6m and the tunnel axis is 200m; the elevation of inlet bottom is 737.40m, and the cross-section is of an arch shape and the structure dimension is 7m x10.23m.

The main tailrace tunnel is merged via bifurcation into the pattern that one tunnel is arranged for two generators and is a non-pressure tunnel. The tailrace pond at the head of the water diversion system is 48.05m in total and the clear dimension of cross-section is 12.5m x 25.1m - 12.5m x 17.5m; the main tailrace tunnel is close to the pond and the arrangement mode of straight section-bend section is used on the panel; the axis of tunnel inlet is vertical to the longitudinal axis of gate chamber; the axis of tunnel outlet is orthogonal with the tailrace outlet and the vertical panel is arranged into a slope with a slope ratio of 1:2500; the elevation of inlet bottom is 758.86m and the elevation of outlet bottom is 756.00m. Single non-pressure main tailrace tunnel is 7,068m - 7,184m and the cross-section is of an arch shape and the structure dimension is12.5m x 17.5m.

The tailrace tunnel is bricked with reinforced concrete and the bricking thickness of branch tunnel is 0.9m and that of main tunnel: Class II wall rock 0.3m-0.4m, Class III wall rock 0.6m-0.7m. Class IV wall rock 0.8m-0.9m and Class V wall rock 1.2m-1.3m.

The tunnel is initially supported by system shotcrete anchorage and the shotcrete is 10cm and is hanged with weaved galvanized steel mesh; the system anchor bolts are 5-6m long Φ25 deformed bars and the inner-row spacing is 1.5m.

(2) Tailrace bulkhead gate chamber
The tailrace bulkhead gate chamber is arranged at the place about 170m downstream of main powerhouse and the arrangement that an independent gate shaft is set in the lower part and the upper part is connected through as a gate operation gallery is adopted.

The access tunnel of gate chamber vertical to and on the right end of the gate operation gallery is connected with the right end of main transformer chamber. The access tunnel of gate chamber also serves as its ventilation tunnel.

The excavation dimension of gate operation gallery is 162m x 6m x10m; the elevation of base slab is 771.00m; the elevation of vault is 781.00m and the dimension of bulkhead gate orifice is 7m x10.23m. The gate gallery is supported with shotcrete and the hoist is overhead hoist and the beam of overhead hoist is of rock-anchored beam structure.

2.7 Electromechanical Engineering

2.7.1 Mechanical and Auxiliary System

(1) Hydro-generating unit

Ayago Hydropower Station is originated from the trunk stream of the Nile of Lake Victoria, about 250km away from the northeast of Kampala. The total installed capacity of the hydropower station is 840MW, the number of units installed is 6, and the single rated capacity is 140MW, Max unit output 154MW.

The operating scope of the water head of the hydropower station is 65.00 to 95.10m, which is the ideal and applicable scope for water head of the mixed-flow turbine. Therefore, the vertical-shaft mixed-flow turbine is selected in the hydropower station.

a. Main Parameters of Turbine
The main performance parameters of the actual turbine are as follows:

Turbine type	HLFI011A -LJ-475
Rated speed	150.0r/min
Runaway speed	295.0r/min
Rated output	142.0MW
Max output	156.2MW
Rotating wheel diameter D1	4.75m
Rated flow	190.04m3/s
Flow while unit max output	216.78 m3/s
Suction height	-5.54m
Installation elevation of turbine	EL.754.0m
Rotating wheel weight	71.0t
Total weight of turbine	460.0t

b. Main Parameters of Generator
The vertical shaft, air cooling and three-phase synchronous generator shall be selected and main performance parameters of the generator are as follows:

Rated capacity:	140.0MW
Max capacity:	154.0MW
Rated voltage:	13.8kV
Rated efficiency:	>98.6%
Rated power factor (lagging / leading):	0.9
Rated frequency:	50 Hz
Rated speed:	150r/min
Rotation direction:	Overlooking clockwise
Excitation mode:	Self-excited static controllable silicon excitation
Ventilation and cooling mode:	Sealed self-circulating fanless air cooling
Moment inertia t.m2	≥21000.0
Rotor weight:	440.0t
Total weight of generator:	985.0t

(2) Speed Governor

The speed governor system includes electrical, mechanical parts and oil pressure device. The type of speed governor is PID digital electro-hydraulic. The specification is YZ-4.0-6.3.

(3) Transient Calculation

On the condition that the given rule of direct closing of guide vane and various most unfavorable operating combined conditions, the calculated values of the transit process of unit meet the requirements of codes and specifications. In the tailrace tunnel, the fluctuation of free-surface-pressure flow is small and there is no water flow cut-off. However, at this stage, the hydraulic kinetic energy parameters are not clearly. Therefore, the transient process calculation will be researched thoroughly in the next stage.

(4) Auxiliary Equipment

The main bridge crane is made of two sets of single trolley whose specification is 250t/50t. The auxiliary equipment of Ayago Hydropower Project includes cooling water system, compressed air system, and dewatering & drainage system. The cooling water system adopts from gravitational and pressure reduced flow taken from the penstock. The dewatering & drainage system is used for unit maintenance and powerhouse dewatering, both of which adopt the three sets of submersible pumps separately. In order to avoid the downstream pollution, one set of oil-water separation equipment is equipped for the powerhouse dewatering system. The compressed air system in the power station consists of two parts - medium pressure air system and low pressure air system, which are provided separately. The governor medium pressure system shall consist of two reciprocating compressors each supplying air to the turbine governor pressure tanks. Two air receivers of the vertical type shall be provided. The lower compressed air system shall be supplied compressed air with pressure of 0.5~0.8MPa to the generator unit braking and plant maintenance service, which consist of three sets of lower air compressor and three air receivers of the vertical type. The oil industry is designed to provide assemblies of the turbines, generators and transformers with oil. The oil system in the power station consists of two parts – turbine oil system and transformer oil system, which are provided separately. For the turbine oil purification system, one purified oil tanks and one operation oil tanks are provided, two sets of precise oil purifiers and one set of turbine oil filter are provided. In addition, two sets of gear boil pumps are provided. For the transformer oil purification system, two purified oil tanks and two operation oil tanks are provided, two sets of precise oil purifiers and one sets of high vacuum oil filter are provided. In addition, two sets of gear boil pumps are provided.

2.7.2 Electrical System

Located inside Murchison Falls National Park, Uganda, the Ayago is one of the most important large scale hydropower development projects in the Victoria Nile River. Ayago hydropower plant will be installed six (6) generator units each rated at 140MW, totally 840MW of power. Generated power at Ayago hydropower station will be connected to Karuma switchyard through two (2) 400 kV circuits and then to be transmitted to Kawanda substation which is in suburbs of Kampala. The length of transmission line of the Ayago hydropower station between Ayago and Karuma is 58km. For the heavy output of the generator unit, one-generator-one-transformer unit connection will be used, and double busbar connection will be adopted for 400kV system, including six (6) transformer incoming bays, two (2) line feeder bays and one (1) bus coupler bay.

2.7.3 Control, Protection and Communication

(1) Computer supervisory and control system

The computer supervisory and control system of the Hydropower Station will adopt the hierarchical distributed architecture; the whole system is divided into two layers, that is, the main control level and the field control level. Specifically, the main control level is used for centralized monitoring and control for the Hydropower Station, as well as to communicate with the external system (including the superior dispatching system). The field control levels will separately configed the local control units according to the distribution of the monitoring objects. The computer supervisory control system will adopt the hierarchical and redundant network structure configuration scheme and will also adopt the redundant configuration for the important function nodes.

(2) Relay Protection System

The protection device will adopt the fully computerized protection system. Each generator of the Hydropower Station will be configured with a set of redundant generator protection; each main transformer will be configured with a set of redundant transformer protection; the 420kV busbar protection and the 420kV transmission line protection will adopt the redundant configuration; in addition, the Hydropower Station will also be configured with the safety and stabilizing device, 420kV circuit breaker protection, etc.

(3) Excitation System

The Hydropower Station will adopt the self-shunt static thyristor excitation system, which specifically is composed of the excitation transformer, thyristor rectifiers, de-excitation & overvoltage protection device, field flashing & electrical braking device, microcomputer excitation regulator, as well as other operation, measurement, protection, and signal equipment, etc.

(4) Communication System

The communication system is mainly composed of the electrical power system communication and the hub internal communication. One set of SDH optical fiber communication equipment (capacity of 622Mbit/s) and one set of power line carrier communication equipment will be adopted for each power line. The administrative communication will adopt one set of 512-line administrative switchboard. The dispatching communication has proposed to adopt one set of 384-line scheduling switchboard.

2.7.4 HVAC System

The power station is underground. The powerhouse is equipped within the group, oil, gas and water system equipment and excitation change, plant use change, PT cabinets, switchgear, high-current bus and other electrical equipment. There are on duty and long-term precision instrument rooms, such as the control rooms, offices layout at ground switching station. Based on the above characteristics, the HVAC and smoke control design of the left bank power station is selected as follows:

i. The outdoor air goes into the air conditioning room of the plant through the ventilation tunnel. After processing through the modular air handling units the air is sent into the main plant through the vault ventilation ducts, then going through the generator layer, turbine layer, the bus hole, main transformer holes in turn. After a gradual warming of air, taking away the plant's waste heat and humidity, it is discharged outside through the exhaust tunnel finally.
ii. Each bus holes are arranged with cabinet fan coils in place for circulation cooling the hot air; reduce the temperature inside the cave.
iii. The oil depots, oil treatment room, battery room, which contain flammable, explosive and corrosive gases, are set up separate ventilation system.
iv. Dehumidifiers are provided at the humid positions at the layer of the power house to dehumidify.
v. The building's ground switch station such as the control room, communication room, a computer room and other electrical rooms and offices are arranged with multi-line central air conditioning system.
vi. Two sets mechanical smoke exhaust system are arranged for the powerhouse: The smoke fans and vaulted cave ducts are arranged for the main plant smoke exhaust. The exhaust fan start to

exhaust the flue gas through the ducts to the outside in case of fire; The usual exhaust system of the bus bar hole is used to eliminate smoke. It is converted to exhaust operation in case of fire.

2.7.5 Fire Fighting System

In case of a fire to electromechanical equipment in the Station, such as hydro generating unit, main transformer, turbine oil tank, insulating oil tank and cable gallery to which Class B or E fire tends to happen; special fire fighting devices such as water spray extinguishing system, foarm or gas extinguishing system shall be used. A fire happening in the living administration area and common area of the Station generally is Class A fire which is easy to extinguish and causes less harm. Therefore overall fire fighting design for the project is planned as follows: Class A fire is mainly extinguished using water; for parts or locations where water is inappropriate, mobile fire extinguisher may be used. All buildings shall be provided with proper quantities of indoor and outdoor hydrants and mobile fire extinguishers.

2.8 Metal Structure

2.8.1 Sluice and open/close device of flood releasing structure

The left bank of Ayago hydropower station will be equipped with three scouring holes, which are used for dam releasing silt and sand regularly in front of reservoir . The width of scouring hole is 10.00m; the elevation of bottom sill is 837.00m. The scouring hole is deployed with maintenance gate slot and working gate slot along with the direction of water flow, they are respectively deployed with one stoplog sluice for maintenance and 3 plane working sluices. The working sluice is operated by fixed winch; the stoplog sluice for maintenance is operated by electric hoist on the top of dam.

2.8.2 Metal structure and open/close device of diversion power generation system

Uganda Ayago hydropower station is diversion type underground powerhouse, the water inlet of hydropower station is deployed on the left bank of river bed, and it is equipped with 6 units of water-turbine generator sets with unit capacity 140MW. Main structures include water inlet tower, diversion tunnel, underground plant, tail water tunnel etc. The frontier of water inlet tower is equipped with vertical trash rack slot, the water inlet section of water inlet tower is deployed with one layer of plane maintenance gate slot and one layer of plane rapid slot, each unit has one water inlet, the front edge of each unit section inlet is divided into 4 trash rack holes by using concrete separating pier. The inlet of hydropower station is equipped with trash rack, maintenance gate of hydropower station inlet and rapid door of hydropower station inlet in turn. The tower top platform is equipped with a set of 2-way portal crane with sewage disposal device, vice hook is used for operating trash rack, main hook is used for operating maintenance gate and also can be used for maintenance and lifting of rapid door and open/close device, the rapid door is operated by the hydraulic open/close device equipped on the top of water inlet tower.

The Diversion tunnel supplies water through a single pipe and single machine. The connection place of its end and shell is equipped with pressure steel pipe, the diameter of pressure steel pipe is φ6.6~5.3φ, the length of single pipe of pressure steel pipe is 66.5m. The tail water of hydropower station unit is equipped with one layer of tail water maintenance gate, each unit is equipped with one outlet tail water maintenance gate, the sluice is operated depending on automatic beam grasping operation by bridge type open/close device equipped inside the hole, Tail water of hydropower station is equipped with three tail water tunnels, its outlet is equipped with a layer of tail water tunnel outlet maintenance gate ,the outlet section of tail water tunnel is equipped with tail water tunnel outlet maintenance gate, the sluice is operated by truck crane depending on automatic beam grasping operation.

2.8.3 Metal structure and open/close device of fishway

The Fishway of Ayago hydropower station is deployed on the slope of left side of Central Island; there are one inlet and one outlet. The inlet of the fishway is equipped with one layer of maintenance gate slot, equipped with one inlet maintenance sluice. The size of hole is 2.5×7 (width × height), height of bottom sill is 838.00m; the water head in design is 7m. The structure mode of sluice is plane sliding door, the forward and reverse support adopt sliding block and single lifting point, the panel and waterstop are deployed on the upstream surface. Gate leaf is made in sections. Sluice is usually hung above the hole. Operation mode is opened and closed by flowing water; it is operated by a fixed winch on the top of sluice.

The outlet of fishway is equipped with one layer of outlet working door, and is equipped with one outlet working sluice. The size of hole is respectively 2.5×4.74 (width × height), height of bottom sill is 850.00m; the water head in design is 4.74m. The structure mode of sluice is plane sliding door, the forward and reverse support adopt sliding block and single lifting point, the panel and waterstop are deployed on the downstream surface. Sluice is usually hung above the hole. Operation mode is opened and closed by flowing water; it is operated by a fixed winch on the top of sluice.

The middle of fishway is deployed with one layer of flood-proof Watergate and one flood-proof sluice. The size of hole is 2.5×5.74 (width × height), the height of bottom sill is 849.00m; the water head in design is 5.74m. The structure mode of sluice is plane sliding door, the forward and reverse support adopt sliding block and single lifting point, the panel is deployed on the upstream side and waterstop is deployed on the downstream surface. Sluice is usually hung above the hole. Operation mode is opened and closed by flowing water; it is operated by a fixed winch on the top of sluice.

2.9 Commissioning of the Scheme

According to the generation capacity plan in Uganda PSIP Report Final, conducted by PB in association with Sunshine Projects, the Ayago HPP with installed capacity of 840 MW (up from 600 MW) is likely to get commissioned in the year 2025. According to the load forecast in Uganda PSIP Report Final, the peak demand projected in 2025 is 1457 MW and in 2026 is 1537 MW. It would be possible to meet the peak demand mainly with generation at Kiira/Nalubale HEP (380 MW), Bujagali HPP (250 MW), Karuma HPP (600 MW), Isimba HPP (183 MW) and Ayago (840 MW). The surplus power available can be exported to neighboring countries. The diesel based thermal stations can be operated to supplement generating capacity in case of outages. Ayago Hydro Power Project has been planned as a Run-of-the River scheme and it would not only meet the electricity demands of Uganda but also of neighbouring countries in the future, and trigger rapid industrialization of the country.

Table 3: Engineering Characteristics of the Ayago Hydropower Project

1	**Reservoir**	
	Maximum Water Level	El. 852.00
	Full Reservoir Level	El. 852.00
	Minimum Drawdown Level	El. 852.00
	Water Spread at FRL	74.45Ha
	Water Spread at MDDL	74.45Ha
2	**Dam**	
	Type	Concrete Gravity

	Length at top	595 m
	Overflow	340 m
	Non-overflow	255m
	Top Width	7 m
	Top of Dam	El.857.00m
	Maximum Height above deepest foundation	24.00m
3	**Coffer Dam**	
	Phases	Two
	Type	earth-rock cofferdam
	Maximum Height	El.856.00m
	Top Width	10m
4	**Diversion Channel**	
	Size & Shape	Bed Width100m
	Diversion Discharge	2500m^3/s
5	**Silt-Flushing Arrangements**	
	Type	Under Sluice
	No. of Gates	3Nos.
	Size of Gates	10.00m(W) X54.00 m(H)
	Crest Level	El. 857 m
6	**Water inlet**	
	Type and location	Shore tower type water inlet, base rock is biotite gneiss; it is located on the left bank of the dam, appearing about 93 º angles with axis of dam.
	Dimension	Total width 147.6m, height 22.0 m
7	**Headrace tunnel**	
	Diameter and shape	Diameter 7.2m, circular
	Length	Length of single tunnel is about 190m
	Type of lining	The lower curved section and lower flat section are steel lining sections; others are constructed by reinforced concrete section.
8	**Plant**	
	Type and location	Underground plant is located on the left bank of the Nile, 130m away from downstream of back edge of water inlet.
	Total flow capacity in design	1140.24m3/s
	Water head in design	80 m
	Size of main plant	147.6m x 23.3m x 55.2m (length x width x height)
	Type of unit, number of set, unit capacity	Mixed-flow Type Water Turbine-Generator Units, 6 units in total, unit capacity 140.00MW
	Total installed capacity	840 MW
	Elevation of installation	EL.754.00 m
	Elevation of floorslab of generator floor	EL.768.00 m
	Busbar hole	6 busbar holes, arch straight wall type, 45m in length for each, the net size of section is 7mx6m (width x height)
9	**Main transformer hole**	
	Deployment and size	It is framework structure with 2 layers, the lower layer is main

		transformer layer ,the upper layer is GIS layer, the excavation size is 169m x 18m x 31m (L x W x H)
10	**Tail water system**	
	Tail water lateral tunnel	Hole having pressure, 6 holes, net size of section is 7.0mx10.23m (width x height), the length of single lateral tunnel is about 200m.
	Main hole of tail water	Including water pool and tail water tunnel, it is a hole without pressure, 3 holes, net size of section of tail water tunnel is 12.5m x 17.5m(width x height) , the length is 7,068m - 7,184m.
	Operating corridor of tail water maintenance sluice	Excavation size is 162mx6mx10m (length x width x height)
	Outlet of tail water	Three independent platforms are set in the tailrace tower; the elevation of platform top is 776.50m; the plane size of tower top is 25m x 21.8m; the elevation of base slab top is 756.00m; the towers are connected via access bridges on tower top.
11	**Power Generation**	
	Rated net head at Design Discharge	80.0 m
	Installed Capacity	6 X 140MW = 840 MW
	Annual generation	4953.03 Million Unit

Table 4: The Main Quantities of Ayago Hydropower Station

Items	Unit	Quantities				
		Dam	Power station	Total main works	River diversion	Total
Open excavation of earthwork	Ten thousand m^3	12.90	18.48	31.38	70.34	101.72
Open excavation of stonework	Ten thousand m^3	5.53	35.36	40.89	2.26	43.15
Stonework tunneling	Ten thousand m^3		590.23	590.23		590.23
Earth-rock filling	Ten thousand m^3				70.34	70.34
Concrete	Ten thousand m^3	11.67	116.44	128.11		128.11
Rebar	t	2864.24	95575.68	98439.92		98439.92
Steels	t	42.96		42.96		42.96
Steel arch	t		3202.08	3202.08		3202.08
Anchor rod	Piece	517	513560	514076		514076
Anchor rope	Bundle		433	433		433
Metal structure installation	t	330.1	3417.5	3747.6		3747.6

2.10 Hydrographic Data

The designed flood of dam site and plant site is shown in Table 6 while Table 7 shows runoff results of the dam site. The dam site stage-discharge relation curve is shown in Figure 4. Figure 5 shows the plant site stage-discharge relation curve.

Table 5: Designed Flood of Dam Site and Plant Site

Designed Frequency (%)	0.1	0.2	0.5	1.0
Peak Discharge (M3/S)	3820	3560	3230	297o

Table 6: Runoff Results of dam

Month	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Monthy average Dischargs	953	929	919	936	972	1010	1027	1051	1058	1037	1036	1004

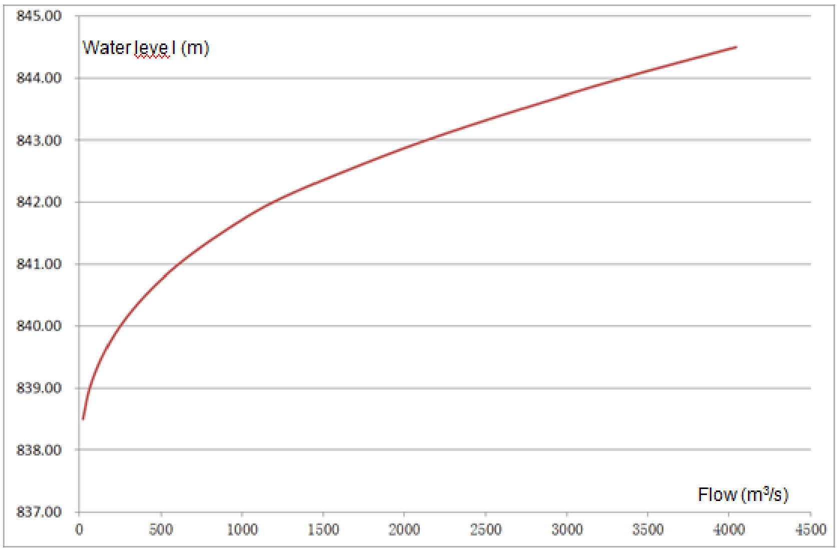


Figure 4: Dam site stage discharge relation curve

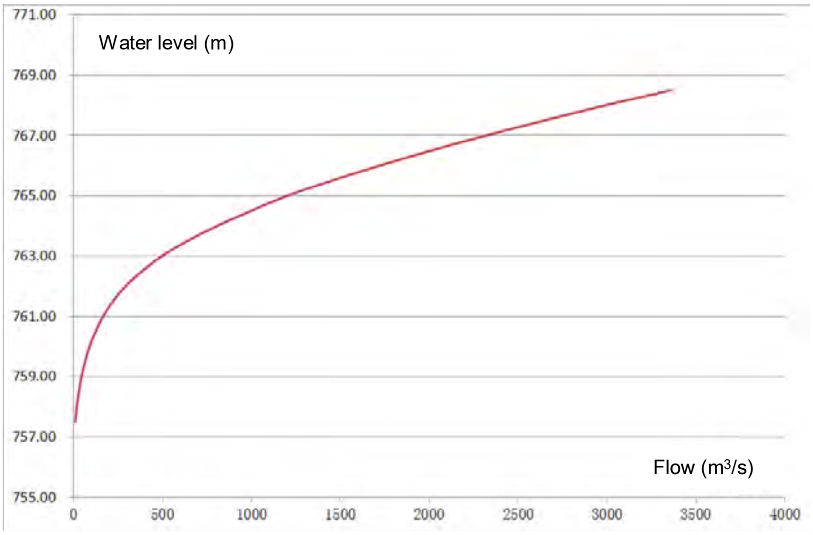


Figure 5: Plant site stage -discharge relation curve

2.11 Construction Phase and Programme

2.11.1 Duration of Construction

The total duration of Ayago Hydropower Station construction will last five and a half years (66 months) and the power generation period will last four years and eight months (56 months). Among them, construction preparation will last 13 months, construction of main body will last 43 months and construction completion 10 months. Construction preparation of the Project will start in January of the first year, and excavation of main powerhouse will start in February of the second year, the first unit shall be put into production at the end of August of the fifth year and the Project completed at the end of June of the sixth year.

2.11.2 Construction Schedule

Details of the construction schedule can be found under Volume III under feasibility study report. However, a summarised construction schedule is provided below:

a) Project construction starts in January of the first year, and construction of access road, access tunnel and tailrace tunnel adit will be started;
b) At the end of January of the second year, powerhouse top adit will be completed; excavation of main powerhouse starts in February and ends in December of the third year, a period of 22 months;
c) Concrete placement of main powerhouse starts in December of the third year; by January of the fifth year, concrete placement for the first unit will be completed, a period of 14 months; and concrete construction of the powerhouse will be completed in June of the fifth year;
d) Installation and commissioning of the first unit lasts from February to August of the fifth year, a period of 7 months; the first unit starts power generation at the end of August; one more unit will be put into production in every 2 months later, and all units will be put into production in June of the sixth year, and the project will be completed then.

2.11.3 Construction Intensity and Supplies

Table 8 presents the construction intensity of Ayago hydropower station in different years. The main building materials to be used are: Cement (407000t), Flyash (94000t), Steel (145000t), Timber (3500m^3) and Explosives (8680t). In a peak year, the number of labor force is 4800 persons, and the annual average labor force is about 3700 persons.

Table 7: Construction Intensity of Ayago Hydropower Station in Different Years

ITEM	UNIT	1ST Year	2nd Year	3rd Year	4th Year	5th Year	Total
Open Excavation	10000m^3	63.98	49.85	20.01	7.01	4.02	144.87
Tunnel Excavation	10000m^3	28.92	231.05	226.68	103.57		590.22
Earth rock-filling	10000m^3	50.33	20.01				70.34
Concrete Pouring	10000m^3	4.21	9.6	44.98	65.94	3.38	128.11

2.12 Construction Method and Equipment

a) Construction of diversion structure

Underwater rock excavation will be conducted during low water season; for excavation of the part exposed above water surface, hole shall be drilled with down-the-hole drill. Underwater blasting shall be conducted, underwater exaction shall be conducted with 2m^3 backacting shovel, and slag tapping shall be conducted with 15~20t dumper. For the part which is not exposed above water surface, a drilling platform shall be set up at the bank side. Underwater drilling shall be made with down-the-hole drill, underwater blasting shall be conducted, pad slag shall be exposed above the water surface, underwater excavation shall be conducted with 2m^3 backacting shovel and slag tapping shall conducted with 15~20t dumper. The available part of excavated materials shall be transported to the cofferdam charge make-up area, the comprehensive transportation distance is about 2.0km; and the rest shall be transported to upstream 1# waste disposal area, the comprehensive transportation distance is about 1.5 km. Details can be found in Volume II under the feasibility report.

b) Construction of cofferdam

Underwater part of cofferdam shall be constructed by the random filling method. The filling materials shall be transported with 20~25t dumper, and randomly filled and advanced into water by the end-advancing method, and the filling materials shall be pushed into the water with 180~220Hp bulldozer. The part of cofferdam above water shall be paved and rolled by layers. The seepage-proofing wall shall be constructed after it is filled to the construction platform elevation of the seepage-proofing wall. The filling materials shall be transported with 20~25t dumper, leveled with 180~220Hp bulldozer and compacted by layers with 15~20t vibration roller. The filling materials of the second stage cofferdam shall use the excavated materials of powerhouse, which shall be directly transported to the cofferdams or transferred, and the comprehensive transportation distances are respectively as 2.5 km and 1.0 km. The cofferdams at the inlet and outlet of the powerhouse shall use the excavated materials at the powerhouse' near positions as filling materials, the comprehensive transportation distances being respectively as 1.0 km and 0.5km.

c) Construction of flood-releasing water retaining structure

The overburden layer of water retaining structure shall be directly excavated with 2m^3 excavator, slag shall be collected with 100~120hp bulldozer and slag shall be transported with 15~20t dumper. For rock excavation, the borehole-blasting method shall be used, holes shall be drilled with down-the-hole drill and top-down differential millisecond blasting construction shall be conducted.

d) Construction of concrete work

The flood-releasing water retaining structure concrete shall be poured with 10t crawler crane and 3m3 bucket. Three 10t crawler cranes shall be arranged at the dam at the left bank, and additional 1~2 concrete pumps shall be arranged in the peak time of concrete pouring. Three 10t crawler cranes shall be arranged at the dam at the right bank for concrete pouring.

e) Construction of diversion power generation system

Open excavation method of inlet/outlet is the same as that of water retaining structure. Usable excavated materials can be transported to aggregate processing system and material preparation field of the cofferdam respectively, and other materials can be transported to 2# upstream waste slag field and downstream waste slag dield respectively. Their haul distances are 1.5km, 1.0km, 2.0km and 5.0km respectively.

Excavation of access tunnels and construction adits: short-step drilling and blasting method is adopted to excavate the access tunnels and construction adits, i.e. drill the hole with a three-boom drill jumbo, cut the hole in the center, and blast smoothly in the surrounding. Excavation of headrace tunnel: layered excavation method is adopted in upper flat section and upper curved section of the headrace tunnel: hole-drilling by means of three-arm drill jumbo, center cutting, and surrounding smooth blasting are applied to the upper layer; for lower layer, multiple-boom drill jumbo is used to drill horizontal hole, and smooth blasting is used for surrounding holes.

Excavation of the power house and installation field: top layer of the power house shall be excavated from the middle firstly and then on two sides. Hole is drilled by means of multiple-boom drill jumbo, and surrounding holes are blasted smoothly.

Excavation of bus tunnel: full-face excavation is adopted for the bus tunnel. Drill the horizontal hole by means of multiple-boom drill, cut the hole in the center, and conduct smooth blasting in the surrounding.

f) Construction ventilation

For the underground chamber, it is difficult to arrange the branch construction tunnel, the distance is long and the construction ventilation condition is poor. It is planned to adopt 110kw×2 axial-flow forced ventilation for the construction of the tunnel with the longest single work surface of 2.5km.It is planned to adopt 90kw×2 axial-flow forced ventilation for the construction of tunnel with single work surface of 1.5~2.0km. Besides, vertical ventilation shaft will be set up at proper positions to auxiliarily exhaust dust to meet the ventilation requirements for the project construction. The details of locations and determination of permanent and temporary ventilation types will be determined during detailed design and separate EIA will be developed for these shafts.

g) Construction drainage

Main water stagnated in tunnel is underground seepage water and waste construction water. During the excavation, drainage ditch and collecting well will be set up at the lower places, and the aforesaid water will be drained via pumping or self-flowing to the sedimentation pond outside the tunnel, and finally drained into designated after being treated in such pond.

h) Earthwork construction

The covering layer will be directly excavated by a 1–2 m3 excavator; soil/rock will be collected by

100–120hp bulldozer and transported by 15–20t self-dumping truck. Drilling and blasting method will be adopted for the rock excavation. Hole will be made by down-the-hole, and rock will be blasted by layers from the up down. Explosion residue will be loaded by a 1–2 m3 excavator and transported by 15–20t self-dumping truck. All waste slags will be transported to the 1# residue field, and the comprehensive transportation distance is around 1.0 km. Top soil will first be removed and piled in a designated place which shall be kept for future restoration purposes.

i) Concreting work

Concrete for the fishway will be horizontally transported by the concrete tank truck, delivered into the chamber by concrete pump truck and vibrated by plug-in vibrators.

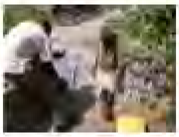
j) Seepage control work

Generally, curtain grouting will be started from the riverbed to both banks. Grouting sequence: downstream rows, upstream rows, and certain order among rows. Geological rotary drill or hydraulic rock core drill will be used for drilling. Fast drill is used for making all holes at one time. These holes will be grouted by the grouting pump. An automatic grouting recorder will also be used with the grouting pump. Holes with depth of 6m will be grouted at one time, and holes with depth more than 6m will be grouted by section. Backfill grouting in tunnel will be conducted after the reinforcement concrete lining reaches 70% design strength. Grouting pipes will be embedded before reinforcement concrete lining.

2.13 Construction Material Plan and Sourcing

The total amount of filling material is 703,000 m3, including rock slag material of 620,000 m^3 and rock block of 83,000 m^3. The Project needs concrete aggregate of 1.37million m^3 in total. There is almost no river sand or open quarry yard near the Project area. Concrete aggregate has three sources: ① choose quarry yard outside the National Park to manually prepare aggregate; ② find nearby potential quarry yard inside the National Park to manually prepare aggregate; ③ excavate material via tunnel to manually prepare aggregate. According to the geological data, there are 4 rock material yards investigated outside the Murchison Fall National Park, and their features are stated in Table 9.

Table 8: List of Rock Material Yards outside the Murchison Fall National Park

Material Yard	Material Yard 1	Material Yard 2	Material Yard 3	Material Yard 4
Picture				
Location	Mashindi 36N 350894E, 197103N	Kiryandango 36N 404187E, 215976N	Bweyale,Nyamusasa 36N 404196E, 218228N	Mutanda 36N 419336E, 237238N
Yard conditions	Commercial quarry	Local material yard	Lawn Arable land	Karuma-Pakuche Road material
Geology	Granitic gneiss suitable for concrete aggregate	Granitic gneiss suitable for concrete aggregate	Granitic gneiss suitable for concrete aggregate	Metamorphic base rock suitable for concrete material, and better than the previous three kinds of material
Distance	107 km	100 km	90 km	84 km

Investigation shows that the natural sand (fine aggregate) after treatment can be obtained from the sand dune or beach on the bank of Albert Lake, and the potential sources for granular material are Wanseko, Buliisa and Butiaba along the bank of Albert Lake. Within the aforesaid areas, there is no specialized sand material supplier, and they are only brokenly exploited by the locals. According to the geological investigation, there are two quarry areas inside the national park, one at the north bank, and one at the south bank.

In total 703,000 m^3 of rubble and rock ballast materials need to be filled for the Project. The materials from building excavation will be mainly biotite gneissic rocks, harder in mechanical property, meeting the quality requirements for rubble and rock ballast for filling. After deducting the utilizable material for processing concrete aggregate, aggregated rock available will be approximately 5.1 million m^3, greater than the demanded quantity of aggregated rock for filling. Therefore the excavated material will be utilized for all filling material.

2.14 Construction Transportation

The heavy and large pieces of the unit of Ayago Hydropower Station, after unloading at Mombasa Harbour, will be transported via road to the dam site. According to the external transport conditions and sources of materials for Ayago Hydropower Station, the main materials in large quantity and mechanical & electrical equipment will be shipped by sea to Mombasa Harbour of Kenya, transferred at the harbor to transportation by road to the dam site. The recommended route for external transportation is Mombasa → Nairobi → Kisumu → Busia → Jinja →Kampala →Karuma → dam site of Ayago Hydropower Station.

The road transport mileage from Mombasa to Karuma is approximately 1200 km. All of the three lines from Karuma to the dam site are located inside Murchison Falls National Park and/or Karuma Widlife Reserve. Among them the two paths at the left and right banks are only 2m–3m wide at the roadbeds, and in poor conditions. Should these two paths be selected as the access to the site, broadened roadbeds and additional pavement surface will be required to meet the requirement for external materials to access the site. The rebuilding and expansion required will be approximately 72 km for the left bank path, and approximately 47 km for the right bank path, which will have a bigger impact on the environment of Murchison Falls National Park. The Karuma-Pakwatch highway, with a hardened surface and broader roadbed, will be able to meet the transportation requirement of the materials in large quantity and the heavy & large pieces needed for construction of the hydropower station. The dam site area, mainly flat with small undulations, is a relatively easy place for building new roads. Therefore the Karuma-Pakwatch highway is currently recommended as the road for external transportation from Karuma to the dam site. This plan requires building 6.1 km of new road, and rebuilding or expansion of 8.2 km of the existing road. In this plan the road mileage is 43 km from Karuma to the road at the dam site. The two paths on the left and right banks can be used as auxiliary access roads. The standard for the new road and rebuilt or expanded road is class 4 roads, 6.0 m wide at the road surface, and 6.5 m wide at the roadbed, with asphalt concrete penetration pavement. Figure 6 presents a sketch of the access roads to the site.

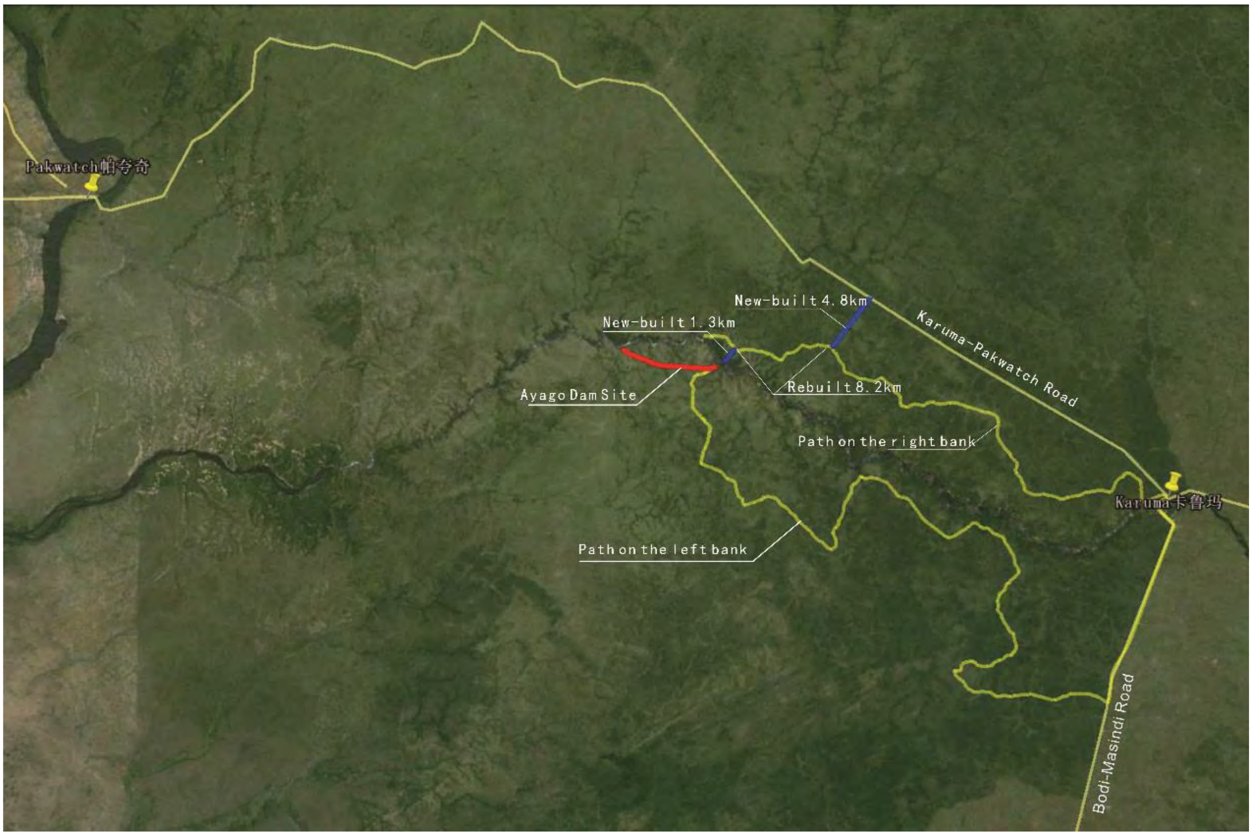


Figure 6: Sketch of the proposed access roads to the site

2.15 Aggregate Processing

The processing technology of the system is controlled as per Grade II concrete aggregate, and can meet the technical requirements of the project for Grade III concrete aggregate. The aggregate preparation relies on the combined sand making technology of three-stage crushing, vertical shaft crushing and rod mill. The primary crushing is an open circuit production of jaw crusher, the secondary crushing is an open circuit production of cone crusher, and the fine crushing is a closed circuit production of cone crusher. The sand making by vertical shaft impact crusher is a closed circuit production. Table 10 presents the main Mechanical Equipment of Artificial Sand and Stone Processing System.

Table 9: Main Mechanical Equipment of Artificial Sand and Stone Processing System

S/N	DESCRIPTION	MODEL & SPECIFICATION	UNIT	Qty	POWER (kW)	REMARKS
1	Grizzly feeder	VF561-2V	Set	2	22x2	
2	Jaw crusher	C110	Set	2	110x2	Primary crushing
3	Cone Crusher	GP300S	Set	2	250x2	Secondary crushing
4	Cone Crusher	HP300	Set	2	132x2	Fine crushing
5	Vertical shaft crusher	B9100	Set	3	315x3	Vertical sand making
6	Rod mill	MBZ2136	Set	2	210x2	Rod mill sand making
7	Chute-type mud washing machine	2400x8300	Set	2	75x2	
8	Heavy-type circular vibrating screen	2YKRH2136	Set	2	22x2	First screening
9	Circular Vibrating screen	3YKR1845	Set	2	37x2	Second Screening
10	High Frequency vibrating screen	3618VM	Set	3	37x3	Third screening
11	Spiral classifier	FC-15	Set	3	7.5x3	
12	Linear vibrating screen	ZKR1236	Set	6	11x6	Dehydration
13	Vibrating feeder	GZG80-120	Set	18	1.1x18	Semi-finished material yard
14	Electrically operated radial gate	800x800	Set	24	0.75x24	
15	Vibrating feeder	GZG50-100	Set	12	1.0x12	Finished material yard
16	Iron separator	RCDD-12	Set	3	3x3	
17	Belt conveyor		m/belt	1780/37	1150	

2.16 Construction Water Supply

The construction & production water and domestic water of Ayago Hydropower Station are from trunk stream of Victoria Nile River. During the construction of Ayago Hydropower Station, the water supply system will mainly provide the production water for sand and stone processing system and concrete production system; provides construction water for such works as diversion tunnel, dam, underground power house, diversion tunnel, headrace tunnel, discharge tunnel, water cushion pool, bank-protection works and house building; and provides domestic water for work area construction personnel, management personnel, construction factory, warehouse, fire-fighting equipment, among others. According to the statistics, the total water supply scale is 3.01 × 104 m3/d, including 2,500 m3/d of domestic water and 2.76 × 104 m3/d of production water. Water quality shall be maintained according to national standards as stated by DWRM.

Ayago Hydropower Station is planned to have four construction areas, i.e. left-bank plant dam construction area, left-bank tailrace tunnel construction area, left-bank tailrace outlet construction area and right-bank construction area. The left-bank upstream water supply system provides the production water and domestic water for left-bank plant dam construction area and left-bank tailrace tunnel construction area, with a design scale of 2.4 × 104 m3/d; the left-bank downstream water supply system provides the production water and domestic water for left-bank tailrace outlet construction area, with a design scale of 5,800 m3/d; and the right-bank water supply system provides the domestic water for the Owner's management camp in the right-bank construction area, with a design scale of 320 m3/d. The water supply system has the process flow illustrated in Figure 7. Table 11 presents the main works of the construction water supply system.

Water Purification Station

Figure 7: Water Supply System flow Chart

Table 10: List of Main Works in Construction Water Supply System

S/N	NAME OF WORKS	SCALE OR SPECIFICATION	UNIT	QTY	REMARKS
I	Left-bank upstream water supply system				Floor area: 3,500m^2
1	Pumping station	Q=24000m^3/d	Nr.	1	
2	Water Purification Station				
2.1	Integrated water purifier	Q=35m^3/h	set	2	
2.2	Production water pond	V=4500m^3	Nr.	1	
2.3	Domestic water pond	V=400m^3	Nr.	1	
2.4	Ultraviolet sterilizer		Set	1	
2.5	Booster pump station	Q=70m^3/h, H=55m	Nr.	1	

3	Water supply pipe (galvanized steel pipe)	DN 450	m	2700	
	Water supply pipe (galvanized steel pipe)	DN 350	m	5800	
	Water supply pipe (galvanized steel pipe)	DN 150	m	3600	
II	Left-bank downstream water supply system				Floor area: 1500m^2
1	Pumping station	Q=5800m^3/d	Nr.	1	
2	Water purification station				
2.1	Integrated water purifier	Q=30m^3/h	Set	1	
2.2	Production water pond	V=800m^3	Nr.	1	
2.3	Domestic water pond	V=250m^3	Nr.	1	
2.4	Ultraviolet sterilizer		Set	1	
3	Water supply pipe (galvanized steel pipe)	DN300	m	240	
	Water supply pipe (galvanized steel pipe)	DN100	m	480	
III	Right-bank water supply system				Floor area: 700m^2
1	Pumping station	Q=320m^3/d	Nr.	1	
2	Water purification station				
2.1	Integrated water purifier	Q=15m^3/d	Set	1	
2.2	Domestic water pond	V=130m^3	Nr.	1	
2.3	Ultraviolet sterilizer		Set	1	
2.4	Booster pump station	Q=15m^3/h, H=50m	Nr.	1	
3	Water supply pipe (galvanized steel pipe)	DN100	m	560	

2.17 Construction Power Supply

The main power loads in the construction period include: earth rock excavation and filling, concrete pouring construction, drainage of foundation pit, exploitation and processing of sand and stone materials, concrete production system, water supply system, comprehensive processing plant and other construction enterprise, as well as other production and living lighting. The total installed capacity of electric equipment in Ayago Hydropower Station is about 19,200kW.

Since there is no available construction power supply near the construction area, it is planned to use the diesel generators to provide all construction power for Ayago Hydropower Station, and the construction equipment shall be of oil driven type as far as possible. The principle of diesel generator arrangement:

according to the construction general layout and power load distribution, the arrangement shall meet the power load growth and voltage quality requirements in various construction stages, shall be economical and reliable, and shall avoid the construction interference; the important construction power loads shall be provided with standby generator sets. Table 12 presents the main works of the construction power supply.

Table 11: Main Equipment Configuration

S/N	NAME OF EQUIPMENT	MODEL AND SPECIFICATION	UNIT	QTY	REMARKS
1	Diesel generator	2000kW. 0.4kV	Set	3	Upstream power house construction area (2 running and 1 on standby)
2	Diesel generator	1000kW. 0.4kV	Set	3	Upstream power house construction area (2 running and 1 on standby)
3	Diesel generator	800kW. 0.4kV	Set	3	Upstream power house construction area (2 running and 1 on standby)
4	Diesel generator	800kW. 0.4kV	Set	2	Upstream power house construction area
5	Diesel generator	1000kW. 0.4kV	Set	3	Tailrace adit construction area (2 in running and 1 on standby)
6	Diesel generator	800kW. 0.4kV	Set	2	Tailrace outlet construction area (2 running and 1 on standby)
7	Diesel generator	800kW. 0.4kV	Set	2	Tailrace outlet construction area
8	Diesel generator	800kW. 0.4kV	Set	2	Owner's camp

2.17 Project Infrastructure layout

Ayago Hydropower Station has an arrangement of diversion conduit type head underground power house, and the water diversion and power generation structures are arranged on the left bank. The overflow and water retaining structures are arranged on the river bed. The dam is a concrete gravity dam with a relatively small scale, and the maximum dam height is 24m. The diversion is a stage diversion based on the central bar. The left-bank overflow gravity dam, flushing gate and non-overflow dam monolith are first built, and after that, the right-bank overflow gravity dam and non-overflow dam monolith are built.

The junction layout pattern and diversion method of Ayago Hydropower Station determines that the construction layout is mainly on the left bank; the left bank is mainly the underground power house and the concrete dam construction areas; main temporary construction facilities are arranged near the left-bank power house access tunnel exit and the water retaining and discharge structures. The tailrace tunnel of the station is relatively long, i.e. about 7 km or more. To ensure the construction schedule, a construction adit will be provided at the middle of tailrace tunnel to develop the working face. According to the layout position of construction adit for tailrace tunnel and the position of tailrace outlet, as well as the topographic and geological conditions of the site, a tailrace tunnel construction area and a tailrace outlet construction area are separately established. Necessary construction factories and camp facilities are respectively provided for these areas to meet the requirements of tailrace tunnel excavation & lining and tailrace outlet concrete pouring construction.Analyzing the above information, Ayago Hydropower Station is planned to have four construction areas: construction area of plant and dam, construction area of tailrace tunnel adit, construction area of tailrace tunnel outlet and construction area out of the park. Construction general layout plan is shown in Figure 8.

Construction area of Plant and Dam

The construction area of the plant and dam is near the riverbed concrete dam and the access tunnel; main construction factories are arranged along the river to meet the construction requirements of the concrete gravity dam and the underground power house. Within this area, the main temporary construction facilities include sand and stone processing system, concrete mixing system for plant and dam, cofferdam material preparation area, upstream waste disposal area No. 1 (also used as the automobile machinery parking area), upstream waste disposal area No. 2 and construction distribution substation. The Plant and dam construction area layout plan is shown in Figure 8.

- Sand and stone processing system: Since most concrete aggregates are the excavated materials of the underground power house, the sand and stone system is arranged near the access tunnel exit of the underground power house, about 350m upstream of access tunnel exit, near the field road No. 5; the site elevation is within 850m–870m, the floor area is 7.5×10^4 m^2, and the system scale is 725t/h; it will provide all concrete aggregates required by the Project.
- concrete mixing system for plant and dam: It is located near the left-bank bridgehead of temporary bailey bridge for construction, with a distance of 300m to the upstream dam and about 650m to the downstream access tunnel opening; the site elevation is 850m and the floor area is 1.8×10^4 m^2; it mainly provides the concrete required by riverbed concrete dam, water intake and underground power house construction.
- Cofferdam material preparation area: It is located about 350m upstream of the dam site, near the field road No. 1; the site elevation is within 865m–870m, and the floor area is 2.0×10^4 m^2; it is mainly the material preparation area for Phase II cofferdam and power house water intake cofferdam filling.
- Upstream waste disposal area No.1 (also used as the automobile machinery parking area): it is located in a gully about 180m downstream of the left-bank dam abutment. The elevation of the waste top surface is planned to be 875m, the floor area is 6.0×10^4 m^2, and the capacity of the waste disposal area is 33.7×10^4 m^3; it mainly accommodates the excavated wastes of the power station water intake and left-bank dam.
- Upstream waste disposal area No. 2: It is located in a gully about 340m upstream of the access tunnel; the waste disposal area has a step-type layout according to the topographic conditions; the top surface elevation is 880m, the floor area is 16.6×10^4 m^2, and the capacity of the waste disposal area is 87.9×10^4 m^3; it mainly accommodates the excavated wastes of the underground power house system.

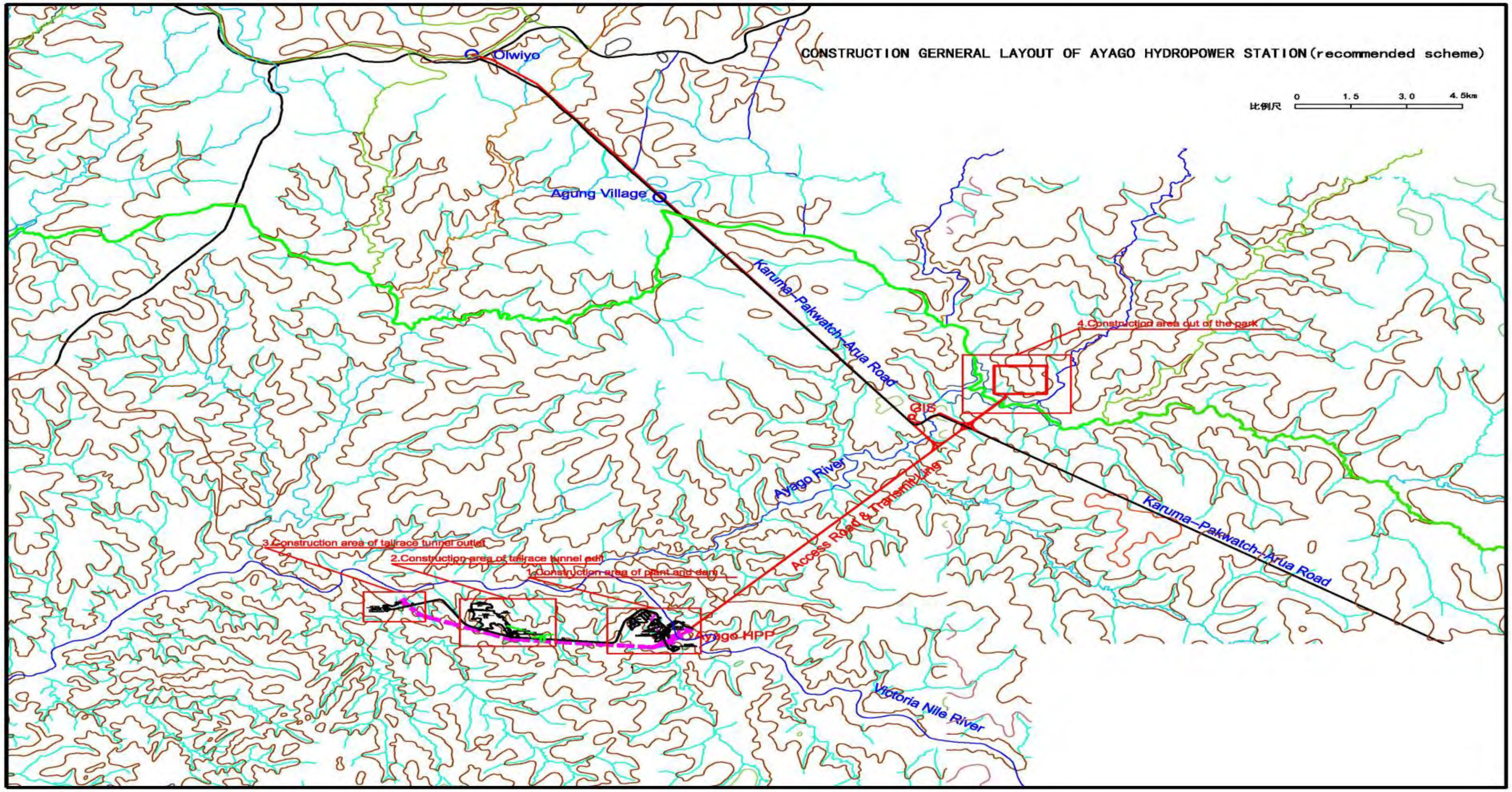


Figure 8: Construction General Layout Plan

- Construction distribution substation: It accommodates construction distribution substation No. 2 and construction distribution substation No. 3: the construction distribution substation No. 2 is located between the sand and stone processing system and the plant dam concrete system, and the construction distribution substation No. 3 is located near the comprehensive processing plant; each has a floor area of 0.1 ×10^4 m^2.

Construction area of Tailrace tunnel adit

The construction area of tailrace tunnel adit is near the inlet of tailrace tunnel construction adit No. 2; it accommodates concrete mixing system for tailrace tunnel, downstream waste disposal area, explosive magazine and construction distribution substation. Tailrace tunnel construction area layout plan is shown in Figure 9.

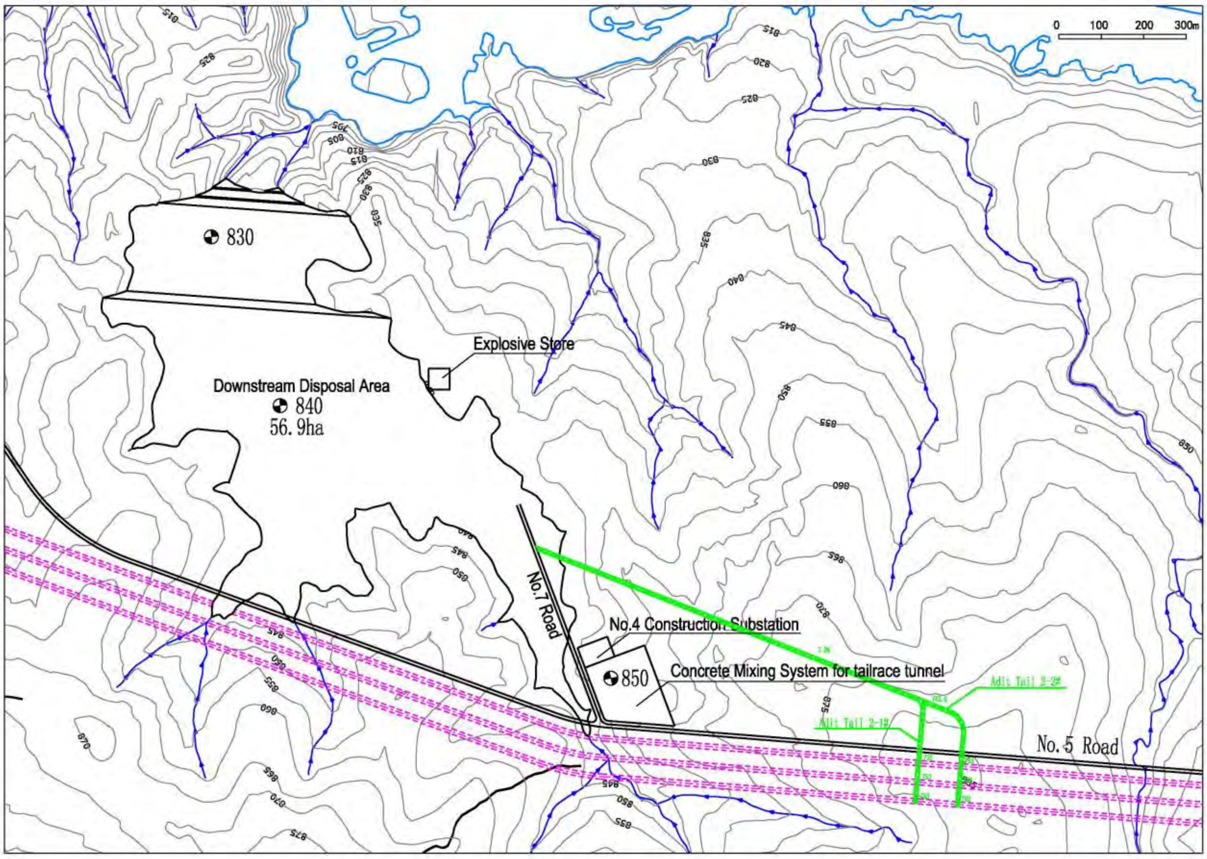


Figure 9: Tailrace Tunnel Construction Area Layout Plan

- Concrete mixing system for tailrace tunnel: It is located near the intersection of road No. 5 and road No. 7, with a distance of about 350m to the opening of tailrace tunnel construction adit No. 2; the site elevation is 850m, and the floor area is 2.5 ×10^4 m^2; it mainly provides the concrete required by the tailrace tunnel lining.

- Downstream waste disposal area: It is located in a gully at the outlet of tailrace tunnel construction adit No. 2, with a distance of 6.9 km downstream of the dam line; the top surface elevation of the waste is planned to be 840m, the floor area is 56.9×10^4 m^2, and the capacity of the waste disposal area is 585.7 × 104 m^3; it mainly accommodates the excavated wastes form tailrace tunnel and tailrace outlet.
- Explosive magazine: It is located near the downstream waste disposal area, with a distance of about 500m to the outlet of tailrace tunnel construction adit No. 2; the floor area is 0.25×10^4 m^2, and the site elevation is 840m.
- Construction distribution substation: It accommodates the construction distribution substation No. 4, which can meet the construction requirements of tailrace tunnel.

Construction area of tailrace tunnel outlet

The construction area of tailrace tunnel outlet is located at about 300m downstream of the tailrace outlet; it accommodates the concrete mixing system for tailrace tunnel outlet and construction distribution substation. Tailrace tunnel outlet construction area layout plan is shown in Figure 10.

- Tailrace outlet concrete system: It is near the field road No. 5; the site elevation is 785m, and the floor area is 1.5×10^4 m^2; it mainly provides the concrete required for tailrace outlet and tailrace tunnel downstream section lining.
- Construction distribution substation: It is the construction distribution substation No. 5, which can meet the construction power supply requirements of tailrace outlet and tailrace tunnel near the tailrace outlet.

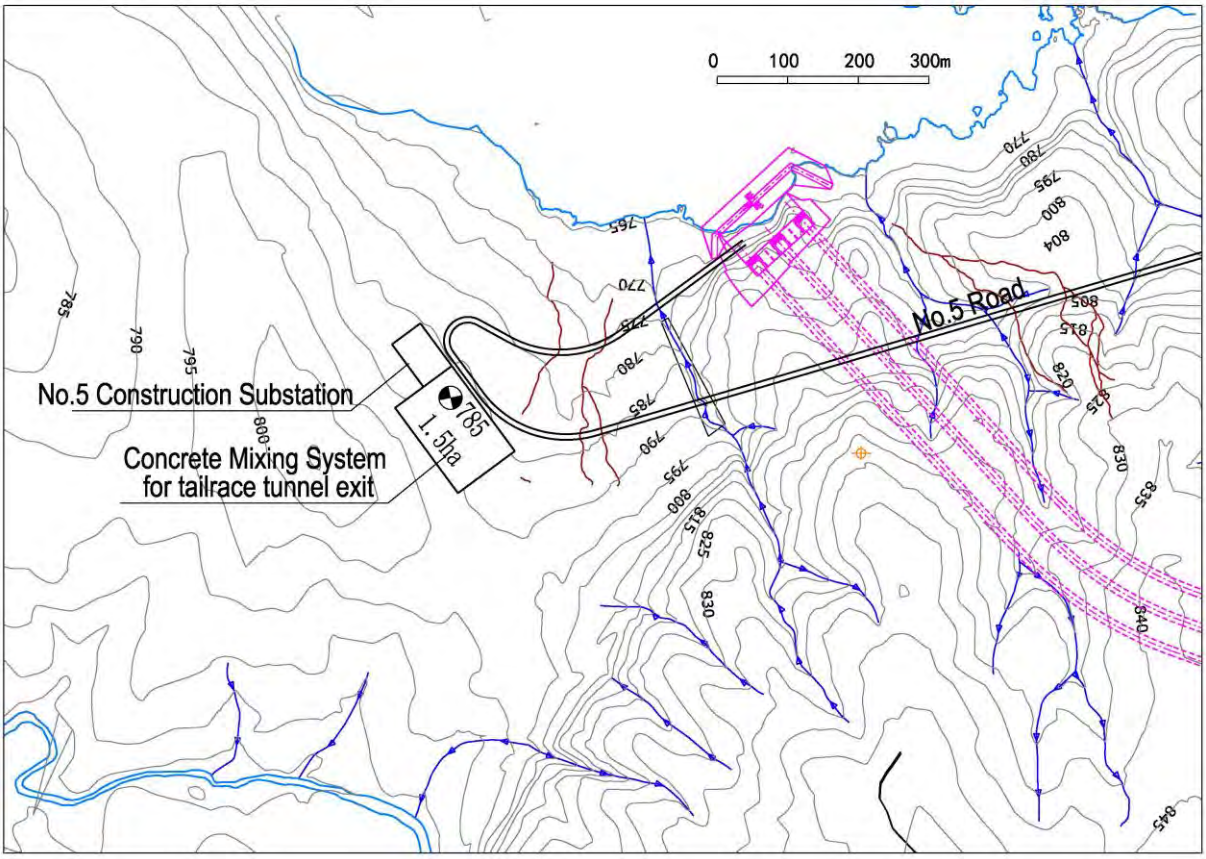


Figure 10: Construction Tailrace Outfall Construction Area Layout Plan

Construction area outside the Park

The construction area out of the park is at the beginning point of access road, along with the Karuma-Pakwatch Road. It includes the owner's management camp, the contractor's camp, the metal structure and electromechanical equipment assembly yard, the construction distribution substation, the oil depot, the comprehensive warehouse and the comprehensive processing plant. These support infrastuctre outside the park will be a subject of separate EIAs.

- Owner's management camp: the floor area is 11.0 × 10^4 m^2.
- Contractor's camp: the floor area is 5.0 × 10^4 m^2.
- Metal structure & electromechanical equipment assembly yard: the floor area is 6.0 × 10^4 m^2.
- Construction distribution substation: it is the construction distribution substation No. 1, which mainly provides the power to the construction area out of the park.
- Oil depot: the floor area is 0.5 × 10^4 m^2, the distance between the oil depot and other construction facilities meets safety requirements.
- Comprehensive warehouse: the floor area is 3.0× 10^4 m^2.
- Comprehensive processing plant: the floor area is 3.0 × 10^4 m^2.

Refer to Table 13 for the list of the temporary facilities in the park and Table 14 for the list of the temporary facilities out of the park.
NB: The owner's and contractor's camp will have separate ESIAs

Table 12: List of the Temporary Facilities in the Park

Location		Name	Scale	Elevation (m)	Area (ha)	Remark
left bank in the park	construction area of plant and dam	sand and stone processing system	725t/h	850～870	7.5	
		concrete mixing system for plant and dam	HZS120-1Q2000	850	1.8	
		cofferdam material preparation area		865～870	2	
		upstream waste disposal area No. 1		875	6	also used as the automobile machinery parking area
		upstream waste disposal area No. 2		880	16.6	
		construction distribution substation No.2		860	0.1	
		construction distribution substation No.3		905	0.1	
	construction area of tailrace tunnel	concrete mixing system for tailrace tunnel	2*HZS90-1Q1500	850	2.5	
		downstream waste disposal area		840	56.9	

	adit	explosive magazine		850	0.25	
		construction distribution substation No.4		845	0.1	
	construction area of tailrace tunnel outlet	tailrace outlet concrete system		785	1.5	
		construction distribution substation No.5		785	0.1	
		Total			95.45	

Table 13: List of the Temporary facilities out of the Park

Location		Name	Scale	Elevation (m)	Area (ha)	Remark
out of the park	construction area out of the park	owner's management camp		950	5	
		contractor's camp		950	11	
		metal structure & electromechanical equipment assembly yard		950	6	
		construction distribution substation no.1		950	0.1	
		oil depot		950	0.5	
		comprehensive warehouse		950	3	
		comprehensive processing plant		950	3	
		total			28.6	

2.19 Cut and Fill, Slag Yard and Waste Management

The total flling and construction materials of about 703,000 m^3 are required in the Project, including gravel materials of 620,000 m^3 and aggregated rocks of 83,000 m^3. The total flling and construction materials of 703,000 m^3 (the solid yardage converted into the natural yardage of 757,400 m^3) are required in the Project, including gravel materials of 620,000 m^3 (the solid yardage converted into the natural yardage of 704,500 m^3) and aggregated rocks of 83,000 m^3 (the solid yardage converted into the natural yardage of 52,900 m^3). The total excavation and dismantling volume of 7,267,600 m^3 (the natural yardage) is required in the Project, including 648,900 m^3 which will be directly used, 1,444,500 m^3 which will be used after being transferred, and the waste slag volume of 5,181,000 m3. The Project requires the concrete aggregates of about 1,370,000 m^3, which will be supplied by the useful materials from the excavated materials in the Project after being processed.

The total volume of waste slags of Ayago Hydropower Station is 5,181,000 m^3 (natural yardage). In the planning there will be three such areas, which will be all located at the left bank, with the volume of the slag yards of 7,073,000 m^3. As for the List of the Slag Yards, see Table 15. Actual locations of Muck disposal areas shall be identified in consultation with UWA and separate EIAs done.

Table 14: List of the Slag Yard of the Ayago Hydropower Station

Name Of The Slag	Location	Elevation Of The Top Surface (M)	Area Occupied(10,000m^2)	Volume Of The Slag Yard(10,000m^3)	Planned Slag Volume (Natural Yardage-M^3)	Remarks
1# Waste disposal area on the upstream	Inside the gully about 180m on the downstream of the dam abutment on the left bank	875	4.2	33.7	18.44	In the late stage it will be used as the parking area for mechanical equipment
2# Waste disposal area on the upstream	Inside the gully about 340m on the upstream of the access tunnel to the left bank	880	16.6	87.9	55.96	
Waste disposal area on the downstream	Outlet of the construction adit of the tailrace water tunnel	840	56.9	585.7	443.71	
TOTAL			**77.7**	**707.3**	**518.11**	

2.20 Evacuation of Power from Ayago Hydropower Plant

Ayago power will be wheeled to the national grid through a 400KV interconnection transmission line (underground cable) from the Ayago plant and terminating in Karuma – Olwiyo 400KV transmission line. A separate feasibility study for the interconnection line has been conducted. Impacts related to the transmission line will be assessed in a separate ESIA. Figure 11 below shows the Uganda National Grid Transmissions showing the Ayago Interconnection (12.57Km).

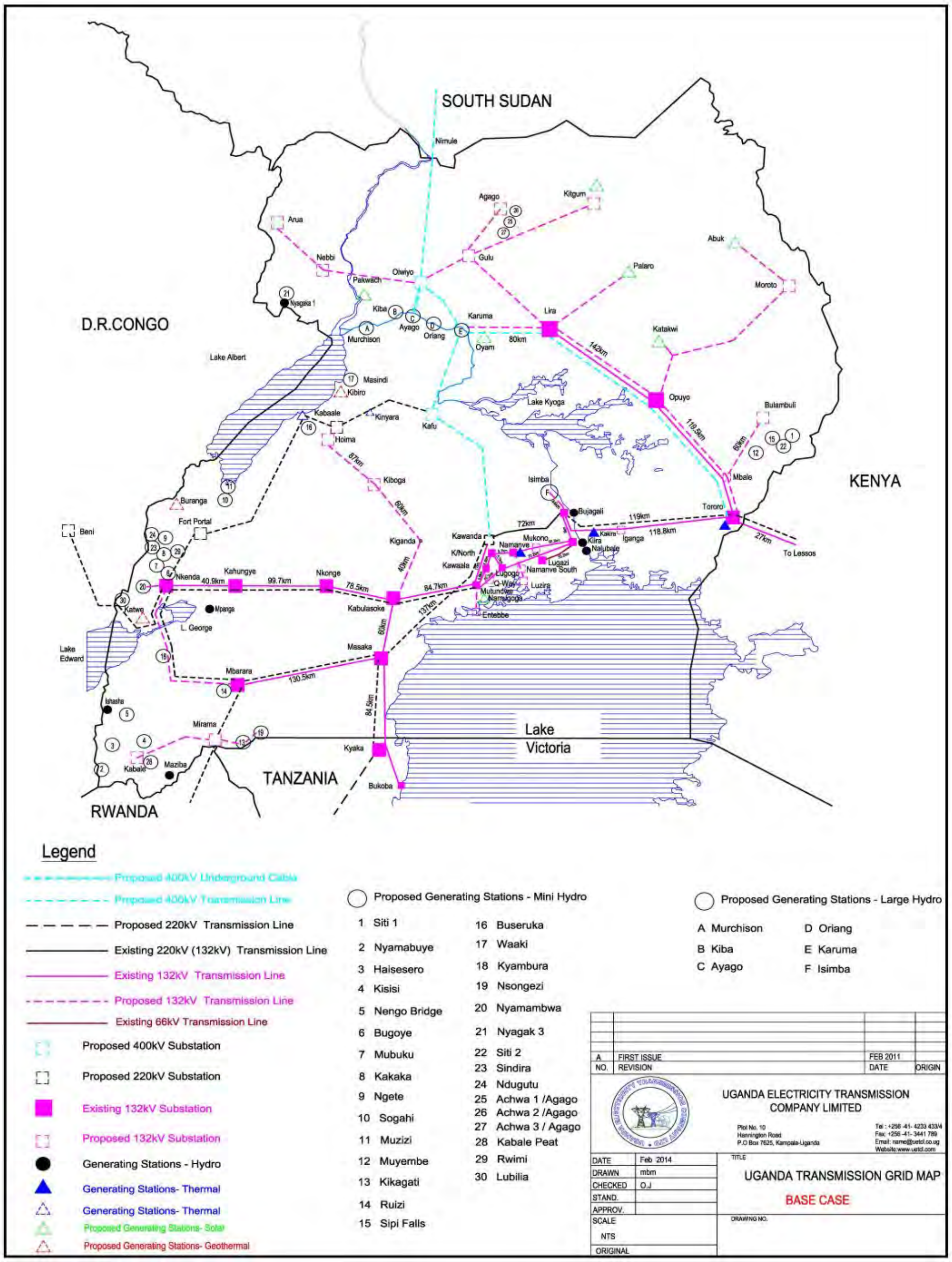


Figure 11: Uganda National Grid Transmissions showing the Ayago Interconnection

2.21 Ecological Flow

The selection of ecological flow is based on Tenant (1976) methodology,which means: minimum environmental flow for general rivers should be no less than 10% of average annual flow, but for rivers with larger flow (average annual flow more than $80m^3/s$), it can be adapted and redefined without exceeding 5% of average annual flow.The average annual runoff of Nile is 994m3/s at dam site, much more than $80m^3/s$, based on which, ecological flow is calculated as $100m^3/s$. Therefore, $50m^3/s$ is taken as the minimum ecological flow of dam site downstream riverway for the Project.

Table 15: Ecological Flow of the Ayago Hydropower Station

Health of the Habitat	Recommended minimum flow as a percentage of the mean annual flow in cumecs			
	% of Discharge	Maximum	Average	Minimum
Optimum	60 to 100	1034-1724	596.5-994.2	268-448
Outstanding	40	689.6	398	179.2
Excellent	30	517.2	298	134.4
Good	20	345	199	89.6
Fair	10	172.4	99	44.8
Poor or degrading*	10	172.4	99	44.8
Severe	0% to 10%	0 to 172.4	0-99	0 to 44.8

Note: The annual discharge data from 1940-2000 has been used to calculate the Maximum, Average and Minimum flow at Ayago.

*Depending on other considerations such as the sensitivity of the ecosytem, at 10% of the discharge, the river could already be severely impacted.

Basing on the average flows at Ayago, an ecological flow equivalent to 10% of the discharge i.e 99.4 (aprox. 100) cumecs is recommended. This according to the Tenant Health of habitat classification, keeps a fairly health river habitat. With the proposed civil modifications downstream of the weir, this should be sufficient. The proposed modofications include creation of weirs and pools to allow the trapping of enough water to sustain the hippos and crocodiles in the stretch between the dam and the tail race outfall. This modification will form more or less a reservoir, but with the continuous flow resulting from the 100cumecs release.

To avoid impacting on the ecology and to keep the system in a health state, it is recommended that instead of EFR of 10%, a fixed discharge of 100cumecs bemaintained all the time.

2.22 Decommissioning of the Scheme

Decommissioning and site reclamation phase will include facility removal; breaking up of concrete pads, foundations, intake, cofferdams and tailrace structures and dams; Plugging of some shafts and Adits, removal of access roads that are not maintained for other uses; recontouring the land surface; and revegetation . These activities would present similar impacts to those during construction, but of less magnitude. There would be temporary increases in noise, dust, fumes and other emissions, and visual disturbance associated with the removal of the project facilities and site reclamation. Negligible to no reduction in wildlife habitat would be expected, and injury and mortality rates of vegetation and wildlife would be much lower than they would be during construction. Large quantities of water would be required for fugitive dust control and consumptive use by the crew.

Removal of the project components would eliminate impacts associated with wildlife interactions with facility structures and from habitat fragmentation. Following site reclamation, the ecological resources at the project site could eventually return to pre-project conditions, depending on the end use selected for the project area. Grasses and forbs may initially be more plentiful during early years of reclamation than existed prior to project development. This could increase forage for some wildlife species. Reclamation of forest or sagebrush habitats could take decades or longer. However, despite the physical removal of the development, the impact of a scarred landscape on an area would likely remain.

3. METHODOLOGY FOR UNDERTAKING THE ESIA

3.1 Introduction

This chapter describes the broad principles of methodology and scope of the EIA indicating the approach that was used to identify, evaluate and recommend mitigation measures for environmental health and social impacts. The consulting team executed the following tasks in pursuit of the ESIA Study:

- Literature review and reference to the already existing published information including laws, regulations and policies to verify how the proposed development would conform to them; the process also encompasses the review of literature from similar projects, on the lessons learned and way forward;
- Field surveys of the proposed project site, including baseline information of the environmental conditions and resources in the project area;
- An indepth stakeholder consultation, including members of the local community and lead agencies with regard to the proposed project; and
- Professional judgment for all the issues related to the nature of the proposed development project.

Field surveys were conducted for the baseline with due consideration to seasonality aspects and these surveys included collection of information for the physical, biological and social environment within the periods starting from 2012 to 2014 using methods discussed in this section.

3.2 Basis of the Assessment

The environmental and social impacts of the project were predicted in relation to environmental and social receptors or people and natural resources. This was accomplished by comparing baseline conditions (i.e. the situation without the project) with situations that would ensue when the project is implemented.

3.3 Physical Environment

3.3.1 Air Quality Assessment

Baseline air quality was measured using a pair of digital MX6 iBrid™ portable gas meters (Industrial Scientific-Oldham) and a Microdust 880 nm digital aerosol monitor (Casella®). Measurement points or locations were selected based on the presence of expected receptors. The pre-calibrated equipment was mounted on a tripod with 1.2 m height, and switched on and wait until the readings stabilized. The measurements were taken for 15 minutes, and the average readings were recorded.

3.3.2 Noise and Vibration Assessment

Measurement of ambient noise levels was carried out using a precision integrating sound level meter, with an active range of 0-140 decibels (dB) and complying with IEC 651 and ANSI S4 standards. Baseline noise measurements were undertaken at locations within the proposed Project's detailed surveys area with potential receptors (animals). A Casella CEL-621C digital noise logger was set to record for a sample period of ten minutes at each of these locations. For each location, measurements recorded include LA_{MAX}[1], LA_{eq}[2], LA_{90}[3] and LA_{50}[4] decibel levels. Sampling locations were recorded and the noise sources and ambient environment at each location noted.

3.3.2 Water Quality Assessment

Water samples were taken from different locations on both the southern and northern banks of Victoria Nile section that flows through the detailed survey areas. A water sample location near Paraa Lodge was also established. Two sets of samples were taken, one for bacteriological quality and the second one for physico-chemical analysis. Microbiology samples were collected in sterilized bottles obtained from National Water & Sewerage Corporation (NWSC). All samples were transported in a cool box to the laboratory on the same day of sampling and kept at 4^{0}C before analysis on the following day. During sample collection, on-site measurements were carried out, and these included pH, temperature, dissolved oxygen (DO) (mg/L), DO Saturation (%), conductivity (mS/cm or microS/cm), total dissolved solids (TDS) (mg/L), oxidative reduction potential (ORP) (mV), resistivity (ohm.com or Mohm.cm or Kohm.com), salinity (PSU), and atmospheric pressure (mmHg). For each site, the elevation above sea level (easl) and locations were recorded. Onsite measurements were carried out using HANNA HI 9828 multi-parameter water quality meter.

3.3.3 Soil Surveys

The specific sites for soil sampling were earmarked in both the southern and northern banks of Victoria Nile which runs through the project area. For correct classification and understanding of the soils of the project area, a soil profile description method was employed for the soil properties at lower horizons. This method involved exposing a profile by digging a 1.5m^2 area test pit with a depth of up to the parent material (Plate 1). The test pits were strategically sited to represent the areas within the water sheds that immediately contribute runoff to the Project area. For each of the horizons in the profile, soil properties were described including depth of the horizon, boundary regularity and sharpness, moisture status, colour, texture, structure, consistence, porosity, compactness, presence of soil fauna, drainage, root distribution and size with their attributes such as shape, nature, health, and age. In addition, details of the vegetation, slope gradient, and susceptibility to erosion around the sample area were recorded.

Plate 1: Soil Characterization Test Pits

The following are the descriptions of the soil characterization scales used:

i. **Depth** – measured from the top of the mineral soil (A1 layer), just under any leaf litter or biomass lying on the top of the soil.
ii. **Boundary sharpness** – If boundary zone is ≤ 5cm wide the sharpness is classed as "***clear***", if zone is 5-10cm wide, the sharpness is "***Gradual***", if the zone is 10cm and above wide, sharpness is "***Diffuse***". Boundary of a horizon always refers to the lower limit of the soil horizon in question.
iii. **Boundary regularity** – This is classified as ***Smooth***, ***Wavy***, ***Irregular***, ***Lobate*** or ***Tongued*** based on the shape.
iv. **Moisture status;**
   - ***Dry*** –Following Munsell notation, soil darkens or assumes a lower colour value when the soil is moistened (Kuehni, 2002; Landa and Fairchild, 2005). In the dry state, the soil will not bind and when broken, dust may be produced amongst other fragments.
   - ***Slightly moist*** – Soil darkens slightly when wetted. When broken the soil falls into fragments with little or no dust produced. The fragments cannot be moulded.
   - ***Moist or damp*** – Soil does not change colour on moistening. The soil does not moisten the fingers immediately but by prolonged working will do so. All except sandy soils can be moulded fairly easily.
   - ***Very moist*** – Soil just below field capacity. On working the soil the fingers are quickly moistened and the soil will stick on to the fingers when moulded and show a slight cohesion.
   - ***Wet (4)*** – Soil immediately wets or sticks to the fingers but water does not readily drip out.
   - ***Water logged*** – All fissures and soil pores completely filled with water. Water drips away and sandy soils especially tend to flow on handling.
v. **Colour –** The most important record of colour is the colour number from the Munsell Soil Colour Charts, given for the soil as recorded in the field.
vi. **Texture –** This term describes the proportions of different sized particles in the soil**;**
   - ***Sandy texture*** – Soil will not roll out into an unbroken thread.
   - ***Loam –*** Soil forms an unbroken thread but usually breaks when held by an end or bent into a half circle.
   - ***Clay loam*** – Soil forms a thread which can be held by one end, can usually be bend into a half circle but not a full circle.
   - ***Clay*** – Soil forms a thread which can be bent into a full circle without breaking**.**
   - **Structure –** This refers to the size and shape of the natural soil aggregates or "peds". Two aspects of structure should be recorded, namely;

   a. ***Its strength or distinctness*** or ***degree of structural development.***
      i. ***Structureless –*** No observable aggregation or no definite orderly arrangement of natural lines of weakness. Common for soil without clay or beyond the weathering zone is usually structureless.
      ii. ***Weakly Developed –*** Poorly formed indistinct peds that are barely observable in place. When disturbed, the soil breaks into a mixture of few entire peds, some broken peds, and little un-aggregated material. If necessary for comparison, this grade may be sub-divided into very weak and moderately weak.
      iii. ***Weak–*** Barely observable in the pit face and the soil breaks into a mixture of broken "peds" and un-aggregated soil.
      iv. ***Strong–*** Distinct in the pit face and the soil separates mainly into whole peds.

   b. ***Its shape***: This involves observations and descriptions in terms of the shapes for the peds when soils from the horizons are crushed between the palm. They can be ***"Platy" "Columnar" "Blocky", "Granular", "Crumb", "Single grain", "Massive".***

vii. **Consistence –** This is the ability of the soil aggregates to resist deformation. It is tested by attempting to break or crush the soil in your hand, and different adjectives are used depending on whether the soil is air-dry or moist, or wet. Since most of the soil pits were moist that is when moisture content is about half-way between Field Capacity and air dry, the following adjectives were used: Loose, Friable, Firm, Very firm and extremely firm.

viii. **Porosity –** is described based on the sizes of the spaces within the soil aggregates as:

Table 16: Description of Porosity

Porosity	Diameter (mm)
Fine porous;	<1
Porous;	1-3
Spongy;	3-5
Cavernous;	5-10

ix. **Compactness –** describes the resistance of the fabric to penetration or disintegration;

Table 17: Description of Compactness

Description	Spade/hoe/shovel
Very compact	Will not enter; pick-axe or bar needed
Compact	Enters with difficulty much fragmentation
Loose	Enters easily and spit falls readily into pieces
Friable	Digs well with fine fragmentation
Indurated	pick axe needed to break, then digs easily
Tenacious	Clogs and tears away from uncut faces

x. **Drainage –** the ability of the soil to let water pass through it naturally. The quality of drainage was described in four drainage classes:

- **Excessive drainage** – water moves rapidly through the soil mass and insufficient is retained for normal plant growth.
- **Perfect drainage (free – drainage)** – water moves easily through the soil to give ideal aeration while at the same time the pores retain sufficient water for normal plant growth.
- **Imperfect or poor drainage** – there is some fluctuations between aerobic and anaerobic conditions usually brought about by the compaction of the soil.
- **Impeded Drainage** – there is definite obstacle to downward percolation of water and is frequently associated with pans, rock pavements, perched water tables or a permanently high zone of saturation.

xi. **Roots –** may be classified under seven headings:

Table 18: Description of Roots

Roots	Quantities
Abundant	more than 100 per ft^2 of profile face
Frequent	100 – 20 per ft^2 profile face
Few	20 – 4 per ft^2 of profile face
Rare	3 – 1 per ft^2

Size	Diameter
Large	½ inch
Medium	½ –1/3 inch
Small	1/8 – 1/32 inch

For the size, the descriptive adhectives long, medium and short were at times used

- ***Shape*** – Free-growing or distorted
- ***Nature –*** Woody, fleshy, fibrous, or rhizomatous
- ***Health –*** Dead, alive, strong or weak
- ***Age –*** *Old*, young, that is for previous or present vegetation cover respectively,

xii. **Fauna –** Any observed soil fauna was described and noted including ants, centipedes, earthworms, termites, millipedes or any evidence of cast, burrows, and droppings.

xiii. **Special features observed –** for example any mineralization, parent material, water table were recorded.

<u>*Triangulation*</u>

Additionally, soils were sampled within the horizons and were analysed for different chemical and physical properties to triangulate between the field diagnosis and laboratory analysis. The mehlich-3 extractable method was used to analyze for the soil minerals. Soil water extract was used to provide the pH and electrical conductivity with respective probes. Nitrogen was determined using the Kjeldah method. The organic matter on the collected samples was determined following the Walkley-Black method. Soil texture was determined by the Bouycous hydrometer method while the textural triangle was used to identify the textural classes. The following soil properties were analyzed pH, total Nitrogen, Organic matter, organic carbon, available phosphorus, exchangeable bases (Sodium, potassium, calcium and magnesium), texture determination (percentages of sand, silt and clay), particle size distribution, trace elements (zinc, copper, iron and manganese), salinity and plasticity. Also cores were used to take samples from the respective horizons for bulky density determination. For some of the parameters, laboratory analyses provided a check for the conclusions drawn during in-situ investigations.

3.3.4 Transportation

The purpose of the traffic surveys is to ascertain the existing traffic and assess/predict future traffic demands during the construction and operation of the Project. The aim is meeting the prevailing traffic flow, future traffic growth, and loading without considerable deterioration in the quality of service. More specifically the purpose of the traffic surveys was to determine:

1. Volume of traffic along the main routes around the MFNP (northern and southern bank) that will be affected by the Project,
2. Type or classification of traffic along the main routes around the MFNP (northern and southern bank), and
3. Volume and classification of traffic from and into the MFNP.

This would assist in quantifying the existing traffic impact on the MFNP and assess future impact during construction and operation of the Project. Two manual methods of data collection were used:

1. Manual Classified Count (MCC) – Observers count the number of vehicles passing a given point on a road and classify them according to vehicle type (e.g. Heavy Goods vehicles, cars, motorbikes etc.).
2. Manual Classified Turning Count (MCTC) – Observers count the number of vehicles passing through a junction according to the manoeuvre they make at the junction, and classify the vehicles according to type (e.g. cars, motorbikes).

The manual traffic counts were divided into three intervals of four hours over the twelve hours in a day. Experience shows that although traffic volumes may grow over time, the relative variations of traffic at the various hours of the day of a month are often quite consistent year after year. The manual traffic counts were conducted for twelve hours each day from 7am to 7pm.
These methods of data collection can be expensive in terms of manpower, but it is nonetheless necessary in most cases where vehicles are to be classified with a number of movements recorded separately, such as at intersections.

3.4 Biological Environment

3.4.1 Vegetation and Flora

Literature Review
The desk-based study of the area was undertaken in July 2012. Existing sources of data were used to gather a range of information to identify potential biological information, and also to define the most appropriate scope of work for the field surveys. The available literature about the vegetation, flora, and their conservation status was reviewed. Previous vegetation classifications were reviewed to provide an overview of the likely vegetation and habitats present within the study area. This was intended to identify beforehand, the unique, threatened, rare and other cases of conservation concern species and habitats known to occur in the area of the proposed seismic activities. The data sources used included Langdale-Brown et al. (1964), Osmaston (1971), Oneka (1996), Kalema (2003), Kalema (2005), Plumptre et al. (2007), IUCN (2011). Oneka (1996) published a vegetation map of the Murchison Falls area using vegetation types adapted from work originally published by Langdale-Brown et al. (1964). The Oneka (1996) classification provided a more detailed classification and this was used as the basis for the initial vegetation classification and identifying survey locations for the field survey.

Scoping Visit
A scoping visit was organized in August 2012. This included the senior botanist on the team. During the scoping studies, purposeful visits were made to selected sites. The main vegetation types were identified, basing on the direct observation of the areas visited, the previous vegetation classifications, and satellite images available. These formed a basis for identification of the survey sites to represent the whole range of habitats in the project Area.

Field Surveys
The main field surveys were conducted in two separate seasons of the year; first in the wetter part of the year in October 2012, and later in the drier part of the year in January 2013. The survey localities are indicated along transects discussed in section 5.7.1. In each season, transects were established and surveyed in both

the areas to the north and south of the River Nile. Transects varying in length from 1.5 to 3 km to reflect the relative coverage of the different vegetation types were established. A total of 28 transects were completed during both the first and second phases of the survey. These were used to survey the vegetation and flora. Along each transect, rectangular plots measuring 30 x 30 m were used for description of the vegetation community and survey of woody plants. A small quadrat measuring 5 x 5 m was nested in the 30 x 30 m quadrat for survey of non-woody plants. Sampling points were established at intervals of an average of 100 m. However, records of any species of plant or communities that were of particular interest were made when encountered in between sampling points. Azonal habitats believed to be unique within a given area were sampled for this purpose. These included such areas as water wallows, old termite mounds, patches with some bare ground and drainage channels.

At each sampling point, the vegetation type was described. This characterization was based on the floristic and landscape features observed in the habitat types, the variation in habitat structure and species composition. Dominant species of plants in the woody and herbaceous layers were identified and used for the purpose. The general terrain and proximity to important features such as river and streams were noted. All species of plant encountered were identified and recorded. The taxonomy of each plant was done at family, genus and species (and in a few instances sub species or variety) levels as appropriate. The life form of each plant was recorded as Tree, Shrub, Woody Climber, Herbaceous Climber, Grass or Herb. This included both woody and non-woody plants in a given quadrat. The relative abundance of each species was estimated visually by scoring on a DAFOR scale, where D=Dominant; A=Abundant; F=Frequent; O=Occasional; R=Rare. This is a quick though subjective method of assessing relative abundance (Kent & Coker 1992).

The available literature about the vegetation, flora, and their conservation status had earlier been reviewed with a view of identifying the unique, threatened, rare and other cases of conservation concern species and habitats known to occur in the areas of the proposed dam construction. Species of plants of conservation concern, e.g. those on IUCN red data lists and endemic taxa were looked out for. Photographs and notes were made at each waypoint taken to record the habitat, some species and landscape. These field notes and photographs were used to describe each survey location.

Plant voucher specimens were collected of any species that could not immediately be determined in the field for subsequent identification at the Makerere University Herbarium, where they were also deposited. These were preserved by drying in plant presses. Observations made between survey transects was used to further characterize the vegetation at various points in different habitat types. The geographic coordinates of all the areas of survey, both along transects and at quick inventory points were recorded using a GARMIN Global Positioning System (GPS) for easy location in the future, should this be necessary.

Analysis of Findings

The relative abundance of the species at each survey site was estimated using the DAFOR scale (Kent & Coker 1992). In order to estimate the relative abundance of a species over the total area surveyed, a species was assigned a score of 5 for D, 4 for A, 3 for F, 2 for O and 1 for R in each of the surveyed sites where it occurred.

Limitations

In some instances, access limited the areas that could be sampled. The road/track network was particularly limited in the project area south of the Nile.

3.4.2 Invasive Plant Species

Survey Period
The main invasive and alien survey was carried out during the period of December 2012. Secondary surveys were made alongside the main survey of the vegetation and flora during the months of October 2012 and January 2013.

Data Collection
Two approaches for data collection following tracks traversing the area from Karuma Wildlife Reserve into the Murchison Falls National were employed:

i. Following the access roads and tracks within the project area: all the motorable roads and tracks within the project area were used as baselines for sampling;
ii. Extracting additional data from the general vegetation and flora surveys conducted along transects on the same project.

The existing roads and tracks were used for access. Sampling points were established at 2 km intervals by driving slowly along each road or track. However, if an invasive or alien species was encountered in between successive sampling points, the point was surveyed. At each sampling point, a distance of 50 m from the track was covered carefully looking for the invasive or alien plant species. Where such species were found, this distance was extended to span the entire width of the species' coverage. The invader was identified, the area of its coverage estimated by taking the distance from the edge of the road to the interior of its coverage and measuring the length of its coverage along the road. The vegetation within which it was growing was described, and the dominant species of plants noted. The percentage cover of the invasive or exotic species was estimated visually in the context of the general flora of the vegetation in which it was growing.

3.4.3 Fire and Vegetation Trends

Survey Area
A survey was carried out in and around the proposed Ayago HPP area for locations that had signs of burning.

Survey Period
The main survey for fire was 22nd – 28th Feb 2013. However, during the general vegetation and flora survey periods of Oct 2012 and January 2013, any areas with signs of burning were recorded.

Data Collection
A review of accessible literature about burning in the MFCA was made. This was coupled with consultations of staff and records from UWA. Aerial photos at different points in time were also examined to analyze the influence of the fire on plant succession and trend in vegetation change to-date. Identification of areas that have been subject to burning in the past was done by driving along the available access roads and tracks in the project area. The area was surveyed checking for evidence of burning. The recently burnt areas with ash evident, charred bark of trees and others were recorded. Geographical coordinates of areas with such evidence were recorded. The extent of burn was estimated as far as was possible. More information about burning was gathered from past studies including Buechner & Dawkins (1961) and later Spence & Angus (1971). Consultations with UWA staff and records also yielded information about areas that are burnt.

3.4.4 Large Mammals

The surveys for mammals in the project area were conducted using different approaches to record small mammal and large mammal presence. The primary method that was employed for surveying the large mammals was relied on game cameras that were deployed in a 12 x 12 km grid in the core project area. Game cameras were mounted at a spacing of 1.5 km along nine transects (See Section 5.9). Each of these east–west oriented transects were designed to have nine game camera points. Additional game cameras were placed opportunistically in locations that were identified as very good although not at the predefined grid locations. Game cameras were also set following areas traversed by available access routes (the Nanda road and the road from Project area to Wangkwar gate) as well as the three proposed power evacuation routes. The transect walks to check Game cameras, also provided opportunity to observe and acquire record for:

i. Species occurrence in areas away from game camera locations,
ii. Habitat features of importance to mammals (such as watering points, salt licks and burrows),
iii. Evidence of poaching.

Game cameras were maintained from June 2012 to August 2013 and were checked in July, October, and December 2012 as well as January, March, May and August 2013 to recover any data captured. The August check was the last before camera removal. During the game camera checking visits, exhausted batteries were replaced, game camera positions for those not performing to expectations were changed and overgrown vegetation in front of game cameras was cleared. To survey the small mammal community a trapping regime (using Sherman live traps, pitfall traps), museum special and Victor rat traps) was conducted in the areas inland near and around location (380559.24 258601.24) to record small rodents and insectivores in the area. Mist netting and the use of an Anabat Bat detector were also used to survey the bat species diversity in the area.
Trapping was mostly conducted in December 2012 and January 2013, and traps were left in place for as long as they were still productive. Surveys for microbats activity using the Anabat Bat detector was conducted in December 2012 and January 2013.

3.4.5 Hippopotamus

The survey was undertaken between 2nd and 11th November 2012. The survey counts were conducted on foot on the north and south sides of Victoria Nile along a section between coordinates (370759, 261534) and (387754, 256219). The river section through the Project area was divided into 1 km grids in which the surveys, mapping and counts of the Hippopotamus were conducted. On each census day the surveys were done by two groups, each walking from and to agreed locations along the river. Each census group carried maps of the different 1 km square grids that were to be traversed on the particular day. Whenever Hippopotamus were encountered a GPS coordinate was taken (marked with a GPS and also recorded on the recording sheet) for the location at which the count was conducted while the estimated location of the Hippopotamus in the water was marked on the printed maps. The numbers of Hippopotamus seen and their relative sizes (Large-L, Medium-M, and Small-S) would then be recorded in the data recording sheet. The river section between eastings 378000 to 384000 (longitudes 31.90279 to 31.95672) on the south side of Victoria Nile was surveyed again the following day to cross check the results of the first count. This helped to check the accuracy with which individuals were seen and counted. Other evidence of different animals (Crocodiles, Black and White Colobus) as well as poachers' evidences was also recorded and a GPS coordinate recorded whenever these were encountered.

3.4.6 Small Mammals

Several trapping methods were employed including pitfalls for shrews and the smallest rodents (*Mus* sp.), mist nets for bats, and the standard small mammal trap lines for rodents.

Pitfall Traps with a Drift

This method was used to sample the smallest ground dwelling small mammals, particularly shrews and members of the rodent genus *Mus*. The basic principle behind this trapping method is that ground dwelling animals encounter a barrier termed a 'drift fence' which causes them to be directed laterally into bucket traps (Bennun *et al* 2004). Two pitfall lines of 25 m each were set up. Five buckets were placed five meters apart. Additionally, two pitfall lines set up by the herpetologist Dr. M. Benhanga were reused. One was adjacent to the field camp and was comprised of six (20 ltr) buckets without drift fence and with vegetation cut one meter on each side. The other was some 2 km distant and was comprised of six (20 ltr) buckets.

Mist nets

Mist nets were used to collect bats in the study area. Three twelve meter nets were set at particular points in the grassland near and within field camp. One six meter mist net was placed in the camp in order to take advantage of the insects attracted by our generator-fed lights. The 6 m net across a seasonal stream was placed next to a fruiting fig tree in the middle of Trap line 2. Nets were opened in the evening at 1830 and monitored up to 2200 for any bats. Scarab beetles were particularly problematic. Nets were left open throughout the night and checked in the morning for bats. The two nets in the grass land (MN 1 and MN 2) stayed up for four nights; the net at the camp site was put up for two nights, and the net along the stream stayed up for two nights.

Snap Traps and Sherman Live Trapping

To enhance trapping success, traps were placed along the edge of boulders and logs, along paths across leaf litter, moss or soil, near apparently active burrows and holes (Yves Tuyishime 2011), and up to 2 m high in trees. Trap lines determined the presence of rodents of the various species present in the study area. Grid locations were chosen to maximize the variety of habitats across the total study area. Four different types of traps were used for this method.

- Museum special snap trap (MS)
- Victor break back snap trap (V)
- Sherman live traps in two sizes: 8" and 6"
- Tomahawk live traps

Three trap lines where established which are: gallery forest adjacent to the Victoria Nile (TL 1), along a seasonal stream feeding into Victoria Nile (TL 2), and in the wooded tall grassland (TL 3). All trap lines included stations of two traps each, set at 10 m intervals. In the Gallery forest (TL 1), 50 traps where set along a 250 m transect. It was comprised of 25 stations with two traps per station. A Sherman trap was placed at each station (n=25) in association with either a Museum Special (n=15) or a Victor (n=10). All traps were baited with a mixture of peanut butter, maize flour, and sweet bananas. The trap line stayed out for five nights (3^{rd} December 2012 to 7^{th} December 2012).

For the trap line along a seasonal stream (TL 2), all traps were placed touching the remaining pockets and pools of water and were baited with rehydrated dry fish and a mixture of peanut butter, maize flour, and sweet bananas. This trap line consisted of 20 Museum Special traps, 20 Shermans, and 10 Victors. At each station, one trap was baited with fish. The trap line stayed out for five nights (3^{rd} December 2012 to 7^{th} December

2012). In the wooded tall grassland (TL 3), 12 stations were set up with 24 traps: 4 tomahawks, 10 Museum special and 10 Sherman. The trap line stayed out for two nights (6th December 2012 to 7th December 2012). Most traps used were live Sherman traps. After identification, the mammals were released back to their habitats. A few were retained for verification of identity. Likewise, the birds trapped in mist nets were also released back to their habitats after identification.

3.4.7 Birds

Field work was undertaken in October and December 2012, and January 2013. October coincided with the end of the main wetter season in northern Uganda, through to a relatively dry period (although in fact rain in January and February 2013 was above average, and the expected extensive burning was delayed until late February; nevertheless, we did find some burnt areas in early January). From an ornithological standpoint, our visits covered a period of southward passage (mainly September to November, so that October captured the southwards peak), as well as for winter visitors (mainly October to March, so in December and January they were well-established). The return northwards passage would have had fewer birds than in October, since some will have died in the meantime. (This assumption can be supported by data from other sites in the MFCA: DP, unpubl). It was not possible to fully cover the seasons for Afrotropical migrants, since for every month there are some of these species present, which only further visits would fully cover. However, those missed are considered a minor part of the avifauna as a whole.

<u>Landbird transects</u>
The principal method for this study was line transects (Bibby *et al* 2000, Voříšek*et al*, 2008), each approximately 2 km long, in accordance with the procedure accepted for Bird Population Monitoring by NatureUganda, which co-ordinates twice-yearly counts along some 70 transects throughout Uganda. The same method is used in several other countries in eastern Africa. We used two of the existing long-term transect routes of NatureUganda, both near Chobe, and set up 12 new ones. Five were roughly circular, ending some 200 m from the starting point, whilst the others were along park tracks, roughly straight lines. The latter were preferred in areas of dense undergrowth – mainly grass, especially *Hyparrhenia* and *Loudetia* species. In such areas, the noise made by observers struggling through the vegetation will have scared some birds away, as well as the sounds drowning out more distant bird calls, which were thus missed. Further, the need to look for a way through the vegetation distracts one from looking for birds. With the exception of the Chobe *Terminalia* site, very few vehicles came to disturb us; and even the Chobe road had only 1-3 per hour. Counts were made by George Kaphu, Taban Bruhan, Lilian Twanza and Derek Pomeroy, the last two being the main recorders. Data quality was assured by discussion, on the spot, of any doubtful observations, and supported by reference to the standard field guide (Stevenson & Fanshawe 2002). Where identification was deemed highly likely, but not certain, the number of individuals was preceded in the record by a 'p' for probable, e.g, p1, p4. Opportunistic records of birds at or near a transect route, but outside the transect time, were recorded as P (= present). A small number of observations from August 2012 are also included in the 'P' category.

Transect sites were chosen to represent all the main vegetation types in the project area; they were selected during the scoping visit in August 2012. The principle habitat characteristics were amounts of woody vegetation, and grass height, rather than plant species, since birds seem more affected by vegetation structure than species composition.

Transects were walked slowly, each taking from 70 to 110 minutes, and all identified individuals were registered; and for one count at each site, a note was also made as to whether detection was by site or sound (and a note was also made of the numbers of unidentified birds – typically those flying into a distant tree with dense foliage). Birds were recorded at any distance so long as they were in or above the habitat being sampled. Counts were made at various times of day, and whenever possible counts at any one site were made at different times, to span activity patterns; for example, many birds are most active early in the morning, but large raptors and some aerial species are not on the wing until the air is warmer. In accordance with regional practice, each transect was divided into ten sections, each of 200m, and each recorded separately. This gives the potential, at some future date, of making detailed comparisons of birds and vegetation.

Other Birds

The banks of the Nile, and to a lesser extent its tributaries, are flanked in many places by riverine forest, which extends up to about 100m away from the water in most places visited, grading then into moist woodland. As some forest species are difficult to observe, and generally silent, mist nets were set up in forested areas on north and south banks, near the Ayago-Nile confluence and weir site, respectively. Birds seen or heard were also noted from both sites.

3.4.8 Herpetofauna

The main methods of the study were Visual Encounter Surveys, Transect Surveys, and Opportunistic studies. Pitfall trap line and soil pitfalls were also used during the surveys. A total of 27 transects were sampled for amphibian and reptilian fauna.

3.4.9 Invertebrates

Two methods were used to sample the butterfly taxa;

- Transect sweep netting
- Baited traps

Transect Sweep Netting

The butterfly fauna in the proposed Project site were sampled through the systematic use of sweep net for a total of 9 man-days. A total of 23 transects as shown in section 5 were established within different habitat categories mainly (woodland, open grassland, wooded grassland, and riverine forest). A minimum of 2 km was sampled per transect. Specimens of unidentified species in the field were collected and taken to Makerere University Zoology museum.

Table 19: Transect sections in the project area

Transect	Name	Description
Transect 1	Chobe Terminalia woodland	Terminalia woodland
Transect 2	Chobe Acacia woodland	Acacia woodland
Transect 3	Nanda far West	Woodland
Transect 4	Nanda East	Nanda woodland
Transect 5	River Bulaya	Terminalia riverine woodland
Transect 6	Roudetia-combretum wooded grassland	
Transect 7	Acacia wooded grassland	
Transect 8	Piliostigma-Combretum woodland	
Transect 9	Ayago	Ayago woodland
Transect 10	Ayago wooded grassland	Transects 10 and 11 go through riverine

Transect	Name	Description
Transect 11	Ayago woodland6	Acacia woodland having a stream with flowing water
Transect 12	Southern end of N transmission route	
Transect 13	Camp West	
Transect 14	Open grassland	
Transect 15	Riverine woodland 2	
Transect 16	Riverine woodland	Where most trapping was done
Transect 17	Camp transect (New)	
Transect 18	Nanda West	Woodland
Transect 19	Northern end of N transmission route	Woodland
Transect 20	Kiba transect	Woodland
Transect 21	Kiba Plateau	Area from T-junction to River Kiba.
Transect 22	Camp South	Open grassland on road to camp
Transect 23	Wankwar	Area from T-junction to River Kiba.

Baited Traps
The traps were set up at uniform intervals of 20 m apart along a transect in the understory. Traps were hanged 2 m high from the ground using fermenting banana as bait.

Dragon Flies Survey Method
Dragonflies were sampled by sweep netting along transects. Systematic surveys were carried out along the River Nile and other smaller rivers and streams that feed into the Nile. Voucher specimens were prepared and preserved for further identification at Makerere University Zoology museum. Several fresh specimen photographs were taken to avoid misidentification due to the fading colors from preserved specimens.

Beetles Survey Methods
Systematic searching (Direct observation) of mammals' dung and the use of baited pitfall traps containing 10% formaldehyde were used. The traps were checked daily and samples of beetles found were photographed and beetles specimens were stored in absolute ethanol and kept for further identification at Makerere University Zoology museum. Piles of dung were directly searched for any beetles, including the immediate surrounding where the dung was found especially to look for the rollers. The combination of methods was to maximize effort since not all dung beetles are attracted to fecal materials. Opportunistic samples were taken from mammal dung spread across the Project areas, away from the transect lines. They were then identified to species and morpho types. Those specimens with difficult identification were given code names as they await taxonomic expertise.

Moths Survey
Light traps were attempted near the south camp site but very poor yields per night were observed. As such, the moths were eliminated from the survey as very limited area would be covered.

3.4.10 Fish

Experimental fishing was done using mainly four fishing gears;

i. Monofilament gill-nets, each fleet made of gill-nets of graded mesh sizes in approximately 12.5 mm increments from 1" (inch) to 6",

ii. Minnow traps, baited and used in streams,
iii. Cast-net, used mainly in open waters,
iv. Angling, using different sizes of hooks baited with worms or live fish.

The fish were sorted into various taxa, measured from the anterior extremity using a measuring board to the nearest one millimeter to determine total length (TL), standard length (SL), or forkal length (FL), and weighed to the nearest one gram. The information generated above was used to determine species composition, the fish population structure (size distribution), their length-weight relationships, and their condition factor ($100W=2L^3$).

The survey was planned to capture fish of size ranging between 1 cm and 1 m, in order to understand the habitat of youngest fish and smallest fish species. In that respect, experimental fishing was done employing seven fish catching gears including; long handle hand nets, D-shaped large hand nets, cast nets, fyke nets, gill nets, trammel nets and two types of fish traps. Fish were captured using appropriate methods for each point to maximize the species and size variation. The locations within the Ayago HPP area where fish surevys were undertaken are presented. Yellow points are First and Second fish survey and green points are exotic fish survey.

Aquatic Habitat Assessment: Three habitat types (River, Stream and Pond) were surveyed and the results were compared. For easy classification of studied water bodies, a river was defined as a permanent natural unwadeable watercourse; stream was a permanent natural wadeable water body; and pond was stationary mass of water in valley of seasonal stream or depression. At each survey site visited, assessment was made of transparency, depth, flow and morphological features (substratum/bed, pools, runs and riffles). Characteristics of the riparian zone recorded included presence of vegetation hanging on the banks, wetlands/marshes, riverine forests or grasslands. The location of each survey site was recorded using a hand-held GPS and the site photographed.

Fisheries Survey: Aquatic habitats and fisheries surveys of water bodies within the project area of the proposed Ayago HPP were undertaken. Fish sampling was done using gill-nets, trammels nets, cast-nets, hand nets, baited hooks and baited fish traps. At each river bank station investigated, two fleets of graded multifilament gillnets of mesh sizes 2.54 to 13.97 cm were used. Monofilament gill net; single netting panel with sections of different mesh sizes of 3.81 cm, 5.08 cm, 6.35 cm, 7.62 cm, and 10.16 cm, with floats and weight of the solid core lead line to keep it vertical in water. The fleets were set in series along the river banks at a depth of at least three metres. Gill nets were used on the Victoria Nile and streams (with flowing water). The nets were set along banks, fastened onto vegetation or steel piles and left overnight. While two fleets of graded trammel nets of mesh sizes 1.27 to 15.24 cm were used for the open water (offshore) stations. Trammel net has three panels of nets tied together on a common float line and common lead line made up of two outer twisted monofilament nylon panels (walls/brails) of 20.32 cm mesh size and an inner twisted monofilament nylon panel of different mesh sizes of 5.08 cm to 15.24 cm mesh, with floats on the top (float line) and weights on the bottom (lead line) to hold them vertical in the water; Trammel nets were used offshore in the Victoria Nile and across the Nile-inflow stream junction, fastened onto steel piles or exposed rocks and left overnight.

Fyke net has a series of bag-shaped 2.54-cm mesh nets, 0.5 m high, held open by hoops and equipped with wings for fastening. Fyke nets of mesh 5.08 cm were set in slow flowing streams and river meanders. Baited fish traps of 2.54 cm mesh were set in sheltered/vegetated shallow shorelines or wetlands. Cast nets were used on water bodies <1 m wide ≤1 m deep. The water bodies included isolated ponds, dotted pools in seasonal stream valleys and the Victoria Nile. The nets were thrown by hand while standing at the banks of streams and pools, and standing in water on Victoria Nile. The 2.54 and 10.16 cm cast nets of 2 and 4 metre radius respectively were randomly thrown three times each, inshore within 3 metre radius. Then the nets were retrieved by pulling the landline and fish trapped/captured were sorted.

The D-shaped hand nets were used in vegetated river bank areas by pushing it beneath the vegetation and then disturbing by kicking the plant over the net vigorously. The net is then immediately withdrawn and residue contents sorted. The long handle hand nets were used in small shallow (≥0.5 m deep) pools along the Victoria Nile and dotted within seasonal stream valleys. The net was used to scoop the pool content. The gill nets, trammel nets, fyke nets and fish traps were set in the evening and retrieved the following morning. The fish specimens from the different fishing gear were identified to species as in Greenwood (1966), sorted into various taxa, measured from the anterior extremity using a measuring board to the nearest one millimeter to determine total standard length (SL). Specimens of fishes not easily identifiable in the field were preserved for later identification. Unidentified specimens were assigned code names used therein.

3.4.11 Aquatic Ecology

"Two environment types (River and Stream) were surveyed and the results were compared. For easy classification of studied water bodies, a river was defined as a permanent natural unwadeable watercourse; stream was a permanent natural wadeable water body. At each survey site visited assessment were made of morphological features (substratum/ bed, pools, runs and riffles). Characteristics of the riparian zone recorded included presence of vegetation hanging on the banks, wetlands/ marshes, riverine forests or grasslands.

Phytoplankton samples were collected using a phytoplankton net and samples kept in capped 25 ml bottles with Lugol's solution to fix and preserve the cells. The analyses of phytoplankton communities involved quantitative determination of algal components present in each sample collected. Determination of phytoplankton taxonomy was made using an inverted binocular microscope and identified to genus level. Literature used in determining algal groups included Clesceri et al (1989) and Dillard (1999).

Zooplankton samples were collected using plankton net of 60 µm mesh size with a circular 0.25m diameter mouth opening. A three litre plastic container immersed at all investigation sites on the stream to haul draw water. The water was then filtered through the 60 µm mesh to concentrate the sample into a well labeled 25 mL universal bottle and preserved in 70 % ethanol. The samples were transferred to the laboratory for analysis. Results were computed as number of individual organisms per taxon per 1 litre volume.

A three composite sample was collected from each point using a 0.15 m^2 rectangular Dip net with 500 µm netting. The net was placed on the stream floor with the opening facing upstream and the stream floor 0.03 m upstream was disturbed by kicking for 3 minutes. The macroinvertebrates were washed through a 500 µm mesh size sieve, hand sorted and preserved in 70% alcohol in labeled vials. In the laboratory, the macroinvertebrates were identified to family level according to Miller et al. (1983) and Hawking & Smith, (1997), counted and recorded. Taxon diversity, richness, distribution, dominance and relative abundance was done to evaluate macroinvertebrate composition.

3.5 Social Survey

Archaeological Studies
Desktop study was carried out in order to identify any known or potential sites of archaeological interest within the study area and to evaluate the cultural significance of these sites once identified. The following were non-

exhaustive list of resources that were consulted as part of the research programme; the Department of Museums and Monuments office, published and unpublished papers and studies, publications on relevant historical, anthropological and other cultural studies, unpublished archival papers and records, collections and libraries of tertiary institutions, historical documents held in the Public Records office, Lands Registry, District Lands office, District office and Museums of History, cartographic and pictorial documentation, and geotechnical information.

Site Visit/Survey of the Study Area

To supplement the information gathered in the desk-based study, a site visit and survey of the study area was undertaken. It was done to assess the current status of the study area and also to make note of existing impacts.

Key Informant Interviews

Key informant interviews were also done through unstructured questions to officials from different establishments deemed resourceful to the Project during the assessment.

Focus Group Discussions (FGD)

The team met up with major stakeholders with heritage interests in the project area; these included the Uganda National Museum, Uganda Wildlife Authority officials, cultural institutions, traditional practitioners, district and local leaders.

Ethno archaeological Study

Meeting and interviews with stakeholders and the local people were another major source of information about the impact of the project on the current socio-cultural lives of the people living in and around the area.

Observation (Non Participant observations)

Observations were made to certain key points in the study area that facilitate this impact assessment. This was done with relevant value judgments and proper records.

Documentation (Photographs and inscriptions)

Record books, GPS cameras, tape measures and all other relevant archaeological equipments for proper documentation were used.

Data Analysis

The team sorted out and studied the types of diagnostic cultural materials e.g. ceramics, fossils, stone tools etc, in numbers and types in line with stratigraphic layers as well as burial sites and ancient architectural technology.

Test Pit Excavations

Test pit excavations were carried out to verify the archaeological potential within the study area. The choice of location for test pit excavations depended on various factors such as desk-based information, landforms, field scan as well as issues relating to access. Hand trowel excavations of test pits in different sites measuring 1x1x1.5m (LxWxD) was carried out in order to determine the presence/absence of archaeological deposits and their stratigraphy. Most test pits proved productive producing cultural materials of great significance.

4. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

4.1 Introduction

The legal regime in Uganda applying to the Ayago hydropower project, including the proposed transmission line, is complex. The ESIA has been carried out under the framework of local, national and international environmental regulations. The legislative framework applicable to the project is governed by the High-level regulatory context for the Project consisting of the following:

- National legislation (Constitution of the Republic of Uganda, including the trans-boundary Nile Cooperative framework agreement, the Nile Basin Sustainability Framework, Nile Basin Initiative (NBI) strategy for hydropower development, power interconnections and power trade, NBI sub-basin guidelines for environmental and social assessments, NBI guidelines for transboundary Environmental Impact Assessment (EIA);
- Selected international and regional conventions;
- Selected international standards, practice and guidance, including Japan International Cooperation Agency) policies;
- National legal and administrative framework.

Uganda has various laws, policies and institutional set up governing the management of its natural environment as discussed in the following sub-sections.

4.2 Policy Framework

4.2.1 Environmental and Social Policy, NBI June, 2013

Developed by the Nile Basin Initiative (NBI), the policy is to harness the resources of the Nile to create better conditions for the millions of people who depend on it. This includes the sound management and development of the river's resources in a manner that respects the needs of the Nile system so that it can continue to nurture generations to come. The policy intends to provide coherence for the NBI's activities by covering the environmental and social dimensions of sustainable development in line with international best practice. Its overarching goal is to ensure social and environmental sustainability of NBI program outcomes.

Relevant to this ESIA is Policy objective 2, which aims at providing guidance for the management of trans-boundary environmental and social impacts of national activities. Objective 3 aims at giving support to the Nile basin countries for the protection and conservation of critical environmental resources in the Nile basin. The Policy area 3 of this document further highlights the substantive areas facing risks and impacts in the project cycle including human health, water quality, climate change, biodiversity, involuntary resettlement wetland degradation and public consultation, disclosure and awareness.

4.2.2 The National Water Policy, 1999

The National Water Policy, 1999 promotes an integrated approach to manage the water resources in ways that are sustainable and most beneficial to the people of Uganda. The future framework for management and functioning of the water sector is based on the Water Act (1995), National Water Policy (1999), The Local Government Act (1997), and on-going water sector reforms. The Water Policy was developed under two distinct, categories, namely;

- Water Development and use
- Water Resources Management.

Water Resources Management covers objectives, principles and strategies for Monitoring, assessment, allocation and protection of the resources and management framework. The policy objective as listed in Chapter 4: water resources management is to manage and develop the water resources of Uganda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social economic needs of the present and future generations with the full participation of all stakeholders. In keeping with the policy objectives, the developer has undertaken an ESIA to assess any and all impacts likely to arise from the development and have these addressed so that there is sufficient quantity/quality left in the river for other users and uses downstream. Chapter 7, 7.4 which states that government will promote hydropower generation by supporting efforts to attain self reliance in energy production and will promote regional co-operation for optimal development of hydropower and for the benefit of the region.

4.2.3 The National Environment Management Policy, 1995

The policy calls for public and private sector development options to be environmentally sound and sustainable; any environmental consequences should be recognized early and taken into account in project design. It also goes further to state that EIAs should consider not only biophysical/environmental impact but address the impact on existing social, economic, political and cultural conditions. In recognition of the policy, the development commissioned an ESIA to be carried out, for which terms of reference were submitted and subsequently approved on the 5th of July 2012 by NEMA.

4.2.4 Uganda Wildlife Policy, 1999

The overall aim of the Uganda Wildlife Policy is to promote the long term conservation of the country's wildlife and associated biodiversity components in a cost effective manner which maximises the benefits to the people of Uganda. The Uganda Wildlife Authority was engaged as a key stakeholder throughout the ESIA to ensure that the overall objective was achieved; given a large scale development is likely to have some adverse impacts on the wildlife in the area.

4.2.5 The National Gender Policy, 2007

The Policy objectives are to reduce gender inequalities so that all women and men, girls and boys, are able to move out of poverty and to achieve improved and sustainable livelihoods; to increase knowledge and understanding of human rights among women and men so that they can identify violations, demand, access, seek redress and enjoy their rights; to strengthen women's presence and capacities in decision making for their meaningful participation in administrative and political processes; to address gender inequalities and ensure inclusion of gender analysis in macro-economic policy formulation, implementation, monitoring and evaluation. The Developer will ensure that policy objectives are adhered to by ensuring equal employment for both men and women.

4.2.6 The National Energy Policy, 2002

The policy goal is to meet energy needs of Uganda's population for social and economic development in an environmentally sustainable manner. The policy recognizes linkages between the energy sector and other sectors such as economy, environment, water resources, agriculture, forestry, industry, health, transport, education, decentralization and land use. Hence at the sectoral level, the policy strengthens provisions of the National Environment Management Policy, 1994 that emphasises need for environmental impact assessment. This policy recognises the energy sector as potentially having more significant environmental impacts than most other economic sectors. Since energy development and environmental damage are related, the policy recognises need to mitigate both physical and social environmental impacts of energy projects. The policy outlines several objectives of which key to this assessment is to manage energy related environmental impacts by:

- promoting the use of alternative sources of energy and technologies which are environmentally friendly;
- sensitizing energy suppliers and users about the environmental issues associated with energy;
- working towards the establishment and acceptance of broad targets for the reduction of energy-related emissions that are harmful to the environment and energy users;
- promoting efficient utilisation of energy resources; and
- strengthening the environment-monitoring unit in the energy sector

4.2.7 The National HIV/AIDS Policy, 1992

In Uganda current effort to combat HIV/AIDS is characterized by a policy of openness by Government and this has, to a large extent, been emulated by civil society, political and social institutions, and workplaces. HIV/AIDS is recognized by Ministry of Health as a considerable risk in construction of infrastructure projects and it (together with the ministry responsible for labour) encourages employers to develop in-house HIV/AIDS policies, provide awareness and prevention measures to workers and avoid discriminating against workers or living with or affected by HIV/AIDS. To ensure HIV/AIDS is addressed in the workplace, the policy encourages employee awareness and education on HIV/AIDS. To protect the infected and affected persons from discrimination, employers are required to keep personal medical records confidential. Employees living with, or affected by, HIV and AIDS, and those who have any related concerns, are encouraged to contact any confidant within the organization to discuss their concerns and obtain information. It is anticipated that during construction phase, there may be an influx of people into the project area possibly resulting into sexual fraternization and a risk of HIV/AIDS spread. The policy also guides about HIV/AIDS management including awareness and provision of condoms in workplaces.

The requirements of this policy are expected to be fulfilled by the Ayago HPP and associated transmission line construction contractors or their subcontractors, especially in regard to having an in-house HIV Policy, Health screening, worker sensitisation and provision of free condoms. This policy is relevant to the project if implementation of proposed Ayago HPP and associated transmission line construction leads to in-migration into the project area by people seeking construction jobs and indulging in prostitution or irresponsible sexual fraternisation associated with HIV/AIDS risk

4.2.8 The Occupational Health and Safety Policy

This policy will be especially relevant for Occupational Health and Safety (OHS) of the Project and associated transmission line construction crews and subsequently, maintenance personnel. The policy will also have relevance in mitigation measures that protect the public from health and safety impacts as a result of project construction and subsequent operation and maintenance activities.

4.2.9 The National Forestry Policy, 2001

The forestry policy puts an emphasis on ecological and socio-economic importance of protecting the country‘s forest resources. Implementation of the Policy is a responsibility of the National Forestry Authority (NFA), which also provides guidelines for management of forest reserves, community forests and private forests. The Forest Policy entails provisions for safeguard and conservation of forests so as to ensure sufficient supplies of forest products, protect water resources in watersheds, soils, fauna and flora. The policy also mandates government with responsibility to control unsustainable forest exploitation practices. This policy potentially has relevance to the Project because it provides for protection of forested areas in watersheds.

4.2.10. Uganda Resettlement/Land Acquisition Policy Framework (2002)

With regard to compensation and resettlement issues, the main pieces of legislation are the Constitution of Republic of Uganda/and the Land Act both of which require that:

- Compensation should be aimed at minimizing social disruption and assist those who have lost assets as a result of Hydro Power project to maintain their livelihoods. In accordance with Ugandan laws and standards, a disturbance allowance is to be provided to assist the Project affected individual or family to cover costs of moving and locating to a new holding. This disturbance allowance however might not be sufficient to cover income losses.
- Community infrastructure must be replaced and ideally be improved in situations where it was deficient. This includes installation of sanitary facilities, electricity generation systems, road links and provision of water.

Interpretation: These aspects will be complied with as guided by the Project’s separate Land acquisition Action Plan report

4.2.11. Uganda’s Vision 2040

In Vision 2040‘ Ugandan sets goals to achieve by the year 2040 ranging from political, economic, social, energy, and environment. With respect to environmental goals, Ugandans aspired to have sustainable social-economic development that ensures environmental quality and preservation of the ecosystem. Vision 2040 recognises energy as a key driver of the economic development and notes that for Uganda to shift from a peasantry to an industrialized and urban society, it must be propelled by electricity as a form of modern energy. It estimates that Uganda will require 41,738 MW of electricity by year 2040 thus increasing its electricity consumption per capita to 3,668 kWh. Furthermore the access to the national grid must significantly increase to 80%. To this end, Uganda will fully exploit its hydropower potential by developing large and small Hydropower plants including Isimba, Murchison Bay, Karuma, Kalagala, and Ayago inclusive besides other renewables such as wind, solar and bio-gas. To reduce the energy deficit, in the long-term Government will invest in development of nuclear power from uranium deposits in the country. Vision 2040 notes that to improve access and availability of electricity to the rural and urban areas, especially to economic zones and other productive areas, new transmission lines to evacuate power will be built and rural electrification programmes accelerated.

Interpretation: Therefore the proposed Muzizi HPP and associated transmission line is in line with aspirations of Vision 2040.

4.3 Legal Framework

4.3.1 The Uganda Constitution, 1995

The Constitution in its National Objectives and Directive Principles of State Policy, Objective XIII provides for the protection of natural resources. It provides that "the *State shall protect important natural resources, including land, water, wetlands, minerals, oil, fauna and flora on behalf of the people of Uganda".* Objective XXVII (i) obliges the State to promote sustainable development and public awareness of the need to manage land, air and water resources in a balanced and sustainable manner for the present and future generations.

Paragraph (ii) of that objective goes ahead to state that the State shall take all possible measures to prevent or minimize damage and destruction to land, air and water resources resulting from pollution or other causes.

Article 39 enshrines the right of every Ugandan to a clean and healthy environment. Article 237(2)(b) of the Constitution provides that notwithstanding clause (1) of Article 237 which provides that land in Uganda belongs to the citizens of Uganda to vest in them according to the land tenure systems provided for in the Constitution, Government or a local government shall hold in trust for the people and protect natural lakes, rivers, wetlands, forest reserves, game reserves national parks and any land to be reserved for ecological and touristic purposes for the common good of all citizens.

The Constitution of Uganda provides for the promotion of culture. Objective XXIV of the Constitution states that cultural and customary values that are consistent with the fundamental human rights and freedoms, human dignity and democracy and with the Constitution of Uganda may be developed and incorporated in all aspects of Ugandan life. An archeology survey was undertaken to ensure that the project doesnot lay to waste any important artefacts and that customs and cultures relating to the project area are preserved in as near an original state as possible.

4.3.2 The National Environment Act Cap 153, 1995

The specific legislation that deals with environmental impact assessments (EIA) in Uganda is the National Environment Act (NEA), Cap 153. NEMA was created under NEA and mandated with the responsibility to oversee, coordinate and supervise environmental management activities in Uganda. Third Schedule of the National Environment Act, Cap 153 (Section 10(a), (b), (c): ―Electrical infrastructure including electricity transmission lines and substations") requires this project to undertake an EIA.

The Act provides for various strategies and tools for environment management, which also include EIA (Section 19) for projects likely to have significant impacts on the environment. NEMA sets multimedia environmental standards (Sections 24-32) to prevent contamination of air, water and soil resources. Section 36 entrusts NEMA, lead agencies and the district environment committee with powers to protect quality of watercourses, permanent or seasonal from human activities that could adversely affect them. Section 56 prohibits discharge of hazardous substances like chemicals, oil, etc into the environment except in accordance with guidelines prescribed by NEMA. NEMA will also be responsible for approval of the project EIA and prescribing compliance conditions during project implementation.

The relevance of this Act in developing the ESIA report is further compounded by section 20 of the same Act that requires the submission of an Environmental Impact Statement, and subsection (2) emphasizes the requirement to utilize the guidelines established by the authority. This report has been written in accordance to the NEMA guidelines for EIA of 1997.

4.3.3 The Land Act, 1998

Section 44 of the Land Act 1998 states that a person who owns land shall manage and utilize the land in accordance with the Forest Act, the Mining Act, the National Environment Statute, 1995, the Water Statute 1995, the Uganda Wildlife Statute 1996 and any other law. The ministry of Lands, Housing and Urban Development is mandated with the responsibility to oversee, coordinate and supervise all land management activities in Uganda

Section 45(i) of the Land Act 1998, further reiterates the Constitutional provision that Government or Local Government shall hold in trust for the people and protect natural lakes, rivers, ground water, natural streams, wetlands, forest reserves, national parks and any other land reserved for ecological and touristic purposes for the common good of all the citizens of Uganda.

Under Section 45(5) of the Act, Government or Local Government may grant Licenses, Concessions or Permits to use those resources. Any intended use of such areas should be based only on issuance of a permit as provided for in the National Environment (Wetlands, River Banks and Lakeshores Management) Regulations 2000, and in any case such activities must not violate the provisions under Section 37 of the National Environment Act 1995. The land on which the power plant will be located belongs to the government and therefore formal procedures will be followed in attaining of the approvals for utilization of said area.

4.3.4 Uganda Wildlife Act, CAP 200, 1996

This Act defines wildlife as any wild plant or animal of a species native to Uganda. The Act entrusts ownership of wild animals and plants with the government for the benefit of Ugandan people, a responsibility executed by Uganda Wildlife Authority (UWA). Sections of the Act specifically dealing with the project development activities include:

Section 15. Environmental impact assessment; (1) Any developer desiring to undertake any project which may have a significant effect on any wildlife species or community shall undertake an environmental impact assessment in accordance with the National Environment Act, (2) The authority shall perform all the functions required of a lead agency for purposes of an environmental impact assessment under the National Environment Act, and any regulations made under the National Environment Act.

Section 21. General offences in wildlife conservation areas: Unless provided for by this Act, any person who in any wildlife conservation area unlawfully; (a) hunts, takes, kills, injures or disturbs any wild plant or animal or any domestic animal; (b) takes, destroys, damages or defaces any object of geomorphological, archaeological, historical, cultural or scientific interest, or any structure lawfully placed or constructed; (c) starts or maintains a fire without lawful authority; commits an offence.

Interpretation: This Act is relevant to the Project as development activities will take place in areas where infrastructure and workers may affect wildlife in MFNP. A notable requirement of this Act is avoidance of any hunting and poaching either during project construction or its operation.

4.3.5 Uganda Tourism Act, 2008

An Act to reform, consolidate and streamline the law relating to tourism; to provide for licensing, regulating and controlling of the tourism sector; to give effect to the implementation of the tourism policy of Government; to reconstitute the Uganda Tourist Board to make it private sector driven; to establish a tourism development levy; to provide for the establishment and management of a tourism development fund; to repeal the Hotels Act, the Tourist Agents (Licensing) Act, and the Uganda Tourist Board Act and to provide for related matters. This Act is relevant to the Project as tourism is the main activity and income source of MFNP.

4.3.6 The Electricity Act Cap 145, 1999

Enactment of the Electricity Act, 1999 paved way for liberalisation of Uganda's energy sector, allowing the establishment and operations of independent power producers. This Act liberalized the power sector breaking up Uganda Electricity Board that had monopoly for power generation, transmission and distribution, into three companies responsible for generation (UEGCL), transmission (UETCL) and distribution (UEDCL) of electric power in Uganda. The Act also authorised licensing of independent power producers (IPP), to generate, distribute and sell power. This Act created the Electricity Regulatory Authority (―the Authority‖ in this Act), an independent body responsible for regulating the electricity sector in Uganda and licensing private investors. The Authority retains power to award licenses for power generation; promote efficiency, economy and safety on the part of licensees and the efficient and safe use of electricity. This ensures that the design and operation of generation, transmission and distribution by licensees will have efficiency built in and approved standards.

Section 29(2)(f) and Section 33(1)(g) require that any entity desirous of securing a license to establish a power generation facility provides reports of studies undertaken to assess impact of the project on electricity supply, socioeconomics, cultural heritage, environment, natural resources and wildlife. Section 68 of the Act provides guidelines for the placement of electricity supply lines on land, stating that a developer shall as much as possible minimise damage to the environment and shall ensure prompt payment of fair and adequate compensation to all interested persons for any damage or loss sustained by construction of electricity supply infrastructure. Section 69 of the Act requires a developer or licensee who intends to enter land under the management or control of the Uganda Land Commission or a District Land Board, to give 30 days'notice to the Uganda Land Commission or a District Land Board, stating the nature and extent of the acts intended to be undertaken.

Further, the Act under section (49) (2) requires, when necessary, decommissioning (removal of installations) of the project to be done in accordance with the National environmental Act and prevailing applicable standards Section 75 provides for royalties payable to local authorities as per excerpts below: (7) The holder of a license for hydropower generation shall pay to the district local government in which his or her generating station, including any dam or reservoir, is situated a royalty agreed upon by the licensee and the district local government, in consultation with the authority. (8) Where the licensee and the district local government fail to agree upon the royalty, the authority shall determine the royalty to be paid to the district local government by the licensee. (9) Where the generating station is situated in more than one district local government area, the royalty paid under subsection (7) shall be shared proportionately among the district local governments.

The Electricity Act is relevant to the Project in so far as Section 29(2)(f) and Section 33(1)(g) require that before establishing a power generation station assessment of impact of the project on socioeconomics, cultural heritage, environment, natural resources and wildlife should be undertaken. In practice, from the project point of view, it is expected that Electricity Regulatory Agency (ERA) will endorse the project and support its activities to the extent that those activities are consistent with its mandate.

4.3.7 The Mining Act, 2003

An Act to repeal and replace the Mining Act, Cap. 248, with a new legislation on mining and mineral development, which conforms, and otherwise gives effect, to the relevant provisions of the Constitution; to vest the ownership and control of all minerals in Uganda in the Government; to provide for the acquisition of mineral rights; and to provide for other related matters. The developer will acquire permits from the relevant authorities upon obtaining areas for quarrying stones and will consult with the Ministry of Energy and Mineral Development on technical issues associated with materials extraction.

Stone quarry sites and gravel borrow pits will be necessary for materials needed to construct the power project and applicable licenses shall be obtained from the Commissioner of the Geological Survey and Mines in the Ministry. The Mining Act of 2003 regulates mining developments including set up of new quarries and/or sandpits. Relevant environmental studies required for this license application are described in Part XI. The extraction of stone/aggregate and murram materials will be undertaken in line with the provisions of this Act. Issues of restoration of the sites after murram extraction will be of key importance after construction of the proposed project.

This Act will apply to the project’s contractors who will be required to obtain license for extraction of stone/aggregate, sand and murram materials required for construction of the power station

4.3.8 The Employment Act, 2006

The employment act spells out the general principles regarding forced labour, discrimination in employment, sexual harassment and provisions to settle grievances. The Act further stipulates in section 31 subsection (1) that a child under the age of twelve years shall not be employed in any business, undertaking or workplace. It further states in subsection (2) that a child under the age of fourteen years shall not be employed in any business, undertaking or workplace, except for light work carried out under the supervision of an adult aged over eighteen (18) years and which does not affect the child's education. The developer will not engage any child workers at the project site at any one time during the project lifecycle.

The Act states in section 33 (1) the Minister (Responsible for Labour matters) may by regulations require persons over the age of eighteen years seeking employment involving exposure to hazards specified by regulations to undergo medical examination before being engaged by an employer at regular intervals thereafter. Given the nature of the undertaking in this case, the developer will employ those qualified individuals to undergo medical examination to ensure fitness to undertake the tasks. The medical communication will continue throughout the project cycle where any complaints or ailments experienced by employees are addressed by a qualified medical practitioner.

Section 37 focuses on migrant workers and stipulates in subsection (1) that No person shall organise the illicit or clandestine movement of migrants for employment for purposes departing from, passing through or arriving in Uganda or give assistance to any organisation for that purpose. Sub section (2) further states that a Person shall not employ a person whom he or she knows to be unlawfully present in Uganda. The developer will give first priority during the hiring process to Ugandans and more so to the communities in the Kiryandongo and other neighbouring areas. All migrant expatriates will be required to present proper documentation allowing them to work in the country, and on the project.

Section 51 of the act outlines the requirement for weekly rest and states in sub section 1 that An employee shall not be required to work for an employer for more than six consecutive days without a day's rest, which shall be taken on any day which is customary or as shall be agreed between parties. Workers will be shifted periodically to allow rest periods and prevent over exertion. No one worker shall be engaged in project activities for more than 6 days running per week, except, as stated in subsection 2 (a) for persons holding high managerial positions.

Section 53 of the act lays out the requirements for the length of hours per week to engage any one employee. Subsection (1) states that subject to subsections (2) and (3), in all establishments, the maximum working hours for employees shall be forty eight hours per week. Subsection (4) states those hours of work shall not, except as provided in subsection (5) exceed ten hours or fifty six (56) hours per week. The developer shall abide by provisions of the act.

4.3.9 The Workers' Compensation Act, Cap. 225

This law provides for compensation to workers for injuries suffered in the course of their employment. Under the Act, an employee is entitled to compensation for any personal injury from an accident or disease arising out of, and in the course of his or her employment even if the injury or disease resulted from the negligence of the employee. The employer is immediately required to report to the Labour Officer of the area the accident causing injury or death of a worker. It is an offence to fail to report an accident. Employers are also obliged to insure and keep themselves insured against any liability, which they may incur or their employees under the Act. It is an offence to fail to insure against such liability. The compensation is to be paid by the employer whether the worker was injured as a result of his or her own negligence, mistake, omission or commission.

4.3.10 The Occupational Safety and Health Act, 2006

This Act consolidates, harmonizes and updates laws relating to occupational safety and health. It provides for the health, workplace safety and welfare of employees thus it is relevant to the proposed project. Article 39 gives workers a right to a clean and healthy environment while article 40(1) empowers Parliament to enact laws to provide for the rights of persons to work under satisfactory, safe and healthy conditions. The above provisions shall be adhered to during implementation phases, especially at the construction stage where many workers will be on site.

4.3.11 The Water Act, 1997

The national water act of 1997 vests the rights in water in the government of Uganda along with All rights to investigate, control, protect and manage water in Uganda for any use and shall be exercised by the Minister and the director in accordance with this part of the Act. The Act provides for the use, protection and management of water resources and supply. It further provides for the constitution of water and sewerage authorities; and to facilitate the devolution of water supply and sewerage undertakings. Section 4 of the act outlines the objectives of the act that are, among others; to promote the rational management and use of the waters of Uganda through:

a) the progressive introduction and application of appropriate standards and techniques for the investigation, use, control, protection, management and administration of water resources;
    - the coordination of all public and private activities which may influence the quality, quantity, distribution, use or management of water resources;
    - the coordination, allocation and delegation of responsibilities among Ministers and public authorities for the investigation, use, control, protection, management or administration of water resources;
    - to promote the provision of a clean, safe and sufficient supply of water for domestic purposes to all persons;

b) to allow for the orderly development and use of water resources for purposes other than domestic use, such as the watering of stock, irrigation and agriculture, industrial, commercial and mining uses, the generation of hydroelectric or geothennal energy, navigation, fishing, preservation of flora and fauna and recreation in ways which minimise harmful effects to the environment;

The developer will abide by all the provisions of the act.

4.3.12 Traffic and Road Safety Act, Cap 361, 1998

Section 35 of the Act prohibits driving without a valid driving permit by stipulating under subsection (1) that No person shall drive any class of motor vehicle, trailer or engineering plant on a road unless he or she holds a valid driving permit or a valid learner driving permit endorsed in respect of that group of motor vehicle, trailer or engineering plant. All project drivers will have driving permits in accordance with the class/group of vehicles registered for under the Act.

Section 104 of the Act places limitation of loads by stipulating that under subsection (1), no goods vehicle shall be used on a road with a load greater than the load specified by the manufacturer of the chassis of the goods vehicle. And under subsection (2), no goods vehicle shall be used on a road if it is loaded in such a manner as to make it a danger to other persons using the road or to persons travelling on the goods vehicle; and if any load or part of a load falls from any such goods vehicle, that fact shall be prima facie evidence that the goods vehicle was loaded in a dangerous manner, until the contrary is proved to the satisfaction of the court.

Section 107 of the same Act states under subsection (1) that no motor vehicle, trailer or engineering plant shall be used on a road unless the motor vehicle, trailer or engineering plant and all its parts and equipment, including tyres and lights, are in good repair and in efficient working order and are in such condition that the driving of the vehicle on the road either in the daytime or at night is not likely to be a danger to the persons travelling on the motor vehicle, trailer or engineering plant or to other users of the road. The Project vehicles will be serviced periodically in keeping with the provisions in this act and to prevent accidents on the road within and outside of the Murchison National Park.

Section 109 cautions against bad driving and states that every person who causes bodily injury to or the death of any person by carelessly using a motor vehicle, trailer or engineering plant commits an offence and is liable on conviction to a fine of not less than sixty currency points and not exceeding one hundred and fifty currency points or imprisonment of not less than two years and not exceeding three years or both. Therefore, it will be a requirement that project drivers are all adequately trained to man the vehicles they are assigned, and will be limited to specific speed limits in the park (≤40km/hr) and outside of the park (according to stipulated speed limits set by the UNRA).

Sections 111 and 112 caution against driving while drunk and 111 states that every person who, while under the influence of drink or a drug to such an extent as to be incapable of having proper control of the motor vehicle, trailer or engineering plant, drives or attempts to drive a motor vehicle, trailer or engineering plant on any road commits an offence and is liable on conviction to a fine of not less than five currency points and not exceeding sixty currency points or imprisonment of not less than six months and not exceeding two years or both. It will be upon the developer to suspend drunk drivers from duty until such a time when according to the provisions of this act, are capable of handling a motor vehicle (blood alcohol level below the prescribed limit).

Section 119 states that every person who uses, parks or stands a motor vehicle, trailer or engineering plant on any road carelessly or without reasonable consideration for other persons using the road commits an offence and is liable on conviction to a fine of not less than five currency points and not exceeding thirty currency points or imprisonment of not less than one month and not exceeding one year or both. No project vehicle will be parked on the roads in the park or outside of it, blocking the road or otherwise inconveniencing other drivers on the same road.

Section 120 of the act states that every person who;-

a) drives a motor vehicle, trailer or engineering plant of any class or description on a road at a greater speed than the prescribed maximum speed limit in respect of that road under this Act, or
b) aids, abets, counsels or procures any other person to drive a motor vehicle, trailer or engineering plant at a speed in excess of a speed limit lawfully imposed,

Commits an offence and is liable on conviction to a fine of not less than fifteen currency points and not exceeding sixty currency points or imprisonment of not less than six months and not exceeding two years or both.

4.3.13 The Physical Planning Act Cap 30

An Act to provide for the establishment of a National Physical Planning Board; to provide for the composition, functions and procedure of the Board; to establish district and urban physical planning committees; to provide for the making and approval of physical development plans and for the applications for development permission; and for related matters. The District urban planner and planning committee will be consulted upon during the ESIA development to understand the layout of the area, and to gauge whether the development contravenes the physical plan of the area, or can be modified to fit within the plan.

4.3.14 The Rivers Act Cap 347

Section 4 of the Act states under subsection (1) that it shall not be lawful to dredge in any river without a license from the Minister, which shall be in Form A of the Second Schedule to the Act. (2) Any person dredging in a river without a license, or contrary to the terms of the license, commits an offence and is liable on conviction to a fine not exceeding one thousand five hundred shillings for every day during which the offence continues. A license will be sought from the Ministry of Water and Environment for any dredging in the Nile, especially for the area where the intake and weir are to be constructed, as well as the powerhouse.

4.3.15 The Land Act Cap 227

The Act, in section 44 (1) states that the Government or a local government shall hold in trust for the people and protect natural lakes, rivers, ground water, natural ponds, natural streams, wetlands, forest reserves, national parks and any other land reserved for ecological and touristic purposes for the common good of the citizens of Uganda. Section 70 (1) states that Subject to section 44, all rights in the water of any natural spring, river, stream, watercourse, pond, or lake on or under land, whether alienated or un-alienated, shall be reserved to the Government; and no such water shall be obstructed, dammed, diverted, polluted or otherwise interfered with, directly or indirectly, except in pursuance of permission in writing granted by the Minister responsible for water or natural resources in accordance with the Water Act. In writing the ESIA, the developer applies for permission to carry out activities in and near the Nile and will consequently obtain all necessary licenses needed to operate in the area.

4.3.16 Historical Monuments Act, Cap 46, 1968

The act provides for the preservation and protection of historical monuments and objects of archaeological, paleontological, ethnographical and traditional interest and for other matter connected therewith. This Act makes provision for the declaration and protection of preserved and protected objects (as defined). The Act also provides for acquisition of land any land under Land Acquisition Act of any land which appears to the Minister to be required for the purposes of preserving or affording access to the object. Any land so acquired shall, for the purposes of section 11(a) of the Mining Act, be land dedicated or set apart for public purposes. Section 3 of the act provides for the declaration of protected objects where by the Minister may, by statutory instrument, declare any object of archaeological, palaeontological, ethnographical, traditional or historical interest to be a protected object.

Section 8 of the act stipulates that no person, whether owner or not, shall do any of the following acts to or in relation to any object declared to be preserved or protected under this Act cultivate or plough the soil so as to affect to its detriment any object declared to be preserved or protected; make alteration, addition to, or repair, destroy, deface or injure any object declared to be preserved or protected; allow any animal under his or her control to damage any object declared to be preserved or protected; and write, draw or carve any writing or figure on the object. Section 11 subsection (1) states that any person who discovers any object which may reasonably be considered to be of archaeological, palaeontological, ethnographical, historical or traditional interest shall, within fourteen days, report to the conservator of antiquities or a district commissioner or the curator of the museum. Any person who discovers any such object shall take such measures as may be reasonable for its protection. Excavations may unearth objects considered to be archeological artefacts. Any finds will be reported to the district commissioner or an appointed officer working with the Ugandan Museum.

4.4 Regulations

4.4.1 The National Environment (Wetlands, Riverbanks and Lakeshores Management) Regulations, 2000

According to the Regulations, Government or Local Governments shall hold in trust for the people and protect riverbanks for the common good of the citizens of Uganda.

The objective of this Part of the Regulations is to:

a) facilitate the sustainable utilization and conservation of resources on river banks and lake shore by an d for the benefit of the people and community living in the area;
b) promote the integration of wise use of resources in river and lakes into the local and national manage ment of natural resources for socioeconomic development;
c) give effect to clause 2 of article 237 of the Constitution of Uganda;
d) provide for the regulated public use and enjoyment of river banks and lake shores;
e) enhance research and research related activities; and
f) prevent salutation of rivers and lakes and control pollution or degrading activities.

The regulation also provides that resources in riverbanks lakeshores and wetland should be utilized in a sustainable manner compatible with the continued presence of wetlands and their hydrological functions and services. Environmental impact assessment as required under the statute is mandatory for all activities in the wetlands, riverbanks and lakeshores and special measures are essential for protection of riverbanks, lakeshores and wetlands of international, national, and local importance of ecological systems and habitat for fauna and flora species, and for cultural and aesthetic purposes, as well as for their hydrological functions and values for preventing soil erosion, siltation and water pollution. Every landowner, occupier or user who is adjacent or contiguous with a wetland, riverbank and lakeshore has a duty to prevent the degradation or destruction of the lakeshore, and to maintain ecological and other functions of the wetland. Activities listed below in the protected zone listed in section 23 of the regulations require a permit from NEMA.

- Excavating, drilling, tunnelling or disturbing the bed;
- Deposit any substance in the lake or river in, on or under its bed if that substance is or likely to have si gnificant impact on the environment;
- Divert or block any river from its original normal course; and drain any lake or river.
- This regulation however, does not prohibit the following traditional uses of the wetland resources:

The developer will ensure that all the required permits are acquired and that all regulations are followed when constructing along the banks of the Nile.

4.4.2 Environmental Impact Assessment regulations, 1998

Regulation 10 subregulation (1) outlines the provisions under which an EIA should be undertaken. It states that an environmental impact Study shall be conducted in accordance with terms of reference developed by the developer in consultation with the Authority and the lead agency. The developer in keeping with this regulation undertook a TOR that was subsequently approved on the 15th of July 2012 and appended to this report. Regulation 13 (1) stipulates that where the Executive Director has, under sub-regulation (1) of regulation 9 determined that an environmental impact study be made under these regulations, the developer shall make an environmental impact statement on completing the study.

4.4.3 The Water (Waste Discharge) Regulations, 1998

Under these regulations, the National environment management authority sets the standards for discharge of treated effluent or waste into water or on land in consultation with the lead agency under section 26 of the National Environment Act, Cap 153. The regulations prohibit the discharge of effluent or waste under regulation 4 (1) by stating that no person shall discharge effluent or waste on land or into the aquatic environment contrary to the standards established under regulation 3 unless he or she has a permit in the format specified in the First Schedule issued by the Director. The developer will not discharge any waste or effluent into the environment unless prior permission from NEMA has been given, in consultation with the lead agency on the medium into which they intend to discharge. Regulation 4 (2) obliges a person granted a permit under sub-regulation (1) to (a) ensure that the effluent or waste discharged conforms to the maximum permissible limits established under regulation 3.

4.4.4 The National Environment (Waste Management) Regulations 1999

Regulation 4 outlines the requirement for sorting and disposal of domestic waste. Under sub-regulation (4), a person who generates domestic waste shall sort the waste by separating hazardous waste from non-hazardous waste in accordance with the methods prescribed under sub-regulation (3). Sub-regulation (5) stipulates that a generator of domestic waste may, without a license issued under these Regulations, dispose of non hazardous waste in an environmentally sound manner in accordance with by-laws made by a competent local authority. The developer in keeping with this regulation engage a NEMA licensed waste transportation company to collect waste from the worksite and disposed of it at prior agreed sites with the Authority.

4.4.5 The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations

The regulations outline the standards for effluent into the environment in regulation 3 (1). They further set out the obligations to mitigate pollution in regulation 4 (1) which states that every industry or establishment shall install at its premises, anti-pollution equipment for the treatment of effluent chemical discharge emanating from the industry or establishment. Hydropower generation doesnot generate significant amounts of waste during operation, however, incase there is installation of an onsite treatment plant; The standards that will be adhered to are indicated in Table 21.

Table 20: Some parameters and limits applicable to effluent discharge

No.	Parameter	Permissible Limits	No.	Parameter	Permissible Limits
1	Aluminium	0.5 mg/L	13	Tin	5 mg/L
2	Ammonia Nitrogen	10 mg/L	14	Zinc	5 mg/L
3	Arsenic	0.2 mg/L	15	Lead	0.1 mg/L
4	BOD5	50 mg/L	16	Magnesium	100 mg/L
5	Calcium	100 mg/L	17	Mercury	0.01 mg/L
6	Chloride	500 mg/L	18	Nitrite - N	20 mg/L
7	COD	100 mg/L	19	Nitrite - N	2.0 mg/L
8	Colour	300TCU	20	Nitrogen total	10 mg/L
9	Iron	10mg/L	21	Oil and Grease	10 mg/L
10	Sulphate	500 mg/L	22	pH	6.0 - 8.0
11	TDS	1200 mg/L	23	Phosphate (total)	5.0 mg/L
12	Temperature	20-35 ^{o}C	24	Phosphate (soluble)	5.0 mg/L

4.4.6 The National Environment Regulations (Soil Management), 2001

Regulation 3 sets out the purpose of these Regulations which is, as specified under sub-regulation (a) to establish and prescribe minimum soil quality standards to maintain, restore and enhance the inherent productivity of the soil in the long term. In line with this requirement, the contractor shall develop and implement a decommissioning and Restoration plan for all components of the Ayago project in consultation with releant stakeholders.

4.4.7 The National Environment (Noise Standards and Control) Regulations, 2003

Regulation 3; The purpose of these Regulations is to ensure the maintenance of a healthy environment for all people in Uganda, the tranquility of their surroundings and their psychological wellbeing by regulating noise levels, and generally, to elevate the standard of living of the people by:

a) prescribing the maximum permissible noise levels from a facility or activity to which a person may be exposed (see Tables 22 & 23);
b) providing for the control of noise and for mitigating measures for the reduction of noise; and

Regulation 8; (1) It is the duty of the owner of machinery or the owner or occupier of a facility or premises, to use the best practicable means to ensure that the emission of noise from that machinery, facility or premises docs not exceed the permissible noise levels. (2) The owner of machinery, or the owner or occupier of an industry or establishment shall install, at the premises, sound level meters for the measurement and monitoring of sound from the industry or establishment to ensure that the noise emitted does not exceed the permissible noise levels. (3) The owner of machinery, or the owner or occupier of a facility who contravenes this regulation- commits an offence.

Table 21: Maximum Permissible Noise Levels for General Environment

Facility	Noise Limits B (A) (Leq)	
	Day	Night
A. Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites.	45	35
B. Residential Buildings	50	35
C. Mixed residential (with some commercial and entertainment)	55	45
D. Residential + Industry or small Scale production + Commerce	60	50
E. Industrial	70	60

Time Frame: use duration
Day: 6:00am - 10:00pm
Night: 10:00pm - 6:00am

Table 22: Maximum Permissible Noise Levels for Construction Site

Facility	Noise Limits dB (A) (Leq)	
	Day	Night
Residential	60	40
Commercial	75	50
Industrial	85	65

4.4.8 Draft National Air Quality Standards, 2006

Considering that construction equipment and machinery are powered by diesel/ gasoline engines, pollutants such as CO_2, NO_x, SO_x, VOC and particulates are expected to be emitted. The draft national air quality standards provide the following regulatory limits for these emissions (Table 24).

Table 23: Regulatory air quality standards for selected pollutants

Pollutant	Averaging time for ambient air	Ambient Air Standard
Carbon dioxide (CO_2)	8 hr	9.0 ppm
Carbon Monoxide (CO)	8 hr	9.0 ppm
Hydrocarbons	24 hr	5 mgm^{-3}
Nitrogen Oxides (NO_x)	24 hr 1 year arithmetic mean	0.10 ppm
Smoke	Not to exceed 5 minutes in any one hr	Ringlemann scale No. 2 or 40% observed at 6m or more
Soot	24 hr	500 $\mu g/Nm^{-3}$
Sulphur dioxide (SO_2)	24 hr	0.15 ppm
Sulphur trioxide (SO_3)	24 hr	200 $\mu g/Nm^{-3}$

4.4.9 Water Resources Regulations, 1998

The regulations apply to motorized water abstraction from boreholes or surface watercourses or diverting, impounding or using more that 400 cubic meters of water within a period of 24 hours. Part II, Regulation 3 requires a water permit for operation of motorized water pump from a borehole or waterway. Under Regulation 6, application for permit may be granted on conditions of projected availability of water in the area, existing and projected quality of water in the area and any adverse effect which the facility may cause among other considerations. The developer will be required to abide by provisions of this law in regard to the river diversion, drilling and operation of a borehole at the workers camp and abstraction of water to be used for access road construction. All abstraction points shall be metred and all effluent and waste water shall be discharged into the environment after compliying with national discharge standards.

4.4.10 The Electricity (Primary Grid Code) Regulation, 2003

This Code contains rules and procedures for the efficient management of the electric supply industry in Uganda, taking into account a wide range of operational conditions that are likely to be encountered under normal and exceptional circumstances. The regulation outlines the guidelines of the system Operations Code (SOC), criteria and procedures. It also spells out the objective of the SOC as to ensure that adequate and reliable electric power supply is available to the consumers of the Uganda electric power system under normal, and to as large an extent as possible, under emergency operating conditions. The reliability criteria for normal as well as emergency conditions are described in the System Operations Code. It is possible that there will be power fluctuations due to seasonal changes in river flow, affecting the operating system of the hydropower plant, given that the plant is operated as a run of river scheme.

4.4.11 The Electricity (Tariff Code) Regulations, 2003

The code under the regulation of costs and investments states that the licensee is responsible for justifying that any costs or investments included in the formulation of tariffs are reasonable in the circumstances and the Authority may challenge such costs or investments and where necessary reject them if the Authority considers them to be unreasonable or imprudent.

4.5 Institutional Framework

4.5.1 Ministry of Water and Environment (MWE)

Whose core values it is to ensure sound management and sustainable utilisation of water and environment resources for the betterment of the population of Uganda; and the Mission as: To promote and ensure the rational and sustainable utilisation, development and effective management of water and environment resources for socio-economic development of the country. The ministry, through its directorate of Water resources management (DWRM), will monitor all activities and will be involved in the project as a key stakeholder from preconstruction to decommission phase. The department also sets the quota of allowable abstraction/diversion of the river based on ecosystem need. The directorate is also home to the International Transboundary water Resource Management division, which promotes transboundary regional cooperation for equitable and reasonable utilisation of the shared water resources of the Nile and Lake Victoria basins through active participation in the Nile Basin Initiative (NBI) and the Lake Victoria Basin Commission (LVBC) programmes and activities, as well as other international water resources management programmes (e.g. Global Water Partnership - GWP).

4.5.2 Ministry of Energy and Mineral Development (MEMD)

The mandate of the Ministry of Energy and Mineral Development (MEMD) is "*To establish, promote the development, strategically manage and safeguard the rational and sustainable exploitation and utilization of energy and mineral resources for social and economic development*". The ministry will be responsible for the ESIA review and recommendation. It will also inspect, regulate activities of the developer so that the resource is developed, exploited and used on a rational and sustainable basis. One of the roles and functions of the Ministry is to provide policy guidance in the development and exploitation of the energy resources.

4.5.3 Ministry of Gender, Labour and Social Development (MGLSD)

The Mandate of the ministry is to evaluate and Control the Physical, Chemical, Physiological, Social, and Technical factors that affect a person at Work and the Working Environment. The objectives of the MGLSD are to minimize Occupational Accidents, Diseases and Injuries. promote good Health of the Worker at the Workplace promote good Working Conditions, promote construction of Safe and Healthy workplaces, promote awareness of Occupational Safety and Health among Workers, Employers and the General Public through Training. The ministry, through its department of Occupational Health and Safety (OHS) will be responsible for registering the workplace and monitoring of conditions under which employees on the project are subjected.

4.5.4 Nile Basin Initiative (NBI)

The NBI promotes investments in three areas of priority to all Member States namely Power; Agriculture and Regional Trade; River Basin Management and Development. The role of NBI is to identify opportunities and prepare investment projects which contribute to economic growth and poverty reduction. The NBI lists Power/electricity as a critical ingredient in all sectors of national economy and its supply is directly correlated with the economic performance of the countries. The Initiative identifies hydro-power is the preferred energy source for most Nile Basin countries, and therefore will be key in streamlining efforts to develop the project sustainably through continuous consultations and information sharing. NBI is currently contributing to the transformation of the region’s power sector by providing a forum for joint planning and cooperative development of hydro-power generation and transmission options and promoting power pooling amongst the Nile countries.

4.5.5 National Environment Management Authority (NEMA)

The role of the Authority is to assess and monitor all environmental phenomena with a view to making an assessment of any possible changes in environment and their possible impact. The Authority will also be responsible for the monitoring operation of the, project, with a view to determining its immediate and long-term effects on the environment. The NEMA will then distribute the ESIA reports to relevant sectors (Ministry/Department) and make recommendations on approval or mitigating factors relating to the environmental assessment. The NEMA will also be responsible for following up to ensure that mitigation measures are put in place and ensuring compliance with EIA legislation.

4.5.6 Electricity Regulatory Authority (ERA)

The ERA's mandate is outlined in the Electricity Act 1999 and functions as an issuer of licenses for the generation, transmission, distribution or sales of electricity and the ownership or operation of transmission lines. The ERA will issue a license under the Electricity Act to the developer to generate and transmit electricity to the Karuma Switchyard, 58km away from the project site. The ERA will also establish a traffic structure and approve rates of charges and terms and conditions of electricity services provided by transmission and distribution companies.

4.5.7 Uganda Electricity Transmission Company Limited (UETCL)

UETCL is a Public Limited Company which was incorporated on 26th March 2001. The Company operates under policy guidance of the Ministry of Energy and Mineral Development. It has the operational mandate that is divided into the Single buyer business and Transmission system operator. It therefore undertakes bulk power purchases and sales, import and export of energy, operation of the High Voltage Transmission Grid and plays the national system operator role.

4.5.8 Uganda Electricity Generation Company Limited (UEGCL)

UEGCL is a limited liability company incorporated in March 2001 under the Companies Act, 2012 on the basis of the Public Enterprises Reform and Divestiture Act, Cap 98 and Electricity Act, Cap 145 respectively. UEGCL's key role is to actively generate electric power and sale within Uganda or for export to neighbouring countries; build, operate and maintain Electricity Generation Plants; monitor the operation and maintenance; provide Technical Support as and when required by the Government of the Republic of Uganda through the Ministry of Energy and Mineral Development.

The UEGCL is the implementing agency for the development of Ayago HPP. They are responsible for monitoring and supervising all aspects of the project activities during the development of the project and will also be responsible for the Operation and maintencace of the Ayago power plant.

4.5.9 Uganda Electricity Distribution Company Limited (UEDCL)

UEDCL is a limited liability company incorporated in Uganda under the Companies Act as of the 1st April 2001. The company, fully owned by Ugandan government will be responsible for the distribution of electricity;

they are also responsible for the rehabilitation, upgrade and expansion of the distribution network within the country.

4.6 International Agreements

4.6.1 Convention of Biological Diversity

The Convention on Biological Diversity (CBD), known informally as the Biodiversity Convention, is a multilateral treaty. The Convention has three main goals namely conservation of biological diversity (or biodiversity); sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources. In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development. Uganda is a signatory to this convention and with undertaking of the ESIA for this project, abides by the convention requirement to carry out assessments for all projects likely to have significant adverse effects on biodiversity.

4.6.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Uganda is a signatory to this treaty, which outlines the role of all parties to protect endangered plants and animals. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild, and it accords varying degrees of protection to more than 35,000 species of animals and plants. No animals will be traded in the course of the project implementation from start to finish.

4.6.3 United Nations Convention to Combat Desertification (UNCCD)

Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements. The project, in as far as is practical will avoid forested areas to prevent mature tree felling for any item of the facility.

4.6.4 Convention on the Conservation of Migratory Species of wild animals

The convention aims to conserve terrestrial, Aquatic and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale.

4.6.5 International Renewable Energy Agency (IRENA)

The IRENA was founded in 2009 to promote widespread and increased adoption and sustainable use of all forms of renewable energy. The agency views hydro-electricity and geothermal electricity produced at favorable sites as the cheapest ways to generate electricity. It further aims to provide practical advice and support for both industrialized and developing countries.

4.6.7 Ramsar Convention on Wetlands

Is an international treaty for the conservation and sustainable utilization of wetlands, to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.

4.7 International Best Practice

This ESIA has been conducted to conform to regulations and standards of the GoU and the safeguard policies of IFC, the Wold Bank Branch that lends to the private Sector.

4.7.1 International Finance Corporation (IFC)

The IFC operates a set of Performance Standards on Social and Environmental Sustainability (in force from January 2012. These Standards replace the prior safeguard policies and will be used to evaluate any project seeking funding through the IFC. The Equator Principles[1] have been revised to adhere to the new IFC Performance Standards (but do not reference the Sustainability Policy). The Performance Standards are listed in Box below and ones likely to be triggered by the project indicated by the √ symbol.

Box (a): IFC Performance Standards

- Performance Standard 1: Social and Environmental Assessment and Management;√
- Performance Standard 2: Labour and Working Conditions;√
- Performance Standard 3: Pollution Prevention and Abatement;√
- Performance Standard 4: Community Health, Safety and Security√;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement√;
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management√;

  Performance Standard 7: Indigenous Peoples X;
- Performance Standard 8: Cultural Heritage√.

Performance Standard 1 (see Box below) underscores the importance of managing social and environmental performance throughout the life of a project.

- It identifies the need for an effective social and environmental management system that is dynamic and continuous, involving communication between the client, its workers, and the local communities directly affected by the communities'.
- It requires thorough assessment of potential social and environmental impacts and risks from the early stages of project development and provides order and consistency for mitigating and managing these on an ongoing basis'[2].

Box (b): Objectives of Performance Standard 1

[1] A financial industry benchmark for determining, assessing and managing social & environmental risk in project financing 2IFC (2006).Guidance Note 1.Social and Environmental Assessment and Management Systems. World Bank Group.

- To identify and assess social and environmental impacts, both adverse and beneficial, in the projects area of influence.
- To avoid, or where avoidance is not possible, minimise, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment.
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them.
- To promote improved social and environmental performance or companies through the effective use of management systems.

IFC Performance Standards reinforce the importance of effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them.

Through the Performance Standards (particularly Performance Standard 1) IFC requires clients to engage with affected communities through disclosure of information, consultation, and informed participation, in a manner commensurate with the risks to and impacts on the affected communities.

IFC is committed to putting into practice processes of community engagement that ensure the free, prior, and informed consultation of affected communities, leading to broad community support for the project.

Table 24: Compliance of the study to IFC performance standards

IFC Performance Standards (PS)	Compliance to Standard
Performance Standard 1 - Social and Environmental Assessment and Management System	This ESIA has been undertaken as part of feasibility study in accordance to National Environment Act Cap 153; Environment Impact Assessment Regulations 1998 and PS 1.
Performance Standard 2 - Labour and Working Conditions	This ESIA provided guidance about a Labour Management Plan (See Section 8) to be developed by the contractor so as to comply with labour and working conditions requirements in both national Employment Act, 2006 and IFC‘s PS.
Performance Standard 3 - Resource Efficiency and Pollution Prevention	The ESIA complies with PS 3, national requirements comprised in *National Environment Act Cap 153* as well as the National Environment (Noise Standards and Control) Regulations, 2003; The Environmental Management and Coordination (Air Quality) Regulations, 2008 and the Water Act, Cap 152.

Performance Standard 4 - Community Health, Safety, and Security	▪ In section 7 and 8, the ESIA has proposed appropriate steps to be adopted by the parties concerned to reduce worker public's exposure to vector borne diseases, STDs and construction and operation related safety hazards. ▪ An Emergency Preparedness and Response Plan will be prepared prior to project operations ▪ In section 8. the ESIA requires the contractor to develop appropriate security, hiring, training and enforcement protocols in line with local regulations and requirements of IFC PS. 4.
Performance Standard 5 - Land Acquisition and Involuntary Resettlement	A stand-alone Resettlement Action Plan (RAP) has been prepared for this project

Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources	▪ The ESIA has entailed a comprehensive assessment of baseline conditions related to biodiversity conservation especially in regard to MFNP. ▪ The assessment entailed baseline conditions of terrestrial and aquatic flora and fauna in the project area. ▪ Potential impacts were identified and mitigation recommendations proposed. These will be implemented during project development.
Performance Standard 7 - Indigenous Peoples	There are no indigenous people in the project area and therefore this PS will not be triggered.
Performance Standard 8 - Cultural Heritage	A physical-cultural resource assessment was undertaken in the project area and mitigation measures proposed.

(1) Broad community support is a collection of expressions by the affected communities, through individuals or their recognised representatives, in support of the project. There may be broad support even if some individuals or groups object to the project.

(2) IFC Policy on Social and Environmental Sustainability (paragraph 20).

4.7.2 Comparison of the IFC Performance Standards and the World Bank Safeguards

All key principles of the World Bank Operation Policies have been incorporated into the new IFC Performance Standards. There are, however, some slight differences between the guidelines, the most relevant of which are outlined in Table below.

Table 25: Comparison of IFC Performance Standards and World Bank Safeguards

Performance Standard 1: Social and Environmental Assessment and Management System	World Bank Operational Policies
Goes beyond assessment to address implementation through the use of a social and environmental management system	OP 4.01 mostly focuses on assessment only
Broader scope of assessment with broader geographic and time horizon; third party actions	No equivalent requirement in OP 4.01
Requires more comprehensive and on-going information disclosure and consultation with affected communities for all projects at a level commensurate with the project's risks and impacts.	OP 4.01 requires consultation for all Category A, and as appropriate, Category B projects.
Requires free, prior and informed consultation and informed participation of affected communities for projects with significant impacts on them. In addition, IFC's Sustainability Policy requires that IFC will verify broad community support for the project within the affected communities.	No equivalent requirement in OP 4.01
Requires clients to establish a grievance mechanism	No equivalent requirement in OP 4.01
Clients must disclose the Action Plan to affected communities, provide them with periodic reports on its implementation and disclose any updated measures and actions to address issues of concern to affected communities.	OP 4.01 has no disclosure requirements beyond assessment.
Documentation and processes are driven by risks and impacts, not project categorisation.	Driven by project categorisation.
Requires an ongoing and iterative consultation process throughout the life of the project.	A requirement to consult ―at least twice‖ during the assessment process
All trans-boundary impacts are considered as part of the assessment process.	International Waterways (OP 7.50) deals with transboundary issues.
Alternatives analysis will be focused on alternatives to avoid adverse impacts. No requirement to compare the ―without project‖ situation.	Requirement to compare the ―without project‖ situation.

4.8 Guidelines of the World Commission of Dams (WCD)

WCD was created by World Bank & IUCN in May 1998 in response to growing opposition to large dams. International Commission on Large Dams (ICOLD) defines a large dam as one with a height of 15 m or more from the foundation. If dams are between 5-15 meters high and have a reservoir of more than 3 million cubic meters, they are also classified as large dams. Ayago HPP in this case is a large dam. The WCD recommendations below will be useful for implementation of the proposed project:

a) Development needs and objectives should be clearly formulated through an open and participatory process, before various project options are identified.
b) A balanced and comprehensive assessment of all options should be conducted, giving social and environmental aspects the same significance as technical, economic and financial factors.
c) Before a decision is taken to build a new dam, outstanding social and environmental issues from existing dams should be addressed, and the benefits from existing projects should be maximized.
d) All stakeholders should have the opportunity for informed participation in decision-making processes related to large dams through stakeholder fora. Public acceptance of all key decisions should be demonstrated. Decisions affecting indigenous peoples should be taken with their free, prior and informed consent.
e) The project should provide entitlements to affected people to improve their livelihoods and ensure that they receive the priority share of project benefits (beyond compensation for their losses). Affected people include communities living downstream of dams and those affected by dam-related infrastructure such as transmission lines and irrigation canals.
f) Affected people should be able to negotiate mutually agreed and legally enforceable agreements to ensure the implementation of mitigation, resettlement and development entitlements.
g) The project should be selected based on a basin-wide assessment of the river ecosystem and an attempt to avoid significant impacts on threatened and endangered species.
h) Mechanisms to ensure compliance with regulations and negotiated agreements should be developed and budgeted for, compliance mechanisms should be established, and compliance should be subject to independent review.
i) A dam should not be constructed on a shared river if other riparian States raise an objection that is upheld by an independent panel.

Table 26: Adherence of Ayago HPP to the WCD recommendations

WCD Recommendation	Adherence
a. Development needs and objectives should be clearly formulated through an open and participatory process, before various project options are identified.	This was discussed in Section 1 of this report.
b. A balanced and comprehensive assessment of all options should be conducted, giving social and environmental aspects the same significance as technical, economic and financial factors.	Comprehensive assessment of project options was carried out during the feasibility study (see feasibility study report). The ESIA assessed the social and environmental aspects while the Feasibility report assesses technical, economic and financial aspects of the project.
c. Before a decision is taken to build a new dam, outstanding social and environmental issues from existing dams should be addressed, and the benefits from existing projects should be maximized.	A thorough ESIA has been developed for the Ayago HPP.

d. All stakeholders should have the opportunity for informed participation in decision-making processes related to large dams through stakeholder fora. Public acceptance of all key decisions should be demonstrated. Decisions affecting indigenous peoples should be taken with their free, prior and informed consent.	During the ESIA, all project affected people were consulted from village level, sub-county to district level. In addition national and district workshops were organised to allow opportunities for wider stakeholder participation.
e. The project should provide entitlements to affected people to improve their livelihoods and ensure that they receive the priority share of project benefits (beyond compensation for their losses). Affected people include communities living downstream of dams and those affected by dam-related infrastructure such as transmission lines and irrigation canals.	Detail on entitlements for project affected people shall be provided in a separate RAP Report. Others social benefits such as community development initiatives are provided in this ESIA report and a separate CDAP shall be developed by the developer.
f. Affected people should be able to negotiate mutually agreed and legally enforceable agreements to ensure the implementation of mitigation, resettlement and development entitlements.	All project affected people were consulted from village level, subcounty to district level. Project affected persons shall be engaged personally during the RAP process. It is aslo important to NOTE that Ayago HPP is in a national park and tso there are minimal social issues.
g. The project should be selected based on a basin-wide assessment of the river ecosystem and an attempt to avoid significant impacts on threatened and endangered species.	Basin-wide assessment of the project area was carried out during the scoping study (Analysis of project alternatives) which led to siting of the water way alternative on the left bank
h. Mechanisms to ensure compliance with regulations and negotiated agreements should be developed and budgeted for, compliance mechanisms should be established, and compliance should be subject to independent review.	Mechanisms are proposed in Chapter 8 under management programmes.
i. A dam should not be constructed on a shared river if other riparian States raise an objection that is upheld by an independent panel.	The Ayago HPP will be developed in compliance to transboundary legal frameworks.

4.9 Permits and Licenses required by the Project

Permits and licenses in table below are expected to be required by the project.

Table 27: Permits and licenses to be required by the project

Permit Required	Issuing Authority	Legal Framework
Generation License	ERA	Electricity Act Cap 145
Construction Permit	DWRM	Water Act
Water Abstraction Permit	DWRM	Water Act
River Dredging Permit	DWRM	Rivers Act, cap 357
Waste Discharge permit	DWRM	Water Act, cap 152
Waste Disposal Permit	NEMA	National Environment Act Cap 153; National Environment (Waste Management) Regulation
Waste Transportation License	NEMA	National Environment Act Cap 153; National Environment (Waste Management) Regulation
Storage of Hazardous/ Non Hazardous Waste	NEMA	National Environment Act Cap 153; National Environment (Waste Management) Regulation
Permit to carry out a Regulate activity in a Wetland, Riverbank, Lakeshore	NEMA	National Environment Management (Wetland, Riverbank, Lakeshore) Regulation 2000
License to emit noise in excess of permissible noise levels	NEMA	National Environment Act Cap 153
Surface Water Permit (Part E: Use of Water for Power Generation)	DWRM	Water Act Cap 152
Blasting, importation, storage and transportation of explosives	Ministry of Internal Affairs	Explosive Act Cap 298
Mining Permit, Extraction of minerals, opening up of quarries and sand pits	DGSM/ MEMD	Mining Act Cap 148
Feasibility Conduction Permit	ERA	Electricity Act Cap 145
Permit for Storage of Petroleum Products	PSD/MEMD	Petroleum Act Cap 2003
Work Place Registration	MGLSD	OHS Act 2006
Work Permits	Ministry of Internal Affair	Immigrations Act Cap 66
Certification of statutory equipment	MGLSD, UNBS	OHS Act, UNBS Act
Approval of HPP layout plan	MLHUP	Physical planning Act Cap 281
River Dredging Permit	DWRM	River Act
River Bank Use Permit (Waiver for Blasting in the River Bed)	NEMA	National Environment Management (Wetland, Riverbank, Lakeshores) Regulations 2000

5. BIO-PHYSICAL AND SOCIAL ECONOMIC BASELINE

5.1 Introduction

The impact assessment requires essential baseline data to provide better assessment and prediction on the future trend on environmental quality. This section therefore presents the findings of the Environmental baseline survey carried out in the period of 2012- June 2014 for physical environment (air, noise, water and soil quality, transportation), Biological environment (including surveys of flora and fauna, for both aquatic and terrestrial organisms). This section also includes the social survey covering landuse, ownership, the general description of the local economy of the project area. The education and health status was also investigated as well as tourism and the relationship between the project area management (MFNP and the local community). Culture was also studied through the detailed Archeological survey undertaken of the area. The baseline informs the preceding impact assessment of the specific status of the environment that is likely to be impacted at the onset of project activities.

5.2 Physical Environment

5.2.1 Air Quality

Methods to obtain air quality baseline have been presented in Chapter 4 above. Sampling points for the noise are presented in Figure 12.

Results
Table 29 presents the measured air quality values for various parameters. The air quality of the conservation areas covered by the Project is very good given that there are no pollutant sources. The results confirm the good air quality with no detectable levels for SO_2, NO, and H_2S for all the measured location. Carbon monoxide (CO) was also not detected at any of the measurement locations within the conservation areas but was detected at the one located by Wangkwar gate where vehicle movements were noted. However, all the detected levels for the measured parameters were within the limits of the Draft National Air Quality Standards.

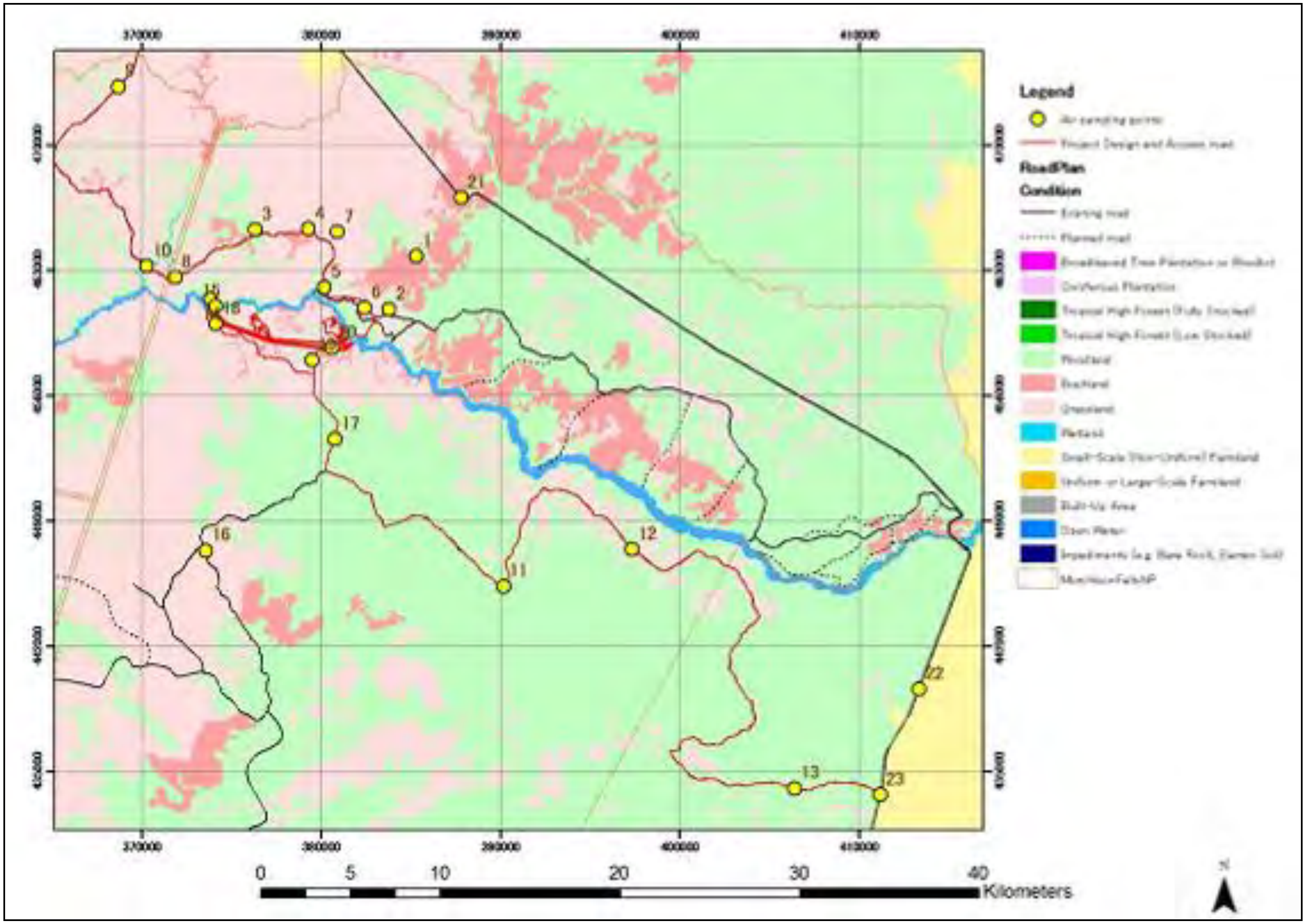


Figure 12: Sampling Points for Air Quality

Table 28: Baseline Air quality as of October 2012

Latitude East	Longitude North	Particulates	SO_2 (ppm)	NO (ppm)	NO_2 (ppm)	CO_2 (%)	NH_3 (ppm)	H_2S (ppm)	H_2 (ppm)	PID (ppm)	CO (ppm)	O_2 (ppm)	Notes
385300	263796	6	0	0	0.3	0.03	0	0	1	4.5	0	20.9	Jungle, light breeze, Chirping Birds
383787	260827	1	0	0	0.3	0.03	0	0	2	0	0	20.9	Jungle, light breeze, Chirping Birds
376329	265297	35	0	0	0	0.03	2	0		0	0	20.8	Jungle, light breeze, Chirping Birds
379308	265336	34	0	0	0	0.03	0	0	2	0	0	20.8	Jungle, light breeze, Chirping Birds
380191	262082	35	0	0	0	0.03	0	0	1	0	0	20.9	R. Ayago Water falls
382432	260925	35	0	0	0	0.03	0	0		0	0	20.8	Jungle, light breeze, Chirping Birds
380897	265168	34	0	0	0	0.03	0	0	0	0	0	20.9	Jungle, light breeze, Chirping Birds
371848	262629	35	0	0	0	0.03	0	0		0	0	20.9	Jungle, light breeze, Chirping Birds
368690	273287	47	0	0	0.5	0.03	0	0	12	0	0	20.7	Wankwar Gate, Truck movements, Human conversations
370259	263262	29	0	0	0	0.03	0	0		0	0	20.9	R. Kibaa Bridge Rapids
390168	245389	34	0	0	0	0.03	0	0	1	0	0	20.9	Jungle, light breeze, Chirping Birds
397341	247428	29	0	0	0	0.03	0	0	0	0	0	20.8	Jungle, light breeze, Chirping Birds
406437	234105	51	0	0	0	0.03	1	0	1	0	0	20.9	Jungle, light breeze, Chirping Birds
373547	247376	35	0	0	0.4	0.03	1	0	1	5.6	0	20.9	Jungle, light breeze, Chirping Birds
380770	253593	65	0	0	0.5	0.03	1	0	1	6.5	0	20.9	Jungle, light breeze, Chirping Birds
374102	260038	35	0	0	0.3	0.03	1	0	5	12.7	0	20.8	Jungle, light breeze,

													Chirping Birds
379481	257990	35	0	0	0.3	0.03	2	0	1	5.2	0	20.8	Jungle, Chirping Birds
380613	258689	35	0	0	0.4	0.03	0	0		2.7	0	20.8	Surveyor Base Camp
387796	267080	35	0	0	0.4	0.03	0	0	4	15.9	0	20.9	Ayago Bridge, Highway traffic, Chirping birds
413380	239638	35	0	0	0.5	0.03	1	0	1	10.4	0	20.9	Diima, Highway traffic, chirping Birds Human conversation
411200	233734	46	0	0	0.3	0.03	0	0	0	9.8	0	20.9	Highway traffic, chirping birds

Source: Adapted from Feasibility study for the Ayago Hydropower Plant 2012

5.2.2 Noise and Vibration

This section presents the baseline of noise and vibration assessment done during the feasibility study for the Ayago Hydropower Plant in 2012. The location and results of the measurements are shown in Table 30 and Figure 13 presents the sampling points.

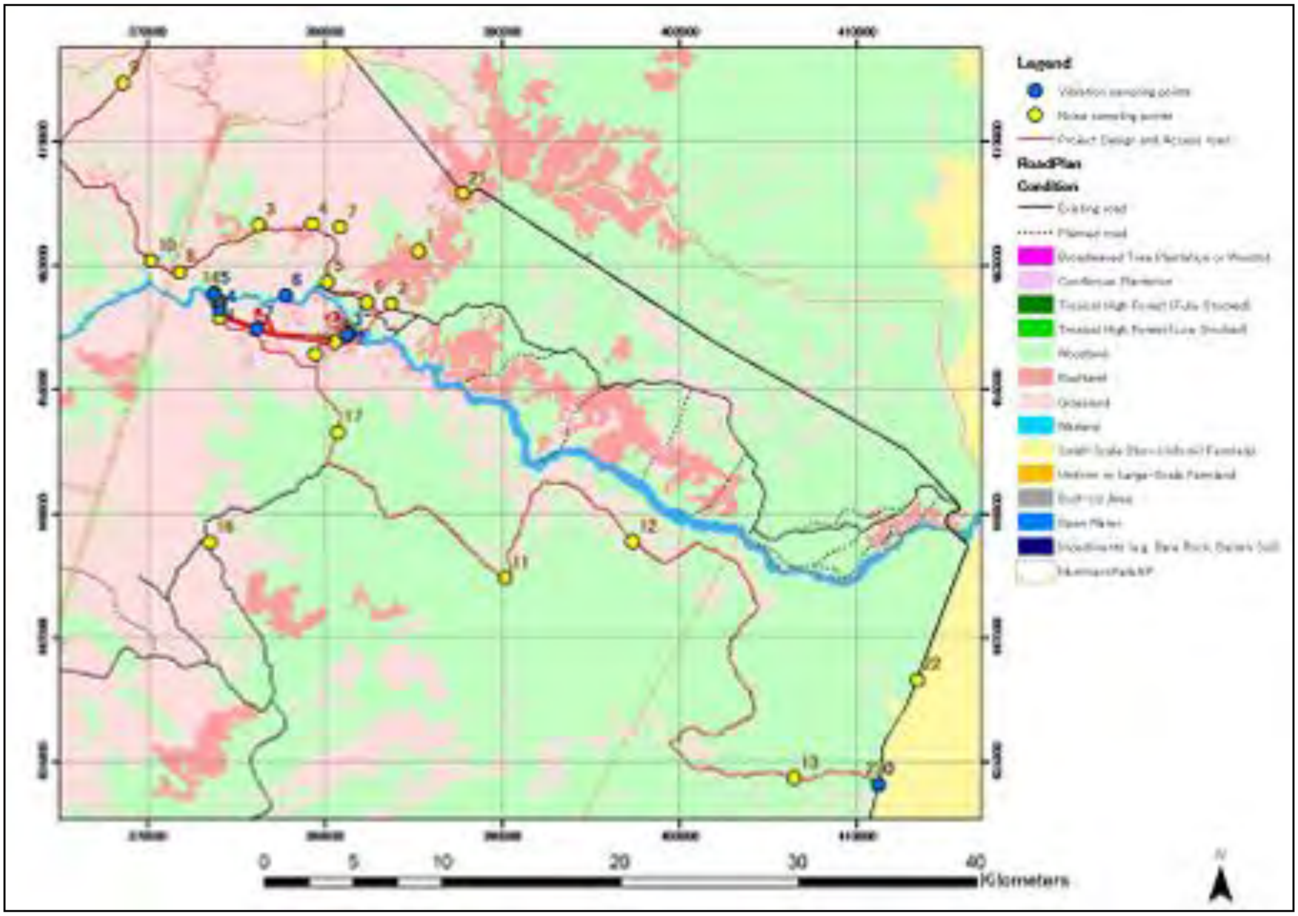


Figure 13: Sampling Points for Noise and Vibration

Results

Table 30 presents the measured noise values in July 2012. Sources of nuisance noise were found to be localized. The measurements indicate that noise levels are generally low, but 'natural' background levels at some locations exceeded standards, especially due to water flowing over rapids and during vehicle movement along the highway.

Table 33 presents the measured baseline vibration values in November 2012. Receptors of the noise and vibrations will mainly include wildlife in the MFNP and the effect shall depend on activities during the seasons especially breeding. Communities along the routes used for construction materials transportation may be affected by elevated noise levels as nuisance as well as the vibrations due to heavy vehicle movement. The vibrations produced from the Project activities are propagated through the ground to a distance that depends on a variety of factors including soil and bedrock types, and topography.

Although there is limited data on large mammals' reactions to the noise and vibrations, it is known that most species are likely to move away as a result of human disturbance. Giraffes, elephants and hippopotamus are also known to use infrasound for communication and have extremely complex low frequencies (<20Hz) hearing systems (von Muggenthaler et al 1999). Infrasound may also play a role in crocodile communication. Langbauer et al (1991) estimated that elephants can hear infrasonic calls at least four kilometers away, and it is therefore possible that noise and vibrations generated from the Project construction and operations activities may disrupt such communication. Noise and vibration are known to affect breeding behavior of amphibians and wetland species. Tables below present noise and vibrations survey results recorded in 2012 and 2013.

Table 29: Noise Survey Results taken July 2012

Latitude	Longitude	Measured Noise Levels (dB)				Notes
East	North	L_{AMax}	L_{Aeq}	L_{A90}	L_{A50}	
385300	263796	56.4	40.4	26.0	29.5	Jungle. Light breeze. Chirping birds
383787	260827	54.8	36.6	34.0	35.5	Jungle. Light breeze. Chirping birds
376329	265297	50.7	33.2	27.5	30.0	Jungle. Light breeze. Chirping birds
379308	265336	49.9	32.2	24.5	26.5	Jungle. Light breeze. Chirping birds
380191	262082	75.3	74.1	74.0	74.0	R. Ayago waterfalls.
382432	260925	55.0	37.9	31.5	34.5	Jungle. Light breeze. Chirping birds
380897	265168	59.1	33.4	27.5	31.0	Jungle. Light breeze. Chirping birds
371848	262629	49.9	31.7	26.5	28.5	Jungle. Light breeze. Chirping birds
368690	273287	78.8	63.7	38.0	49.0	Wangkwar Gate. Truck movements. Human conversations
370259	263262	69.3	64.5	64.0	64.5	R.Kibaa. Bridge. Rapids
390168	245389	50.8	36.9	33.5	36.0	Jungle. Light breeze. Chirping birds
397341	247428	59.0	42.4	36.0	38.0	Jungle. Light breeze. Chirping birds
406437	234105	55.7	35.3	33.0	34.5	Jungle. Light breeze. Chirping birds
373801	261436	64.1	41.7	32.0	35.0	Hippopotamus activity in river.
374115	261003	64.8	48.3	35.0	37.0	Hippopotamus activity in river. Baboon bark.
374115	261003	64.8	48.3	35.0	37.0	Hippopotamus activity in river. Baboon bark.
373547	247376	54.4	36.1	30.0	33.5	Jungle. Light breeze. Chirping birds
380770	253593	56.7	44.1	39.0	42.0	Jungle. Light breeze. Chirping birds
374102	260038	68.1	44.0	37.5	39.5	Jungle. Light breeze. Chirping birds
379481	257990	59.7	41.0	37.5	40.0	Jungle. Chirping birds
380613	258689	57.9	46.4	41.5	45.5	Surveyor base camp
387796	267080	81.8	60.3	32.0	37.5	Ayago bridge. Highway traffic. Chirping birds.
413380	239638	81.7	58.3	34.0	38.5	Diima. Highway traffic. Chirping birds. Human conversation.
411200	233734	92.6	72.4	38.5	48.5	Highway traffic. Chirping birds

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (July 2012)

Table 30: Noise Survey Results as of January 2013

East	North	L_{AMax}	L_{Aeq}	L_{A90}	L_{A50}	Notes
383787	260827	63.1	46.8	44	46	Jungle. Breeze. Chirping birds. Rustling leaves.

East	North	L_{AMax}	L_{Aeq}	L_{A90}	L_{A50}	Notes
376329	265297	72.6	52.6	46	49	Rustling leaves. Chirping birds
379308	265336	58.9	39.6	30.5	34.5	Rustling leaves. Chirping birds
380191	262082	60.6	49.6	48	49.5	R.Ayago. Chirping birds. Rustling leaves.
382432	260925	62.1	53.2	52	53	Distant roaring river. Chirping crickets. Distant snorting hippos. Rustling leaves.
380897	265168	73.9	55.1	41	47	Jungle. Light breeze. Chirping birds
371848	262629	72.8	56.6	38.5	51.5	Jungle. Rustling leaves.
368690	273287	80.4	61.1	56.5	60.5	Wangkwar Gate. Truck movements. Chirping birds and crickets.
370259	263262	69.7	52.4	50	51.5	R. Kibaa. Bridge. Trickling water sound. Chirping birds.
390168	245389	63.8	38.2	28.5	31	Jungle. Light breeze. Chirping birds
397341	247428	54.5	37.7	28.5	34	Jungle. Rustling leaves. Chirping birds
406437	234105	50.6	45	43.5	44.5	Jungle. Chirping birds
373801	261436	64.6	51.2	32.0	35.0	Hippo activity in river.
374115	261003	67.1	52.5	25.5	28.0	Hippo activity in river.
373547	247376	57.9	42.7	37.5	39.0	Rustling leaves. Chirping birds
380770	253593	73.7	52	38	41.5	Jungle. Rustling leaves. Chirping birds
374102	260038	62.0	38.3	30.0	33.5	Jungle. Light breeze. Chirping birds
379481	257990	57.2	39.1	27.5	32	Jungle. Chirping birds. Rustling leaves.
387796	267080	90.8	66.1	54.6	55.7	Ayago bridge. Highway traffic. Chirping birds.
413380	239638	92.7	71	54.5	57	Diima. Highway traffic. Playing children.
411200	233734	89.4	70.9	41	52.5	Highway traffic. Chirping birds

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (January 2013)

Table 31: Noise survey results as of June 2013

East	North	L_{AMax}	L_{Aeq}	L_{A90}	L_{A50}	Notes
383787	260827	58.7	39.1	33.5	36.0	Chirping birds & crickets
376329	265297	68.9	38.5	30.5	32.5	Rustling leaves. Chirping birds
379308	265336	58.5	37.7	30.0	32.5	Rustling leaves. Chirping birds
380191	262082	58.9	46.3	44.0	45.0	Chirping birds & crickets
382432	260925	57.7	40.4	32.2	34.0	Rustling leaves. Chirping birds
380897	265168	66.6	45.0	33.5	37.0	Rustling leaves. Chirping birds. Aircraft overhead.
371848	262629	65.7	37.9	30.5	32.5	Chirping birds
368690	273287	61.2	39.5	31.5	34.0	Rustling leaves. Chirping birds. Human conversation.
370259	263262	65.1	60.9	60.0	61.0	Rustling leaves. Chirping birds
390168	245389	72.0	39.8	29.0	32.0	Rustling leaves. Chirping birds
397341	247428	58.7	39.1	33.5	36.0	Chirping birds
406437	234105	63.5	44.7	39.5	44.5	Chirping birds
373801	261436	58.2	42.6	37.0	39.0	Chirping birds
374115	261003	56.9	41.2	35.0	37.5	Chirping birds. Hippo activity.
373547	247376	69.8	53.1	50.5	52.5	Roaring river. Chirping birds. Hippo activity.
380770	253593	64.8	39.4	30.5	33.0	Chirping birds

East	North	L_{AMax}	L_{Aeq}	L_{A90}	L_{A50}	Notes
374102	260038	64.7	45.9	39.5	44.0	Rustling leaves. Chirping birds
379481	257990	55.5	34.9	30.5	32.5	Chirping birds
387796	267080	88.7	67.3	38.0	45.5	Highway traffic. Chirping birds
413380	239638	82.1	60.5	46.0	49.5	Highway traffic. Chirping birds. School children chatter.
411200	233734	77.9	54.1	43.5	49.0	Highway traffic. Chirping birds. Human conversation.

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (June 2013)

Table 32: Vibration survey Results as of November 2012

Latitude & Longitude		Seismic readings				Microphone (air readings)	Notes
		Signal	Axis			SPL (dB)	
East	North		R	T	V		
374105	260560	Peak (mm/s)	0.3	0.1	0.3	88.0	26.11.2012
		Frequency (Hz)	3.7	0.0	11.0	0.0	
381396	259194	Peak (mm/s)	0.3	0.3	0.3	108.8	26.11.2012. Approximately 180 meters from active drilling rig
		Frequency (Hz)	0.2	0.0	0.0	113	
381256	259100	Peak (mm/s)	0.3	0.4	0.3	108.0	26.11.2012. Approximately 7 meters from active drilling rig
		Frequency (Hz)	12.0	0.0	0.2	53.9	
374118	261011	Peak (mm/s)	0.3	0.3	0.4	88.0	25.11.2012
		Frequency (Hz)	0.0	0.0	0.0	1024	
373798	261402	Peak (mm/s)	0.3	0.3	0.1	97.5	25.11.2012 Hippopotamus activity in river
		Frequency (Hz)	0.0	0.0	0.0	0.0	
377822	261309	Peak (mm/s)	0.3	0.3	0.3	94.0	25.11.2012
		Frequency (Hz)	0.0	0.0	0.0	0.0	
376223	259450	Peak (mm/s)	0.4	0.1	0.3	88.0	26.11.2012
		Frequency (Hz)	4.3	0.1	4.6	0.0	

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (November 2012)

Table 33: Vibration Analysis as of January 2013

Latitude & Longitude		Seismic readings				Microphone (air readings)	Notes
		Signal	Axis			SPL (dB)	
East	North		R	T	V		
374105	260560	Peak (mm/s)	0.3	0.1	0.3	91.5	25.01.13. Hippo activity in river
		Frequency	6.7	0.2	0.0	37.9	

Latitude & Longitude		Seismic readings				Microphone (air readings)	Notes
		Signal	Axis			SPL (dB)	
East	North		R	T	V		
		(Hz)					
381396	259194	Peak (mm/s)	0.4	0.4	0.4	98.8	25.01.13. Rushing water 100m away in middle of river
		Frequency (Hz)	0.0	0.0	0.0	0.0	
374118	261011	Peak (mm/s)	0.3	0.3	0.4	98.3	24.01.13 Hippo activity in river
		Frequency (Hz)	0.0	0.0	0.1	0.0	
373798	261402	Peak (mm/s)	0.4	0.3	0.3	95.9	24.01.13 Hippo activity in river
		Frequency (Hz)	0.0	0.0	0.0	0.0	
377822	261309	Peak (mm/s)	0.4	0.3	0.4	91.5	24.01.13
		Frequency (Hz)	0.0	0.0	0.0	0.0	
376223	259450	Peak (mm/s)	0.3	0.1	0.3	93.7	25.01.13
		Frequency (Hz)	0.0	0.0	0.1	0.0	
411200	233734	Peak (mm/s)	0.3	0.1	0.3	103.5	24.01.13. Highway traffic
		Frequency (Hz)	0.1	0.0	4.9	68.3	
387776	267101	Peak (mm/s)	0.3	0.9	0.3	98.8	24.01.13. Highway traffic
		Frequency (Hz)	0.2	113	0.0	20.9	

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (January 2013)

Table 34: Vibration Analysis results recorded in June 2013

Latitude & Longitude		Seismic readings				Microphone (air readings)	Notes
		Signal	Axis			SPL (dB)	
East	North		R	T	V		
374105	260560	Peak (mm/s)	0.4	0.3	0.3	94.0	26.06.13
		Frequency (Hz)	0.0	0.0	0.1	0.4	
381396	259194	Peak (mm/s)	0.3	0.1	0.3	88.0	26.06.13
		Frequency (Hz)	3.7	0.9	4.3	1024	
381256	259100	Peak (mm/s)	0.5	0.6	0.3	102.8	26.06.13
		Frequency (Hz)	113	113	0.1	48.8	
374118	261011	Peak (mm/s)	0.3	0.3	0.1	88.0	24.06.13
		Frequency (Hz)	0.1	0.0	0.0	0.0	
373798	261402	Peak (mm/s)	0.3	0.3	0.3	88.0	24.06.13 Hippo activity in river
		Frequency (Hz)	0.1	0.0	0.1	0.0	
377822	261309	Peak (mm/s)	0.4	0.5	0.3	91.5	26.06.13 Highway.
		Frequency (Hz)	0.0	0.1	0.1	0.0	
376223	259450	Peak (mm/s)	0.3	0.8	0.3	88.0	26.06.13

		Frequency (Hz)	0.2	41.0	0.1	0.0	

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant (January 2013)

All results presented in the tables have been adapted from the baseline survey of the environment in the Ayago project area and neighbouring surroundings.

5.2.3 Water Quality

The baseline aimed to capture the existing water quality in the river before the commencement of project activities.

Results

The water quality sampling points are shown in Figure 14. The developed 3D-terrain model for the project area indicates that the areas within a two kilometer buffer on both sides along River Nile are drainage catchments to the Nile. This drainage area provides a pathway for any water contaminants from project development activities to both upstream and downsteam of the weir.

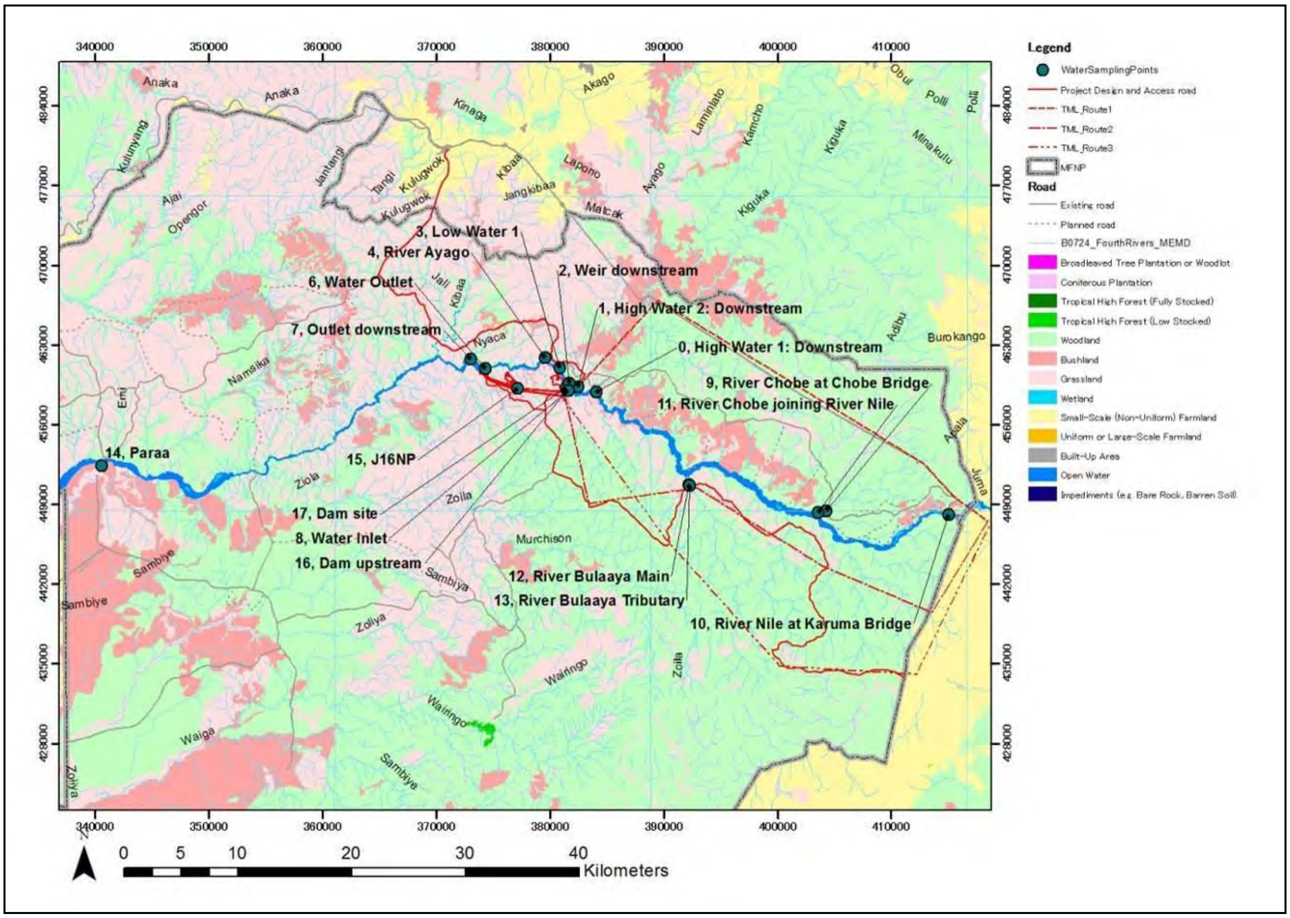


Figure 14: Water Quality Sampling Points

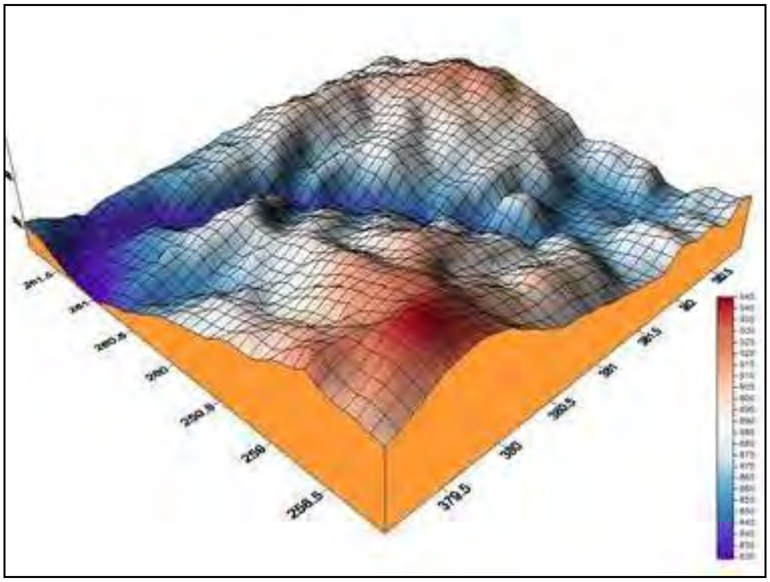


Figure 15: Ayago 3D Terrain Model

Topography defines watersheds which are fundamentally the most basic hydrologic landscape elements. The catchment areas delineated for the area around Ayago HPP are presented in Figure 16. From the figure, watersheds 43, 47 and 48 directly contribute runoff to the area where water will be ponded by the weir during operation.

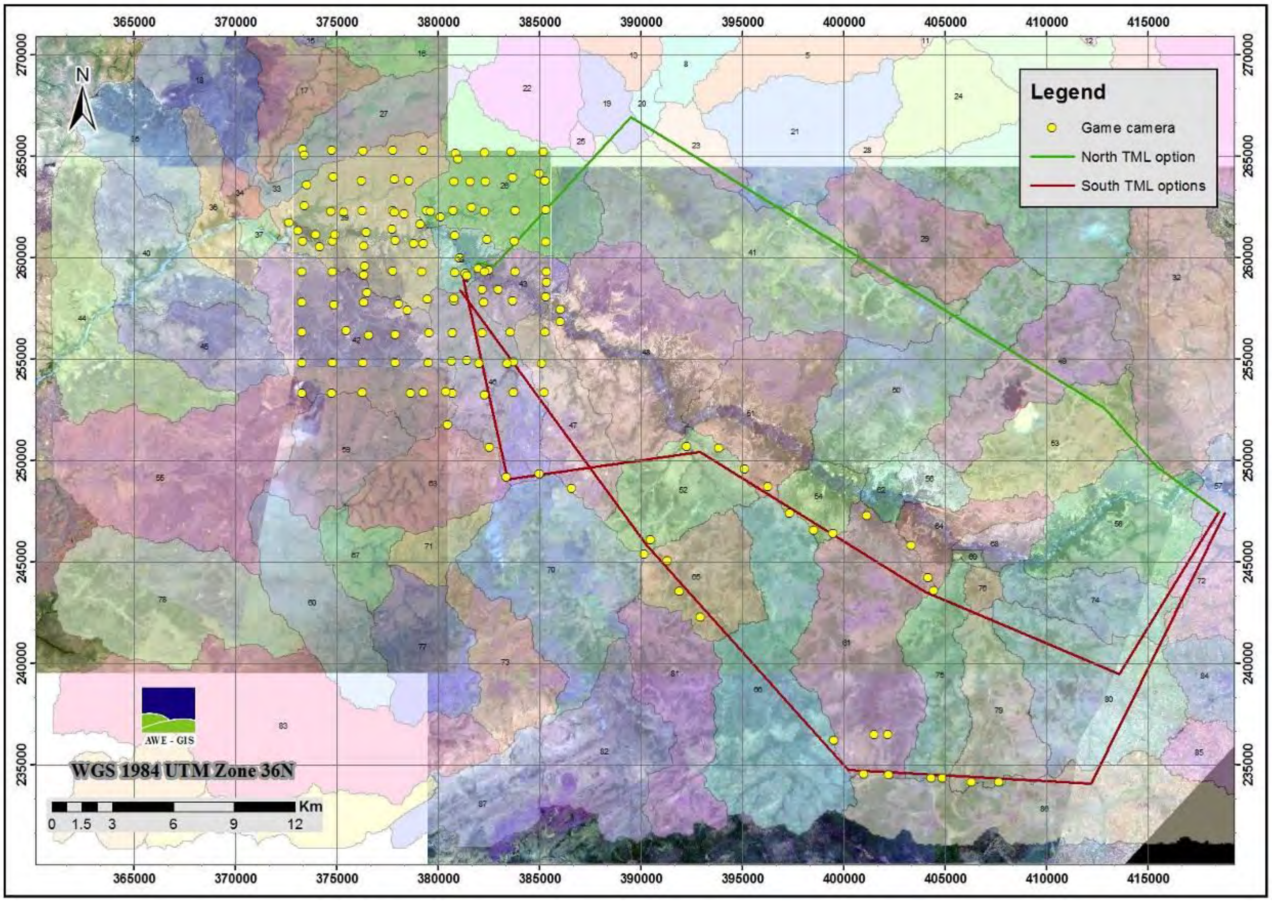


Figure 15: Watershed boundaries within Ayago Hydropower plant area

Table 36 provides the results of the on-site water quality measurements and the laboratory analyses for water samples are presented in Table 37. On-site water quality measurements indicated good baseline river water quality. Minimum measured Dissolved Oxygen (DO) along the Nile was 2.59 ppm which is above the 2.00 ppm DO level that stresses most species of fish. The location with the least DO measurement along the Nile was downstream of the tunnel outlet where water velocity is reduced by river width widening and smaller hydraulic gradient. The enhanced microbial respiration due to organic matter from the vegetation around the point contributes to the low DO values. Low DO levels were also observed at the sampling stations in River Bulaaya and the tributary. The range of pH measured was 6.51 – 7.91 which indicates a good environment for aquatic organisms expected in the area. The results indicated that River Chobe is seasonal and completely dry during January through August 2013 at Chobe Bridge sampling station.

Table 35: Water Quality from Onsite Measurement

Month	Time	DO (ppm)	% DO	Temperature (∘C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Oct	09:40am	5.16	68.04	27.11	7.91	47.1	357	371	0.2	888.1	0.17	178	0.0028

Month	Time	DO (ppm)	% DO	Temperature (◦C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Oct	11:50am	4.77	67.1	27.28	7.38	15.8	203	295	63.7	888.3	0.13	141	0.0035
Oct	12:45pm	7.12	102.1	27.03	7.86	43.9	118	123	13.7	888.2	0.05	59	0.0085
Nov	09:15am	4.72	67.3	28.1	6.86	5.6	121	128	90.1	922.8	0.06	61	0.0083
Dec	09:50am	5.34	74.5	27.44	6.86	-0.3	127	133	33.4	923	0.06	64	0.0079
Jan	10:35am	2.72	38.1	27.85	6.86	-0.2	121	127	90.3	926.1	0.06	60	0.0083
Feb	09:03am	6.86	94.3	26.37	6.86	-0.3	111	114	96.5	918.5	0.05	56	0.009
Mar	08:30am	6.88	95.2	26.89	6.86	-0.5	92	95	31.1	920.4	0.04	46	0.0709
Apr	09:25am	5.88	81.9	27.25	6.86	-0.1	86	90	38.3	921.1	0.04	43	0.0116
May	08:23am	3.49	48.3	27.02	6.86	-0.2	87	90	39.7	922	0.04	43	0.0116
Jun	10:05am	6.12	82	25.29	6.89	8.2	89	90	81.3	923.9	0.04	45	0.0112
Jul	08:50am	6.01	80.5	25.66	6.9	4.9	96	97	-7.5	923.6	0.04	48	0.0105
Aug	09:00am	5.56	75.1	26.22	6.89	2.8	74	75	-26	921.6	0.03	37	0.0135
Sep	09:04am	6.19	82.1	26.61	6.87	4.7	83	85	-31.7	913.7	0.04	41	0.0123
Nov	10:30am	5.47	77.4	28.32	6.86	5.6	121	129	65	924.4	0.06	61	0.0082
Dec	11:40am	5.57	78.5	27.98	6.86	-0.2	139	147	16.5	921.9	0.06	69	0.0072
Jan	11:50am	3.23	45.3	27.91	6.86	-0.1	126	133	-4.4	924.5	0.06	63	0.0079
Feb	09:40am	6.92	95.3	26.56	6.86	-0.3	114	117	82.1	920.3	0.05	57	0.0088
Mar	9:20am	7.34	101.9	27.12	6.87	-0.9	92	96	-54.8	921.6	-0.04	46	0.0108
Apr	10:30am	5.75	80.2	27.43	6.87	-0.5	86	90	-27.8	922.3	0.04	43	0.0116
May	09:20am	3.74	52.2	27.46	6.87	-0.5	88	92	-35.9	923	0.04	44	0.0114
Jun	11:10am	5.17	69.3	25.39	6.91	7.1	93	94	-56.9	924.4	0.04	47	0.0107
Jul	09:40am	6.42	72.7	25.59	6.93	3.2	94	95	-15.2	924.5	0.04	47	0.0107
Aug	09:50am	5.25	71.8	26.29	6.91	2.5	89	91	-71.5	922.5	0.04	44	0.0114
Sep	9:52am	5.85	85.2	26.56	6.87	4	112	116	-34.4	913.8	0.04	56	0.0054
Nov	11:31am	5.86	82.8	28.28	6.86	5.5	125	133	63.7	925.9	0.06	62	0.008
Dec	10:50am	4.97	69.4	27.57	6.86	-0.3	137	144	3.1	923.1	0.06	68	0.0073
Jan	11:05am	2.82	39.3	27.58	6.86	-0.1	122	128	58.7	927.2	0.06	61	0.0082
Feb	10:15am	7.66	105.3	26.65	6.87	-0.4	114	117	25	922	0.005	57	0.0088
Mar	9:55am	7.61	105.5	27.12	6.87	-0.8	92	96	-28.7	922.8	0.04	46	0.0108
Apr	11.10am	6.21	87	27.63	6.87	-0.6	86	90	-37.6	922.5	0.04	43	0.0116
May	10:00am	4.02	56.1	27.47	6.88	-1.2	90	94	-38.6	923.9	0.04	45	0.0112
Jun	12.05pm	5.15	69.2	25.46	6.93	6	91	92	-35	924.4	0.04	46	0.0109
Jul	10:30am	5.58	75.5	25.79	6.94	2.9	95	97	-8.6	924.9	0.04	48	0.0106
Aug	10:32am	5.33	72	26.43	6.91	1.5	91	93	-73.5	923.6	0.04	45	0.0114
Sep	10:37am	6.25	89.2	26.79	6.88	3.9	111	115	-31.1	914.6	0.05	55	0.0019
Oct	10:40am	6.78	96.7	27.23	7.84	42.5	120	125	6.9	888.2	0.05	60	0.0084
Nov	01:00pm	5.44	77.7	29.08	6.86	5.4	122	131	48.7	927.9	0.06	61	0.0082
Dec	12:35pm	6.52	91.8	28.06	6.86	-0.2	132	140	12.3	924	0.06	66	0.0076
Jan	12.39pm	3.73	52.6	28.28	6.86	-0.2	125	133	37.3	924.9	0.06	62	0.008

Month	Time	DO (ppm)	% DO	Temperature (◦C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Feb	11:00am	6.84	94.3	26.78	6.87	-0.4	114	118	41.9	922.5	0.05	57	0.0088
Mar	10:40am	7.28	102.4	27.99	6.86	-0.6	95	101	-36.1	923.3	0.04	48	0.0105
Apr	12:15pm	6.97	98.4	28.12	6.88	-1	85	90	-70.8	922.5	0.04	42	0.0118
May	10:50am	4.1	57.4	27.77	6.87	-0.6	89	93	-18.2	924.7	0.04	44	0.0113
Jun	01:15pm	4.98	67.6	26.07	6.92	6.7	94	96	-54.4	924.7	0.04	47	0.0106
Jul	11:15am	5.21	70.8	26.19	6.93	2.8	93	96	-16.3	927.4	0.04	47	0.0107
Aug	11:18am	4.74	65.2	31.2	6.9	2	76	78	-82.9	925.7	0.03	38	0.0132
Sep	11:30am	6.7	98.6	27.52	6.9	3.2	90	94	-30.3	912.6	0.04	44	0.0113
Nov	01:30pm	6.52	92.2	28.62	6.87	5.3	154	165	42.1	928.2	0.07	77	0.0068
Dec	01:10pm	5.53	79	28.87	6.86	-0.1	151	162	28	924.8	0.07	76	0.0066
Jan	01:12pm	3.5	50.1	29.23	6.87	-0.2	131	142	69.3	928.5	0.06	68	0.0076
Feb	01:25pm	6.06	86.6	28.92	6.86	-0.2	140	150	16.7	924.1	0.06	70	0.0072
Mar	11:25pm	7.16	100.8	28.05	6.87	-0.4	111	117	20.9	925.1	0.05	55	0.009
Apr	12:35pm	6.79	88.8	24.26	6.87	-0.6	100	99	26.2	928.1	0.05	50	0.01
May	11:20am	3.82	54	33.96	6.87	-1	123	131	-13.3	926.4	0.06	62	0.0081
Jun	1.45pm	4.09	57.1	27.83	6.92	6.2	147	154	-24	927.8	0.07	73	0.0068
Jul	12.45pm	6.03	80.2	24.58	6.86	7.8	108	107	27	925.6	0.05	54	0.0093
Aug	12:55pm	6.15	78.8	23.03	6.92	2.6	110	106	-64.9	926.6	0.05	53	0.0091
Sep	1:15pm	6.73	87.6	23.59	6.9	2.7	92	89	-29.7	916	0.04	46	0.0109
Oct	09:12am	4.33	56.3	27.27	7.76	38.3	125	131	52.9	888.3	0.06	63	0.008
Nov	12:00pm	2.59	37.3	29.1	6.51	30.2	119	128	146.9	936.7	0.05	59	0.0084
Dec	11:50am	7.4	102	27.54	6.86	-0.2	124	130	23.2	930.3	0.06	62	0.0081
Jan	12.45pm	8.29	117.3	28.85	6.85	0.3	115	123	104	932.2	0.05	57	0.0087
Feb	11:45am	6.59	90.3	27.01	6.86	-0.2	118	122	22.4	931.2	0.05	59	0.0085
Mar	09:55am	7.67	106	27.37	6.86	-0.2	94	98	19.2	930.4	0.04	47	0.0106
Apr	11:00am	5.72	80.2	28.18	6.86	-0.4	89	94	13.1	932.2	0.04	44	0.0121
May	11:00am	6.13	85.2	27.89	6.86	-0.9	104	110	10.6	931.3	0.005	52	0.0097
Jun	11:50am	5.96	79.8	25.85	6.85	6	131	133	64.4	932.9	0.06	65	0.0076
Jul	10:45am	6.61	88.2	25.69	6.88	6.7	89	90	-21	931.3	0.04	44	0.0112
Aug	11:15am	5.57	75	26	6.9	3.8	82	83	-46.1	932.9	0.04	41	0.0122
Sep	11:27am	6.8	93.1	26.72	6.88	4.2	112	115	-89.3	932.4	0.05	56	0.009
Nov	1:43pm	3.12	45.1	29.84	6.51	25	117	128	61	932.5	0.05	59	0.0086
Dec	10:45am	8.4	116.7	27.73	6.86	-0.1	122	129	47.8	930.4	0.06	61	0.0082
Jan	11:30am	8.1	113.4	28.27	6.85	-0.4	113	120	84.8	932.7	0.05	56	0.0089
Feb	10:45am	7.62	104	26.77	6.86	-0.2	114	118	46.5	931	0.05	57	0.0087
Mar	09:10am	6.51	89.6	27.19	6.87	-0.4	96	100	104.9	930	0.04	48	0.0104
Apr	10:09am	5.45	75.6	27.87	6.86	-0.4	87	91	38.12	931.8	0.04	43	0.0116
May	10:00am	6.5	90.5	27.9	6.85	-0.6	94	99	32.6	932	0.04	47	0.0106
Jun	10:45am	7.53	100.7	25.8	6.87	5.1	92	94	5	933.3	0.04	46	0.0109

Month	Time	DO (ppm)	% DO	Temperature (◦C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Jul	09:45am	7.63	101.9	25.55	6.87	7.4	90	91	44.2	930.7	0.04	45	0.0111
Aug	10:00am	6.2	83.8	26.07	6.88	4.7	81	83	-32.2	932.9	0.04	40	0.0124
Sep	10:17am	6.73	64.4	26.58	6.87	3.9	92	95	-53.3	932.4	0.04	46	0.0108
Oct	11:20am	4.08	58.3	27.46	7.74	37.1	129	135	59	888.4	0.06	64	0.0078
Nov	11:52am	5.98	83.2	27.36	6.86	4	125	130	21.6	923.6	0.06	62	0.008
Dec	12:30pm	6.6	92.3	27.58	6.86	-0.2	124	130	-9.9	922.2	0.06	62	0.0081
Jan	10:45am	6.27	87.1	27.19	6.86	-0.2	114	119	54.7	923	0.05	57	0.0088
Feb	11:05am	6.75	92.2	26.18	6.86	-0.4	112	115	40.8	921.3	0.05	56	0.0089
Mar	09:50am	6.59	91.3	27.12	6.86	-0.3	94	98	10.7	923	0.04	47	0.0107
Apr	09:25am	6.1	85.4	27.69	6.86	-0.2	89	94	-49.1	922.6	0.04	44	0.0112
May	10:05am	6.42	90.3	27.93	6.85	-0.6	93	98	-65.7	923.6	0.04	47	0.0107
Jun	12:20pm	5.75	79	26.54	6.86	2.6	99	102	-59	922.1	0.05	50	0.0101
Jul	09:50am	5.84	80.4	25.36	6.92	2.7	92	93	-32.9	922.9	0.04	46	0.0109
Aug	11:45am	5.91	78.7	26.22	6.89	2	76	78	-77.9	924.4	0.03	38	0.0132
Sep	12:00pm	6.69	92.8	26.65	6.88	2.7	145	159	-39.9	919.7	0.05	52	0.0099
Nov	05:05pm	4.84	58.7	25.76	6.65	16.7	160	163	13.6	912.5	0.07	80	0.0062
Dec	02:10pm	13.54	188.1	26.5	6.85	0.1	115	118	5.3	913	0.05	57	0.0086
Jan	Seasonal River Completely Dry in January												
Feb	Seasonal River Completely Dry in February												
Mar	Seasonal River Completely Dry in March												
Apr	Seasonal River Completely Dry in April												
May	Seasonal River Completely Dry in May												
Jun	Seasonal River Completely Dry in June												
Jul	Seasonal River completely Dry in July												
Aug	Seasonal River completely Dry in August												
Sep	Seasonal River completely Dry in September												
Nov	05:38pm	2.81	39.7	27.94	6.68	14.6	119	126	23.1	906	0.05	59	0.0084
Dec	03:02pm	6.24	89	27.6	6.86	-0.1	125	131	46.5	905.2	0.06	62	0.008
Jan	03:10pm	3.46	49.6	28.07	6.87	-0.4	130	138	-7.2	908.1	0.006	65	0.0077
Feb	02:50pm	5.78	81.1	26.82	6.86	-0.2	119	123	55.3	907.8	0.05	59	0.0084
Mar	12:35pm	6.56	92.9	27.46	6.87	-0.5	95	99	-0.4	908.7	0.04	47	0.0106
Apr	01:55pm	6.68	95.3	27.84	6.88	-1.4	87	92	-42	909.2	0.04	44	0.0115
May	12:30pm	4.51	64.1	27.66	6.87	-1	87	91	-10.5	910.8	0.04	43	0.0115
Jun	05:49pm	5.76	79.9	26.12	6.84	6.2	107	109	-60.9	906.1	0.05	53	0.0094
Jul	02:10pm	6.54	89.9	24.59	6.9	5.5	89	90	-10.6	909	0.04	45	0.0112
Aug	02:20pm	4.65	64.7	26.25	6.93	2	120	123	-69.5	909.3	0.05	60	0.0086
Sep	3:43pm	5.83	82.6	26.95	6.89	3.8	98	102	-99.8	908.2	0.04	49	0.0102
Nov	03:10pm	4.99	71	27.94	6.87	5.3	126	133	77.7	912.9	0.06	63	0.0079
Dec	02:50pm	6.52	95.2	29.4	6.86	0	133	145	28.3	912.6	0.06	67	0.0075

Month	Time	DO (ppm)	% DO	Temperature (◦C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Jan	03:45pm	6.75	102.2	31.52	6.85	0	115	130	27.4	913.6	0.05	58	0.0087
Feb	12:20pm	7.52	108.4	28.63	6.87	-0.4	114	122	20.4	912.5	0.05	57	0.0087
Mar	12:00pm	4.22	62.6	30.34	6.86	-0.3	105	115	28.7	913.6	0.05	52	0.0095
Apr	02:00pm	5.51	82.7	31.04	6.87	-1	89	99	-22.4	914.8	0.04	44	0.0113
May	12:45pm	4.85	71.3	29.91	6.8	-1.6	102	112	7.2	913.3	0.05	51	0.0098
Jun	03:45pm	5.17	80.8	26.84	6.92	6.7	92	95	-34.6	915.5	0.04	46	0.0109
Jul	12:25pm	5.85	82.4	26.94	6.93	3	98	101	-8.8	916.9	0.04	49	0.0102
Aug	12:40pm	5.11	72.1	28.11	6.91	1.5	97	102	-61.8	915.4	0.04	48	0.0103
Sep	2:40pm	6.32	92.1	27.8	6.89	3.7	86	91	-85.9	913.6	0.04	43	0.0116
Nov	09:30am	4.52	56.8	21.54	6.86	4	262	245	40.4	917.4	0.12	131	0.0038
Dec	11:20am	5.5	69.7	21.86	6.86	-0.4	160	150	102.9	914.3	0.07	80	0.0063
Jan	9:25am	3.87	50.2	23.17	6.86	-0.4	333	321	87.6	916.8	0.16	166	0.003
Feb	10:45am	0.7	8.7	20.92	6.86	-0.5	332	306	88.3	915.3	0.16	166	0.003
Mar	08:35am	2.19	28.2	22.64	6.86	-0.4	185	177	75.4	916	0.09	92	0.0054
Apr	08:20am	3.37	43.5	22.78	6.86	-0.1	148	141	27.1	915.6	0.07	74	0.0068
May	08:45am	4.18	53.8	22.71	6.85	-0.9	192	184	-35.8	916.7	0.09	96	0.0052
Jun	10:35am	4.55	57.3	21.55	6.85	2.9	240	225	-55.5	917	0.11	120	0.0042
Jul	09:00am	4.65	57.3	20.33	6.89	4.8	161	147	74.1	916.2	0.08	81	0.0062
Aug	10:20am	3.87	49	21.75	6.86	3.6	203	189	-39.6	916.6	0.1	103	0.0049
Sep	10:45am	4.28	54.8	22.29	6.9	2.7	176	167	-49.7	916	0.08	88	0.0057
Nov	10:53am	6.83	85.2	21.2	6.85	4.3	260	250	53	917.3	0.13	135	0.0037
Dec	11:30am	4.94	61.6	21.01	6.86	-0.3	222	205	-11.6	914.5	0.11	111	0.0045
Jan	9:35am	0.1	1.2	21.18	6.86	-0.5	389	361	-111.9	916.2	0.19	194	0.0026
Feb	10:55am	0.15	1.8	19.49	6.86	-0.5	521	466	-135.1	915.7	0.25	260	0.0019
Mar	08:45am	4.26	54.6	22.46	6.86	-0.4	184	175	69.1	916.2	0.09	92	0.005
Apr	08:30am	2.85	36.3	22.16	6.86	-0.1	195	184	62.5	916	0.09	97	0.0051
May	09:00am	4.6	58.5	22.12	6.85	-0.9	215	203	-6.3	916	0.1	107	0.0047
Jun	10:50am	4.91	61.4	20.91	6.85	3	215	198	-12.4	916.7	0.1	108	0.0047
Jul	09:15am	3.92	47.7	19.58	6.91	3.6	207	185	-17.1	915.8	0.1	103	0.0048
Aug	10:40am	3.62	44.8	20.97	6.87	3.1	220	203	-66.8	916.7	0.1	110	0.0046
Sep	10:52am	4.8	59.7	21.83	6.88	2.8	270	253	-32.4	906.8	0.13	135	0.0034
Nov	03:20pm	6.03	83.8	28.78	6.86	3.7	123	132	17	947.3	0.06	61	0.0082
Dec	02:47pm	7.18	101.2	29.27	6.86	-0.2	118	128	-2.1	942.9	0.05	59	0.0085
Jan	12:50pm	6.84	93.5	27.82	6.86	-0.1	110	116	90.6	946.4	0.05	55	0.0091
Feb	01:30pm	7.12	98.2	28.12	6.86	-0.2	209	222	32.7	943.8	0.1	105	0.0048
Mar	12:10pm	8.08	112.2	28.74	6.86	-0.4	95	102	-11	947.3	0.04	47	0.0105
Apr	11:25am	7.26	102	29.43	6.87	-0.6	86	93	-49.5	947.2	0.04	43	0.0117
May	11:50am	5.68	79.8	29.46	6.86	-1.3	103	112	-67	947.3	0.05	52	0.0097
Jun	3:30pm	6.06	83.9	28.4	6.86	2.8	95	101	-31.7	944.1	0.04	48	0.0105

Month	Time	DO (ppm)	% DO	Temperature (◦C)	pH	pHmV	EC (µS/cm)	Eca (µS/cm-)	ORP	Pressure (mbar)	Sal	TDS (ppt)	Resistivity (MΩcm)
Jul	11:35am	6.26	83.7	26.9	6.92	2.7	100	104	-6.1	948.6	0.05	50	0.01
Aug	02:00pm	6.06	83.6	28.18	6.89	2.2	93	94	-79.6	946	0.04	42	0.012
Sep	2:30pm	6.71	90.5	28.99	6.9	1.5	97	104	-89.9	933.6	0.04	48	0.0095

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant

Table 36: Water Quality Results from Laboratory Analysis

No	Month	Electrical Conductivity (EC) (µS/cm)	pH	Turbidity (NTU)	Total Suspended Solids (mg/L)	Hardness: total $CaCO_3$ (mg/L)	Calcium: Ca^{++} (mg/L)	Magnesium: Mg^{++} (mg/L)	Total Iron (mg/L)	Colour: apparent (PtCo)	Nitrate- N (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride: Cl^- (mg/L)	Flouride: F^- (mg/L)	Sulphate (mg/L)	Alkalinity: Total as $CaCO_3$ (mg/L)	Orthophosphate: Reactive (mg/L)	Total Phosphorus (TP) (mg/L)	E-coli (CFU/100mL)	Faecal Coliforms (CFU/100mL)	Chl-a (µg/L)
National Standards for portable water		1000	6.5-8.5	10	0	500	75	50	1	15	5	700	500	1.5	200	500	5	1	0	0	
J32	Oct	132	7.48	53.4	65	112	11.2	20.16	0.806	384	0.26	84	0.12	0.02	8	68	0.27	0.6	160	230	
2	Oct	239	8.01	14.4	15	188	20.8	32.64	0.221	86	0.08	153	0.24	0.13	2	132	0.41	0.98	60	100	
3	Oct	241	7.69	12.9	20	132	17.6	21.12	0.412	130	0.32	154	0.2	0.09	2	124	0.493	1.24	70	150	
C01	Oct	123	7.48	9.37	16	88	4.8	18.24	0.337	123	0.02	79	0.05	0.1	2	52	0.066	0.25	20	100	
0	Nov	24.9	7.46	3.9	16	56	12	6.2	0.21	1.1	0.03	0	0.86	0.65	-	3.5	31	< 1.0	730	20	44
	Dec	23.9	7.6	6.1	14	59.5	28	8.2	0.3	1.95	0.04	0	0.5	0.55	-	0.2	34	< 1.0	110	20	22
	Jan	24	7.42	4.8	7	48	8	6.7	0.39	0.18	0	0	0.4	0.94	-	1.6	36	< 1.0	100	18	26
	Feb	23.4	7.7	4.62	19	68	16	6.7	0.381	1.22	0.03	0	0.2	0.52	-	1.5	37	<1.0	420	60	19
	Mar	23.4	7.03	3.8	12.8	40	8	4.8	0.037	0.13	0.02	0.01	0.86	0.43	2	8.9	42	<1.0	400	48	20
	Apr	23.9	7.12	3.4	12.8	48	12.4	9.6	0.15	0.35	0.01	0	1	0.4	3	8.9	54	<1.0	520	90	23
	May	24	7.16	4.62	16	80	19.2	7.7	0.344	0.2	0	0	1	0.34	3	3.4	36	<1.0	673	108	17
	Jun	23.9	7.34	8.3	16	68	12.8	8.6	0.219	0.09	0.02	0	0	0.17	0	5.4	49.2	<1.0	421.9	52	49
	Jul	24.1	7.33	4.62	18	24	12.4	6.82	0.14	1.23	0.03	0	0.2	0.36	2	5.5	50	<1.0	421.9	52	49
	Aug	24.3	7.47	9.36	17	44	8	5.76	0.45	0.08	0.02	0.01	0.9	0	1	4.3	41	<1.0	770	50	41
	Sep	22.3	7.17	4.5	8	52	6.4	8.6	0.639	0.09	0.03	0.01	1	0.12	2	5.4	45	<1.0	416	45	43
1	Nov	25	7.54	3	14	60	16	4.8	0.18	1.65	0.03	0	1.5	0.39	-	3	34	< 1.0	1020	40	30
	Dec	24	7.6	8.8	21	80	20	7.2	0.02	1.85	0.04	0	1	0.49	-	0.1	32	<	800	140	18

No	Month	Electrical Conductivity (EC) (µS/cm)	pH	Turbidity (NTU)	Total Suspended Solids (mg/L)	Hardness: total $CaCO_3$ (mg/L)	Calcium: Ca^{++} (mg/L)	Magnesium: Mg^{++} (mg/L)	Total Iron (mg/L)	Colour: apparent (PtCo)	Nitrate- N (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride: Cl^- (mg/L)	Flouride: F^- (mg/L)	Sulphate (mg/L)	Alkalinity: Total as $CaCO_3$ (mg/L)	Orthophosphate: Reactive (mg/L)	Total Phosphorus (TP) (mg/L)	E-coli (CFU/100mL)	Faecal Coliforms (CFU/100mL)	Chl-a (µg/L)
																		1.0			
	Jan	23.7	7.51	6.7	6	44	9.6	4.8	0.329	0.19	0	0	0.3	0.92	-	2	36.8	< 1.0	400	48	33
	Feb	23.2	7.7	5.5	17	74	16.8	7.7	0.391	1.11	0.03	0	0.1	0.59	-	1.9	37	<1.0	380	68	20
	Mar	23.7	7.04	3.5	5	48	9.6	5.8	0.035	0.1	0.02	0.01	2.4	0.42	2	6.64	55	<1.0	382	55	19
	Apr	24	7.25	3.3	4	60.6	4.8	7.53	0.18	0.23	0.04	0	1	0.46	3	6.64	47	<1.0	520	60	23
	May	24.3	7.27	0.3	14	40	6.4	3.8	0.286	0.25	0	0	1	0.38	3	4.1	36.8	<1.0	744	100	20
	Jun	24.1	7.43	7.1	13	72	11.2	10.6	0.103	0.06	0.01	0	0.5	0.09	0	4.6	46.8	<1.0	606.6	91.4	51
	Jul	24	7.58	6.2	18	24	8	0.96	0.095	1.42	0.05	0.04	0.6	0.43	3	3.5	50	<1.0	606.6	91.4	48
	Aug	24.4	7.49	9.69	18	72	16	7.68	0.58	0.06	0.02	0.01	0.6	0	1	3.906	74.9	<1.0	384	53	29
	Sep	22.6	7.12	7.5	17	56	11.2	6.7	0.303	0.03	0.04	0.01	1	0	2	4.86	48.8	<1.0	532	145	33
2	Nov	24.7	7.58	0.2	12	60	16.8	4.3	0.2	1.75	0.03	0	1	0.56	-	3	28	< 1.0	660	370	36
	Dec	24.6	7.5	7.9	18	76	16	8.6	0.31	2.35	0.03	0	1	0.58	-	0.2	30	< 1.0	90	20	27
	Jan	24.1	4.7	8.7	9	40	11.2	2.9	0.339	0.63	0.01	0	0.6	1.13	-	2.7	20	< 1.0	340	57	36
	Feb	23.7	7.7	5.51	19	68	16	6.7	0.345	1.4	0.03	0	0.2	0.5	-	5	80	<1.0	460	106	25
	Mar	23.5	7.03	3.1	3	44	8	5.8	0.036	0.08	0.02	0.01	2	0.45	3	15.8	61	<1.0	412	60	23
	Apr	24.1	7.25	3.7	3	68	6.4	12.5	0.13	0.27	0.03	0	3	0.37	3	26	59	<1.0	670	300	33
	May	24.1	7.33	0.4	13	68	6.4	12.5	0.297	0.26	0	0	1	0.29	3	4.9	10	<1.0	863	120	27
	Jun	24.5	7.48	9.7	15	52	9.6	6.7	0.098	0.04	0.01	0	8.5	0.04	0	5.4	50.4	<1.0	499.3	214.8	40
	Jul	24.3	7.47	4.4	5	66.7	10.4	9.8	0.09	0.75	0.04	0.04	8.1	0.37	2	3.4	49	<1.0	499.3	120	44
	Aug	24.3	7.55	8.87	15	64	4.8	12.48	0.5	0.02	0.08	0.04	0.8	0	1	3.472	38.3	<1.0	328	410	33
	Sep	22.2	7.22	9.4	7	40	6.4	5.8	0.397	0.04	0.02	0	0.5	0.11	0	3.95	33.4	<1.0	480	130	30
3	Nov	24.5	7.61	3.4	16	72	20	5.3	0.25	1.65	0.03	0	1	0.46	-	3	33	<	480	30	29

No	Month	Electrical Conductivity (EC) (µS/cm)	pH	Turbidity (NTU)	Total Suspended Solids (mg/L)	Hardness: total $CaCO_3$ (mg/L)	Calcium: Ca^{++} (mg/L)	Magnesium: Mg^{++} (mg/L)	Total Iron (mg/L)	Colour: apparent (PtCo)	Nitrate- N (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride: Cl^- (mg/L)	Flouride: F^- (mg/L)	Sulphate (mg/L)	Alkalinity: Total as $CaCO_3$ (mg/L)	Orthophosphate: Reactive (mg/L)	Total Phosphorus (TP) (mg/L)	E-coli (CFU/100mL)	Faecal Coliforms (CFU/100mL)	Chl-a (µg/L)
																		1.0			
	Dec	24.9	7.7	8.8	16	68	16	6.7	0.34	2.25	0.03	0	1	0.4	-	0.9	27	< 1.0	442.3	10	33
	Jan	23.9	7.11	7.2	3	56	17.6	2.9	0.486	0.19	0	0	0.6	0.81	-	2.1	43.1	< 1.0	267	40	30
	Feb	23	7.7	10.3	17	80	16	9.6	0.265	6	0.03	0	0.1	0.52	-	2	41	<1.0	350	88	27
	Mar	23.8	7.06	4.1	5	56	14.4	4.8	0.033	0.09	0.03	0.01	8	0.47	1	5.5	64	<1.0	483	40	19
	Apr	24.5	7.23	3.3	2	40	4.8	6.7	0.18	0.26	0.02	0	4	0.42	2	5.5	90	<1.0	514	20	20
	May	24.2	7.25	0.3	10	40	9.6	3.8	0.319	0.17	0	0	1	0.44	3	3.8	43.1	<1.0	942	80	23
	Jun	23.8	7.49	9.5	16	64	9.6	9.6	0.093	0.04	0.01	0	6	0.16	1	4.7	49.8	<1.0	442.3	205	47
	Jul	24	7.62	4.5	9	54	8	8.2	0.175	1.38	0.04	0.03	4.9	0.52	3	3.3	60	<1.0	442.3	240	53
	Aug	24.2	7.44	8.54	17	92	6.4	18.24	0.63	0.03	0.02	0.01	0.4	0	1	3.286	52.4	<1.0	812	80	40
	Sep	23	7.32	9.6	8	40	8	4.8	0.325	0.06	0.02	0	1	0.1	3	4.25	55.8	<1.0	450	48	32
	Nov	24.5	7.8	5.9	13	64	16	5.8	0.29	1.9	0	0	1	0.52	-	1.1	26	< 1.0	530	10	26
	Dec	25	7.8	7.1	17	56	12	6.2	0.27	2	0.03	0	1.5	0.61	-	1.2	16	< 1.0	30	10	37
	Jan	23.9	7.37	10.8	15	56	20.8	7.48	0.469	0.13	0.02	0	0.5	0.56	-	3	17	< 1.0	200	53	27
	Feb	23.4	7.6	13.6	7	48	12.8	3.8	0.081	0	0	0	1	0.27	-	4.3	34	<1.0	266	32	17
4	Mar	23.5	7.27	31.5	22	68	19.2	4.8	0.347	0.08	0.11	0.09	1.5	0.53	4	13.5	31.4	<1.0	587	60	33
	Apr	24.4	7.51	57.8	16	48	9.6	5.8	1.065	0.67	0.07	0.02	1	0.39	5.2	7.6	47	<1.0	623	60	37
	May	24.4	7.35	3.9	10	56	8	8.6	0.629	0.22	0	0	1.2	0.42	3	4.4	14	<1.0	1210	131	26
	Jun	24	7.54	12.4	18	61.1	14.4	15.4	0.356	0	0.01	0	0.5	0.14	1	3.9	35.9	<1.0	492.3	50.8	55
	Jul	23.9	7.53	24.3	17.8	54	3.4	16	0.425	0.38	0.03	0.03	0.8	0.65	5.2	5	25	<1.0	492.3	50.8	41
	Aug	23.1	7.1	22.1	19	56	4.8	10.56	0.95	3	0	0	6	6	0	2.542	9	<1.0	2900	450	30

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	Sep	22.3	7.58	13.1	15	52	9.6	6.7	1.463	0.05	0.05	0.01	2	0.16	5	4.8	34.6	<1.0	450	101	18
6	Nov	24.7	7.74	3.8	13	92	20	10.1	0.21	1.9	0.04	0	0.5	0.48	-	2.4	27	< 1.0	980	40	23
	Dec	24	7.44	5.5	6	52	12	5.3	0.311	0.21	0.02	0	0.4	0.5	-	2.7	16	< 1.0	330	68	30
	Jan	24	7.6	5.04	4	56	8	8.6	0.386	0.2	0.01	0	0.3	0.69	-	2.2	18	, < 1.0	220	60	33
	Feb	23.3	7.5	11.8	18	52	11.2	5.8	0.296	0.27	0.03	0	0.2	0.48	-	2.2	40	<1.0	400	120	23
	Mar	23.7	7.44	15.5	16	44	12.8	2.9	0.265	0	0.04	0.02	2	0.42	3	8.5	51	<1.0	236	40	23
	Apr	23.5	7.29	8.4	10	50	12	4.8	0.655	0.79	0	0	1.5	0.15	5	7.2	40	<1.0	1320	86	30
	May	24.3	7.36	8	9	56	6.4	9.6	0.179	0.2	0.04	0.02	4	0	2	2.7	9	<1.0	716	100	18
	Jun	24.1	7.63	8.9	16	72	8	12.5	0.327	0.04	0.02	0	2	0.33	1	5	49.6	<1.0	600.3	149.3	59
	Jul	24.2	7.58	5	17	64	10.6	8	0.185	0.13	0.04	0.03	1.8	0.37	3	5.4	49	<1.0	600.3	680	40
	Aug	23.6	7.41	8.93	10	52	3.2	10.56	0	2.5	0	0	5	0.07	2	4.38	15.8	<1.0	360	60	35
	Sep	20.2	7.03	7.9	7	36	6.4	4.8	0.46	1.55	0.02	0	2	0.01	0	1.395	54	<1.0	820	360	20
7	Nov	24.6	7.66	3.3	13	48	12	4.3	0.22	1.55	0.03	0	0.5	0.53	-	1.3	30	< 1.0	800	10	24
	Dec	24	7.4	6	6	62	16	5.3	0.221	0.23	0.02	0	0.6	0.4	-	2.6	13	< 1.0	220	40	20
	Jan	24.1	7.37	8.4	10	52	8	7.7	0.406	0.17	0	0	0.5	0.83	-	3.1	12	< 1.0	180	44	26
	Feb	23.6	7.6	11.5	20	44	14.4	1.9	0.28	0.31	0.03	0	0.2	0.59	-	5.1	40	<1.0	350	100	21
	Mar	24.1	7.46	17.2	20	44	12.8	2.9	1.561	0	0.06	0.03	2	0.48	3	7	39	<1.0	310	50	29
	Apr	24.3	7.4	15.6	16	56	12	6.2	1.011	0.9	0	0	2	0.2	7	6.7	50	<1.0	1130	108	34
	May	24.3	7.41	8	10	64	6.4	12	0.211	0.21	0.02	0.02	17	0	3	4.8	13	<1.0	937	80	23
	Jun	24	7.66	11	17	52	8	7.7	0.341	0.05	0.02	0	1.5	0.28	1	5.4	53.8	<1.0	561	61.7	44

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	Jul	24.1	7.69	6.3	16	60	10.6	6.4	0.275	0.08	0.04	0.03	1.8	0.58	3	3.2	52	<1.0	561	61.7	47
	Aug	24.2	7.3	8.01	12	56	9.6	7.68	0	1.25	0	0.01	1	0.04	2	6.25	27.4	<1.0	600	175	40
	Sep	20.5	7.15	14.5	11	8	8	4.5	0.355	1.35	0.02	0	2	0	0	1.86	50	<1.0	430	29	45
8	Nov	24.3	7.45	3.2	7.8	80	11	7.2	0.16	1.45	0.03	0	1	0.5	-	1.5	27	< 1.0	620	70	33
	Dec	24.3	7.34	5.1	5	48	12	4.3	0.301	0.18	0.01	0	0.5	0.43	-	3	17	< 1.0	200	50	17
	Jan	24	7.48	8.3	4	44	9.6	4.8	0.316	0.24	0.01	0	0.6	0.87	-	2.7	13	< 1.0	254	69	22
	Feb	23.1	7.6	10.4	6	68	12.8	8.6	0.248	0	0	0	0.5	0.31	-	3.4	36	<1.0	240	48	22
	Mar	23.2	7.35	7.3	11	24	8	1	0.123	0.32	0.18	0.12	36	0.73	2	4.8	63	<1.0	410	61	28
	Apr	23.7	7.13	6.7	7	56	11.3	2.6	0.324	0.22	0	0	1.4	0.29	3	2.6	27	<1.0	890	110	30
	May	23.5	7.07	7	6	40	9.6	3.8	0.348	0.23	0	0	2	0.58	2	6.4	46.2	<1.0	1040	70	27
	Jun	23.8	7.16	5.91	5	72	11.2	10.6	0.038	0.19	0.02	0	1	0.29	0	6.1	59.9	<1.0	522	110.9	46
	Jul	24	7.86	4.9	8	58	4.8	11	0.165	0.19	0.02	0.02	1.3	0.58	3	4	50	<1.0	522	60	40
	Aug	22.5	7.25	8.24	4	40	8	4.8	0.56	0.06	0.02	0.01	0.8	0	1	3.72	58.8	<1.0	576	10025	23
	Sep	22.8	7.23	7.2	12	48	8	6.7	0.341	0.55	0.01	0	0.5	0.1	1	3.24	52.6	<1.0	310	21	20
9	Nov	24	7.16	3.7	24	88	20	9.1	0.18	1.5	0.13	0.01	3	0.71	-	15.1	89	< 1.0	1060	100	40
	Dec	24	7	78.8	85	40	8	4.8	1.6	2.35	0.08	0	0.5	0.53	-	8	66	< 1.1	40	16	30
	Jan	Seasonal River Completely Dry in January																			
	Feb	Seasonal River Completely Dry in February																			
	Mar	Seasonal River Completely Dry in March																			
	Apr	Seasonal River Completely Dry in April																			
	May	Seasonal River Completely Dry in May																			

No	Month	Electrical Conductivity (EC) (µS/cm)	pH	Turbidity (NTU)	Total Suspended Solids (mg/L)	Hardness: total $CaCO_3$ (mg/L)	Calcium: Ca^{++} (mg/L)	Magnesium: Mg^{++} (mg/L)	Total Iron (mg/L)	Colour: apparent (PtCo)	Nitrate- N (mg/L)	Total Dissolved Solids (TDS) (mg/L)	Chloride: Cl^- (mg/L)	Flouride: F^- (mg/L)	Sulphate (mg/L)	Alkalinity: Total as $CaCO_3$ (mg/L)	Orthophosphate: Reactive (mg/L)	Total Phosphorus (TP) (mg/L)	E-coli (CFU/100mL)	Faecal Coliforms (CFU/100mL)	Chl-a (µg/L)
	Jun	Seasonal River Completely Dry in June																			
	Jul	Seasonal River completely Dry in July																			
	Aug	Seasonal River completely Dry in August																			
	Sep	Seasonal River completely Dry in September																			
10	Nov	24.3	7.51	3.3	14	52	15.2	3.4	0.15	2.1	0.03	0	1.5	0.41	-	3.5	25	<1.0	1060	40	34
	Dec	23.9	7.22	6.2	4	56	12	6.2	0.264	0.2	0.02	0	0.6	0.54	-	2.6	11	<1.0	260	70	27
	Jan	23.8	7.43	7.4	6	60	9.6	8.6	0.393	0.14	0.01	0	0.7	1.01	-	3.7	17	<1.0	300	54	29
	Feb	23.4	7.5	9.6	15	40	8	4.8	0.256	0.24	0.02	0	0.2	0.57	-	2	36	<1.0	360	110	23
	Mar	23.8	7.3	13.8	19	72	8	12.5	0.257	0.01	0.06	0.02	1.5	0.47	3	8.4	50	<1.0	300	38	24
	Apr	23.7	7.05	3.7	4	52	4.8	9.6	0.33	0.47	0.03	0	1	0.42	3	10.6	32.8	<1.0	1008	560	41
	May	23.9	7.03	4.8	17	32	8	2.9	0.358	0.22	0	0	1	0.35	3	5	13	<1.0	1008	140	33
	Jun	23.8	7.33	8.8	16	68	8	11.5	0.296	0.01	0.03	0.01	0.5	0.23	1	5.7	48.9	<1.0	613.7	560	56
	Jul	24	7.45	3.3	16	58	10.1	6.4	0.2	0.18	0.04	0.03	0.7	0.25	2	3.9	23	<1.0	613.7	820	39
	Aug	23	7.37	3.5	10	44	4.8	7.68	0	1.75	0	0	1	0.05	3	2.85	9.8	<1.0	700	50	23
	Sep	20.2	6.95	8.31	6	52	8	7.68	0.34	1.25	0.08	0.01	2	0	0	2.48	43	<1.0	400	20	30
11	Nov	24.7	7.5	3.3	17	64	16	5.8	0.2	1.34	0.04	0	5	0.55	-	1.7	30	<1.0	170	90	20
	Dec	24.7	7.4	11.2	22	88	20	9.1	0.7	2.85	0.04	0	0.5	0.54	-	2.4	24	<1.0	60	10	26
	Jan	23.9	7.53	4	5	192	9.6	40.3	0.296	0.19	0	0	0.4	0.79	-	2.6	29	<1.0	270	30	22
	Feb	23.3	7.7	26	34	80	16.8	9.1	0.583	8	0.05	0	0.6	0.42	-	1.5	36	<1.0	320	54	22
	Mar	23.5	6.85	6.6	11	60	9.6	8.6	0.04	0.1	0.04	0.03	3	0.49	2	15.5	86	<1.0	512	78	34
	Apr	23.9	6.9	5.4	7	62	16	5.3	0.102	0.14	0	0	2	0.18	5	7.8	53	<1.0	1009	140	40

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	May	24.6	7.33	11	16	60	6.4	10.6	0.203	0.28	0.04	0.18	7	0	3	3.7	11	<1.0	800	110	30
	Jun	23.8	7.39	8.5	15	56	6.4	9.6	0.362	0.01	0.02	0	3.5	0.26	0	4.8	49.7	<1.0	448.7	111.5	60
	Jul	24.1	7.37	3.1	20	42	9.6	4.3	0.215	0.94	0.05	0.05	3.3	0.7	3	4	26	<1.0	448.7	380	52
	Aug	24.3	7.32	12.6	21	52	9.6	6.72	0.83	0.04	0.03	0.1	0.4	0	1	3.782	42	<1.0	414	70	45
	Sep	20.4	6.94	9	14	56	8	8.64	0.39	1.8	0.06	0.01	1	0.03	0	1.55	44	<1.0	360	89	61
12	Nov	24.5	7.59	191	294	136	28	15.8	1.7	3.75	0	0	1	0	-	4.6	91	< 1.0	540.2	69.5	38
	Dec	24.2	7.31	6.5	4	52	12.8	4.8	0.882	0.3	0.03	0	0.7	0.49	-	3.3	15	< 1.0	278	60	30
	Jan	24	7.46	4.9	5	64	16	5.8	1.229	0.37	0.29	0.01	0.6	0.4	-	2.5	9	< 1.0	200	54	26
	Feb	23.6	7.6	5.7	1	156	38.4	14.4	0.322	0.5	0	0	1	0.5	-	1.2	17	<1.0	264	30	16
	Mar	24.1	7.18	117	56	92	27.4	5.8	1.195	0.42	0.3	0.3	1	0.59	5.2	12.4	31	<1.0	406	53	17
	Apr	23.9	7.4	10.2	24	70	22.3	3.8	0.631	0.29	0.01	0	1.8	0.99	3	4.6	30	<1.0	1120	150	27
	May	24.1	7.66	11.1	28	76	25.6	2.88	0.826	0.25	0	0	2	1.07	2	4.9	33.2	<1.0	973	70	21
	Jun	24.1	7.32	0.2	0	128	22.4	17.3	0.271	0.2	0.02	0	1	0.3	3	3.7	19.6	<1.0	540.2	69.5	58
	Jul	23.9	7.84	16.5	10	120	14.4	20.2	1.985	0.33	0.03	0.03	1.2	0.73	5	5.1	37	<1.0	540.2	69.5	44
	Aug	23.8	7.41	18.9	10	96	20.8	10.56	1.98	0.09	0.02	0.01	0.4	0	2	3.22	25.9	<1.0	356	54	18
	Sep	23.8	7.34	12	16	56	17.6	2.9	1.83	0.09	0.04	0.01	1	0.1	0	4.36	26.7	<1.0	410	89	20
13	Nov	24	7.69	141	297	124	32	10.6	1.3	3.75	0	0	2	0	-	3.2	87	< 1.0	568.7	104.9	49
	Dec	24.3	7.5	8	6	56	14.4	4.8	0.643	0.5	0.04	0	0.5	0.76	-	4	29	< 1.0	256	34	20
	Jan	24	7.56	8.8	6	44	4.8	7.7	1.189	0.89	0.01	0	0.3	1.27	-	3.3	20	< 1.0	190	41	23
	Feb	23	7.5	28.7	22	244	60	22.1	0.997	2	0	0	0.5	0.76	-	6.4	75	<1.0	308	42	18

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	Mar	24.3	7.42	28	12	92	16	12.5	3.3	0.58	0.18	0.1	1	0.47	4	16.7	44	<1.0	318	50	20
	Apr	24.3	7.63	26.4	12	80	22.3	5.8	0.623	0.64	0.03	0	2.3	0.5	3	5.4	26	<1.0	1420	173	33
	May	24.6	7.72	34	9	88	24	6.7	0.771	0.27	0	0	2	0.46	2	6.4	33.4	<1.0	920	94	27
	Jun	23.9	7.51	3.1	3	160	30.4	20.2	0.168	0.14	0.02	0	31	0.41	0	4.2	29.8	<1.0	568.7	104.9	66
	Jul	23.7	7.71	12.5	8	140	9.6	27.8	0.92	0.32	0.03	0.02	21	0.53	5	3	38	<1.0	568.7	300	54
	Aug	23.1	7.55	9.34	3	148	32	16.32	1.23	0.05	0.02	0.01	0.4	0	1	6.82	24.5	1.25	906	85	31
	Sep	23.1	7.23	28	45	92	24	7.2	2.171	0.07	0.03	0.01	1	0.16	0	8.84	22.9	1.48	230	21	17
14	Nov	24.3	7.59	4	20	48	12	4.3	0.3	1.4	0.03	0	2	0.45	-	1.7	38	< 1.0	210	130	41
	Dec	23.9	7.39	7.3	4	78	16	9.1	0.275	0.15	0.01	0	0.4	0.44	-	3.7	24	< 1.0	208	40	23
	Jan	24.2	7.56	10	7	196	8	44.2	0.335	0.18	0.02	0	0.8	0.83	-	2.9	23	< 1.0	160	38	19
	Feb	23.4	7.4	9.8	15	56	11.2	6.7	0.285	0.21	0.03	0	0.5	0.47	-	1.5	32	<1.0	480	108	26
	Mar	23.5	7.33	12.1	15	44	11.2	3.8	0.17	0.41	0.11	0.06	6	0.59	3	15.2	62	<1.0	469	70	24
	Apr	23.9	7.6	11.2	10	36	8	3.8	0.501	0.53	0.04	0.01	1.9	0.45	2	6.3	50.2	<1.0	1320	200	37
	May	23.8	7.65	12.1	16	32	11.2	0.96	0.519	0.36	0.05	0	2	0.49	3	5.1	45.6	<1.0	956	82	33
	Jun	24	7.27	4.1	4	56	12.8	5.8	0.072	0.24	0.03	0	8	0.34	0	3.4	26.5	<1.0	543.3	90.4	39
	Jul	24.1	7.63	9.3	14	62	8	10.1	0.15	0.35	0.02	0.02	7	0.64	5	4.4	54	<1.0	543.3	55	44
	Aug	22.9	7.09	13.2	20	40	4.8	6.72	0.88	0.02	0.02	0.01	0.8	0	1	3.1	10.4	<1.0	174	26	22
	Sep	23.1	6.92	9.3	15	68	11.2	9.6	0.757	0.6	0.03	0	0.5	0.12	1	3.18	10.4	<1.0	1000	201	40

Source: Adapted from the feasibility study report for the Ayago Hydropower Plant

5.2.4 Soil Survey

The soils within the project area are located on gentle slopes of hills in valleys of which, are located both seasonal and permanent rivers draining to the Nile. These soils are classified as acrisols (Petroplinthic Acrisols) which have low productivity according to the mapping of NARO's Soils and Soils Fertility Program. Acrisols are prone to soil erosion and according to IUSS Working Group WRB (2007), preventing erosion is a key precondition of working with Acrisol soils. The results of the soil survey are presented in section 5.4.1 of this report and the sampling areas are presented in Figure 17.

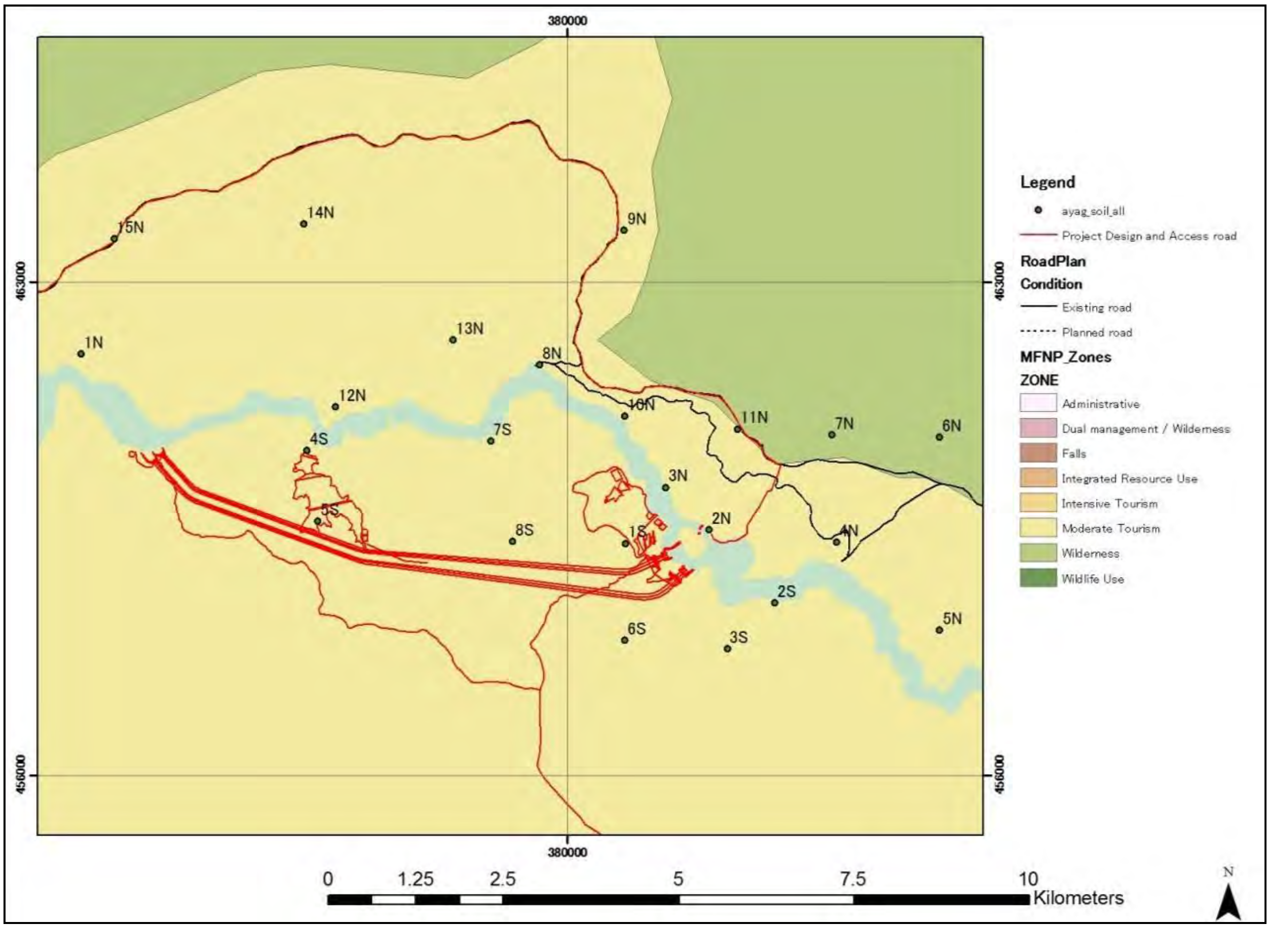

Figure 16: Location of soil survey test pits

Results

Within the Project area the Precambrian biotite gneiss parent material is overlain predominantly by Petroplinthic Acrisols. The profile of the soils in the Project area consists of a top-soil horizon ranging between 17-60cm deep with the sub-soil horizons usually within 100 cm depth. The low organic matter present in the soil was concentrated in the top-soil. The field investigations results are presented in Tables 38 & 39.

- Productivity

The soils are generally poor because the nutrient levels especially for the major nutrients (NPK) are below the critical levels for viable agricultural production. However, the soil pH is about neutral which supports a wide range of crop production which would minimize aggression to any cast concrete during project development. The soil texture ranges between sandy clay and sandy clay loam which are friendly to work with during tillage, the drainage is perfect, allows proper root development and also have the capacity to hold water for plant growth.

- Erodibility

The soils within the project area have large diameter particle sizes above the 100 microns that is considered fragile to erosion, have perfect drainage and exhibit reasonable clay content. Throughout the project area, bulky density is above 1.33g/cm^3 (range 1.37 – 2.43 g/cm^3) which enhances the cohesion forces between the soil particles. Thus erodibility due to rain drop impact may be insignificant especially where there is vegetation cover. However, the shearing action of intensive runoff especially in the sloping areas towards the river banks with less vegetation cover may cause serious erosion. Erosion would be enhanced during the rainy seasons.

Additionally, since most of the soils from the project area are week in terms of the degree of structure development, constant inundation and high velocity runoff from the sloping areas upstream of the weir may lead to silting of the reservoir.

Table 37: Soil Survey Results

PIT	Location	Existing Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpness	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
1N	Close to Camera J31NP	Forested area,	373060	261988	780	A	0 -56	Smooth	Clear	Moist	Weak red	Loam	Weakly developed	Crumb and Granular	Loose	Fine porous	Loose	Perfect	Termites	Few	Small	Free growing	Woody	Alive and Strong	Young	Newly weathered rock in horizon C
		gentle slope towards				B	56 - 100	Smooth	Clear	Moist	Dark reddish brown	Sandy	Weakly developed	Platty	Friable	Fine porous	Friable	Perfect	-	Frequent	Small	Free growing	Woody	Alive and Strong	Young	Insect Burrows in horizon A
		river				C	100-below			Moist	Grey	Sandy	Weakly developed	Platty	Friable	Fine porous	Compact	Perfect	-	Rare	Small	Distorted	Woody	Dead	Old	
2N	Close to Camera J13NP	Deposition of silt,	382019	259492	859	A	0 -17	Smooth	Clear	Moist	Dark reddish grey	Sandy	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	-	Frequent	Medium	Free growing	Woody Fleshy	Alive and Strong	Young	Profile is influenced by deposition
		gentle slope towards				B	17 - 63	Smooth	Clear	Moist	Black	Clay loam	Weakly developed	Crumb	Friable	Fine porous	Loose	Perfect	-	Few	Small Large	Free growing	Woody Fleshy	Alive and Strong	Young	Evidence of deposition in the River
		river				C	63 - 113	Smooth	Clear	Moist	Grey	Sandy loam	Weakly developed	Crumb and Sub-Angular	Friable	Fine porous	Loose	Perfect	-	Rare	Small	Free growing	Woody Fleshy	Alive and Strong	Young	
3N	Close to Camera	Forested area	381407	260093	860	A	0 - 50	Smooth	Clear	Moist	Dark reddish grey	Loam	Weakly developed	Crumb and Sub-Angula	Friable	Fine porous	Friable	Perfect	Ants Termites	Frequent	Small Large	Free growing	Woody	Dead and Alive	Young and old	Bed rock is near (63cm) depth

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpness	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
	J27NP													r												
		Presence of rocks				B	50 - 63	Smooth	Clear	Moist	Dark grey	Clay loam	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	Termites	Rare	Small	Free growing	Woody	Alive and Strong	Young	
						C	Bed Rock	-	-	-	-	Bed Rock	-	-	-	-	-	-	-	-	-	-	-	-		
4N	Close to Camera E08NP	Grass shrubs	383840	259319	876	A	0 - 27	Smooth	Clear	Moist	Dark reddish brown	Sandy loam	Weakly developed	Crumb	Friable	Fine porous	Friable	Perfect	Ants Termites	Few	Small	Free growing	Rhizomatous	Alive and Strong	Young	Evidence of leaching in horizon B
						B	27 - 70	Smooth	Clear	Moist	Dark red	Sandy	Strongly developed	Blocky	Firm	Porous	Loose	Perfect	Ants Termites	Rare	Small Medium	Free growing	Woody	Alive and Strong	Young	Presence of sesquioxides (Iron and
						C	70 - below	Smooth	Clear	Moist	Light red	Sandy	Strongly developed	Blocky	Very Firm	Fine porous	Compact	Imperfect	-	Rare	Small Medium	Free growing	Woody	Alive and Strong	Young	aluminium oxides
5N	Close to Camera F09NP	Scattered trees shrubs	385316	258072	899	A	0 - 50	Irregular	Gradual	Moist	Very dusky red	Clay loam	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	Ants Termites	Abundant	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	Horizon B has gravel mixed with soils
						B	50 - 100	Smooth	Gradual	Moist	Dark reddish brown	Clay loam	Weakly developed	Granular	Friable	Porous	Friable	Imperfect	-	Frequent	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpness	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
6N	Close to Camera D09NP	Grazing grass Scattered trees	385306	260802	920	A	0 - 35	Irregular	Gradual	Moist	Black	Clay	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Ants Termites	Frequent	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	-
						B	35 - 80	Smooth	Clear	Moist	Dark reddish brown	Clay	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Ants Termites	Few	Small	Free growing	Fibrous	Alive and Strong	Young	
						C	Gravel Stones	-	-	-	-	Gravel Stones	-	-	-	-	-	-	-	-	-	-	-	-		
7N	Close to Camera D08 NP	Grazing grass Forested area	383774	260841	903	A	0 - 50	Irregular	Gradual	Moist	Black	Clay loam	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Termites	Few	Small	Free growing	Fibrous	Alive and Strong	Young	-
						B	50 - below	Irregular	Gradual	Moist	Red	Clay	Strongly developed	Crumb	Friable	Fine porous	Compact	Imperfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
8N	Close to Camera J42 NP	Gradual slope, Bare ground	379607	261830	836	A	0 - 60	Irregular	Diffuse	Moist	Black	Sandy silt	Very Weakly developed	Granular	Friable	Fine porous	Friable	Imperfect	-	Frequent	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	Profile is influenced by deposition
		Evidence of erosion				B	60 - below	Irregular	Diffuse	Moist	Weak red	Sandy silt	Very Weakly devel	Granular	Friable	Fine porous	Friable	Imperfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpnes	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
													oped													
9N	Close to Camera B06 NP	Grazing grass scattered trees	380815	263740	912	A	0 - 30	Irregular	Gradual	Moist	Very dusky red	Clay loam	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Earthworms Termites Ants	Abundant	Small	Free growing	Fibrous	Alive and Strong	Young	Presence of Calcium carbonate/ lime
		gentle slope towards tributary				B	30 - 90	Smooth	Clear	Moist	Dark reddish brown	Clay loam	Strongly developed	Granular Crumb	Firm	Very fine porous	Compact	Imperfect	-	Frequent	Small	Free growing	Fibrous	Alive and Strong	Young	white eyes and nodules
						C	Bed Rock	-	-	-	-	Bed Rock	-	-	-	-	-	-	-	-	-	-	-	-		
10N	Close to Camera D06 NP	Forested area	380822	261099	860	A	0 - 30	Irregular	Gradual	Moist	Dark reddish brown	Clay loam	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Millipedes Termites	Frequent	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	-
						B	30 - 70	Smooth	Clear	Moist	Weak red	Sandy clay loam	Strongly developed	Crumb	Firm	Fine porous	Compact	Imperfect	-	Rare	Small Medium	Free growing	Fibrous	Alive and Strong	Young	
						C	Bed Rock	-	-	-	-	Bed Rock	-	-	-	-	-	-	-	-	-	-	-	-		
11N	Close to Camera D07 NP	Grazing grass shrubs	382432	260921	918	A	0 - 40	Smooth	Clear	Moist	Dark reddish brown	Clay loam	Weakly developed	Granular	Friable	Fine porous	Friable	Perfect	Black Ants	Frequent	Small	Free growing	Fibrous	Alive and Strong	Young	-
		Scatter				B	40 -	Irreg	Gra	Dry	Brick	Clay	Stron	Crumb	Firm	Very	Very	Impe	-	-	-	-	-	-	-	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpnes	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
		ed trees					below	ular	dual		red		gly developed			fine porous	compact	rfect								
12N	Close to Camera J47 NP	Thickets	376699	261231	816	A	0 - 30	Irregular	Gradual	Moist	Dusky red	Clay loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Few	Large small	Free growing	Woody Fibrous	Alive and Strong	Young	Presence of a gravel layer in the transition
						B	30 - below	-	-	Moist	Red	Sandy	Strongly developed	Granular Crumb	Compact	Very fine porous	Very compact	Imperfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	layer between the two horizons
13N	Close to Camera J05 NP	Wet area Swamp	378371	262180	849	A	0 -30	Smooth	Clear	Moist	Black	Clay	Weakly developed	Crumb	Loose	Fine porous	Loose	Perfect	Termites Black ants	Abundant	Small	Free growing	Fibrous	Alive and Strong	Young	
						B	30 - 55	Smooth	Clear	Moist	Dark reddish brown	Clay	Weakly developed	Crumb	Friable	Fine porous	Loose	Perfect	-	Few	Small	Free growing	Fibrous	Alive and Strong	Young	-
						C	55 - below	-	-	Wet	Dark reddish brown	Clay	Weakly developed	Massive	Sticky	Fine porous	Loose	Perfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
14N	Close to Camera B03 NP	Woodland	376243	263830	845	A	0 -30	Irregular	Gradual	Moist	Dark reddish brown	Loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Frequent	Large small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	-
						B	30 - 70	Irregular	Gradual	Moist	Dusky red	Sandy	Weakly	Crumb	Firm	Fine porou	Loose	Perfect	Termites	Few	Large	Free growi	Woody	Alive and	Young	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpnes	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
												clay loam	developed			s					small	ng	Fibrous	Strong		
						C	70 - below	-	-	Moist	Red	Clay	Weakly developed	Crumb	Friable	Very fine porous	Compact	Perfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
15 N	Close to Camera B01 NP	Grazing grass Scattered trees	373534	263617	827	A	0 - 35	Smooth	Clear	Moist	Black	Loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Frequent	Large Small	Free growing	Woody Fibrous	Alive and Strong	Young	-
						B	35 - 90	Smooth	Clear	Moist	Reddish Brown	Clay loam	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
						C	Bed Rock	-	-	-	-	Bed Rock	-	-	-	-	-	-	-	-	-	-	-	-	-	
1S	Close to Camera E06 NP	Scattered trees Grazing grass	380835	259299	893	A	0 - 20	Irregular	Gradual	Moist	Dusky red	Clay	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites/brown ants	Few	Small	Free growing	Fibrous	Alive and Strong	Young	Animal burrows in horizons (A and B)
						B	20 - 60	Irregular	Gradual	Moist	Dusky red	Clay	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Few	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	
						C	60 - below	Irregular	Gradual	Moist	Weak red	Sandy loam	Weakly developed	Crumb	Friable	Porous	Compact	Perfect	-	Rare	Large medium small	Free growing	Fibrous	Alive and Strong	Young	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpnes	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
2S	Close to Camera J33 NP	Thickets	382966	258456	860	A	0 - 20	Smooth	Clear	Moist	Dark reddish brown	Loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Millipedes Termites	Frequent	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	
						B	20 - 60	Smooth	Clear	Moist	Reddish black	Clay loam	Weakly developed	Crumb	Loose	Fine porous	Loose	Perfect	Millipedes Termites	Rare	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	-
						C	60 - 90	Smooth	Clear	Moist	Black	Sandy	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	-	Rare	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	
						D	90 - below	Smooth	Clear	Moist	Very dusky red	Sandy	Weakly developed	Granular	Friable	Fine porous	Friable	Imperfect	-	Frequent	Small Medium	Free growing	Woody	Alive and Strong	Young	
3S	Close to Camera F07 NP	Scattered trees Grazing grass	382283	257804	884	A	0 - 30	Smooth	Clear	Moist	Reddish black	Clay loam	Weakly developed	Granular Crumb	Loose	Fine porous	Loose	Perfect	Earthworms Termites	Abundant	Small	Free growing	Fibrous	Alive and Strong	Young	-
						B	30 - below	-	-	Moist	Weak red	Clay	Weakly developed	Crumb	Compact	Fine porous	Compact	Perfect	Earthworms Termites	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
4S	Close to Camera D03	Thickets grazing grass	376284	260614	813	A	0 -30	Smooth	Clear	Moist	Reddish black	Gravel	Weakly developed	Granular Crumb	Loose	Spongy	Friable	Imperfect	Termites	Abundant	Small	Free growing	Fibrous	Alive and Strong	Young	Newly weathered rock in horizon C

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpness	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consistence	Porosity	Compactness	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
	NP																									
		steep slope signs of run-off				B	30 - 60	Smooth	Clear	Moist	Dark reddish brown	Clay loam	Weakly developed	Crumb	Loose	Porous	Loose	Perfect	Termites	Abundant	Small Medium	Free growing	Fibrous	Alive and Strong	Young	
						C	60 - below	-	-	Moist	Pale red	Cake like particles	Strongly developed	Platty granular	Friable	Fine porous	Very compact	Imperfect	Termites	Rare	Small Medium	Free growing	Fibrous	Alive and Strong	Young	
5S	Close to Camera J16 NP	Scattered trees Grazing grass	376440	259610	844	A	0 -25	Smooth	Clear	Moist	Reddish black	Clay	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Frequent	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	-
						B	25 - 54	Smooth	Clear	Moist	Dusky red	Clay loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Few	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	
						C	54 - below	-	-	Moist	-	Gravel	-	Gravel	-	Spongy	-	Imperfect	-	Rare	Small Medium	Free growing	Woody Fibrous	Alive and Strong	Young	
6S	Close to Camera F06 NP	Scattered trees/Grazing grass	380818	257926	899	A	0 - 30	Smooth	Clear	Moist	Reddish black	Clay loam	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	Termites Black ants Millipedes	Frequent	Small	Free growing	Fibrous	Alive and Strong	Young	-
						B	30 - 80	Smooth	Clear	Moist	Dark reddish	Clay loam	Weakly devel	Granular Crumb	Friable	Fine porous	Loose	Perfect	-	Few	Small	Free growing	Fibrous	Alive and Stron	Young	

PIT	Location	ng Condition	Northings	Eastings	Elevation (m)	Horizons	Depth (cm)	Boundary Regularity	Sharpnes	Moisture Status	Colour	Texture	Structure (DSD)*	(Shape of Aggregate	Consisten ce	Porosity	Compactn ess	Drainage	Fauna	Roots (qty)	Roots (size)	Roots (shape)	Roots (nature)	Roots (health)	Roots (age)	Special Features
											brown		oped											g		
						C	Bed Rock	-	-	-	-	Bed Rock	-	-	-	-	-	-	-	-	-	-	-	-	-	
7S	Close to Camera J20 NP	Thickets Rocks Grazing grass	378908	260750	825	A	0 - 40	Smooth	Gradual	Moist	Black	Clay	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	Termites	Frequent	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	Burrows in horizons
						B	40 - 84	Smooth	Gradual	Moist	Dark reddish brown	Clay	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	Termites	Few	Large medium small	Free growing	Woody Fibrous	Alive and Strong	Young	
						C	84 - below	Smooth	Gradual	Moist	Dark reddish brown	Clay loam	Weakly developed	Granular	Friable	Fine porous	Loose	Perfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	
8S	Close to Camera E05 NP	Scattered trees Grazing grass	379224	259325	879	A	0 - 40	Smooth	Gradual	Moist	Dark reddish grey	Loam	Weakly developed	Granular	Loose	Fine porous	Loose	Perfect	Termites	Frequent	Small	Free growing	Fibrous	Alive and Strong	Young	Gravel in horizon A
						B	40 - below	-	-	Dry	Red	Sandy	Strongly developed	Crumb Sub-Angular	Friable	Very fine porous	Compact	Imperfect	-	Rare	Small	Free growing	Fibrous	Alive and Strong	Young	

Source: Adopted from the feasibility study for Ayago Hydropower Project

Table 38: Physical-chemical properties of the soil surveyed in the project area

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm³)	Textural class
S/12/5901	Pit 1 S. Bank	Horizon A	5.1	19.0	0	2.2	0.15	2.9	1205.47	711.54	164.98	trace	117.30	38.80	<0.01	4.23	51.7	41.0	7.3	1.46	Sandy clay
S/12/5902	Pit 1 S. Bank	Horizon B	5.6	24.9	0	1.4	0.12	3.0	1470.32	816.00	181.02	trace	105.52	107.03	<0.01	3.25	49.7	45.0	5.3	1.71	Sandy clay
S/12/5903	Pit 1 S. Bank	Horizon C	6.7	96.1	0	0.9	0.09	2.0	2096.31	1500.00	149.41	trace	37.21	49.86	<0.01	3.53	49.7	41.0	9.3	1.56	Sandy clay
S/12/5904	Pit 2 S. Bank	Horizon A	5.6	32.4	0	3.7	0.19	2.4	1554.59	1089.74	111.28	trace	136.14	84.90	5.04	5.50	67.7	21.0	11.3	1.56	Sandy clay loam
S/12/5905	Pit 2 S. Bank	Horizon B	5.8	26.1	0	3.8	0.20	4.6	1891.66	1339.74	146.39	trace	122.01	62.77	2.26	5.78	69.7	21.0	9.3	1.60	Sandy clay loam
S/12/5906	Pit 2 S. Bank	Horizon C	6	28.3	0	1.7	0.12	5.0	1229.55	1044.88	99.20	trace	138.49	12.06	5.74	4.52	79.7	15.0	5.3	1.57	Sandy loam
S/12/5907	Pit 2 S. Bank	Horizon D	6.7	22.1	0	0.6	0.09	20.2	651.71	435.90	85.38	trace	18.37	0.05	7.83	6.20	89.7	7.0	3.3	1.77	Loamy sand
S/12/5908	Pit 3 S. Bank	Horizon A	5.4	21.5	0	2.8	0.15	21.0	1217.51	910.26	230.11	trace	154.98	0.05	6.09	5.50	59.7	31.0	9.3	1.58	Sandy clay loam
S/12/5909	Pit 3 S. Bank	Horizon B	5.7	13.9	0	1.6	0.11	4.7	1193.44	1012.82	161.64	trace	41.93	95.04	4.00	5.78	33.7	61.0	5.3	1.46	Clay
S/12/5910	Pit 4 S.	Horizon A	5.6	16.6	0	2.6	0.15	4.6	1169.36	967.94	139.87	trace	107.87	0.05	3.30	6.90	69.7	21.0	9.3		Sandy clay

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm^3)	Textural class
	Bank																				loam
S/12/5911	Pit 4 S. Bank	Horizon B	5.9	22.1	0	2.1	0.13	4.3	1301.78	1360.00	148.45	trace	46.64	0.05	5.04	7.60	59.7	27.0	13.3	1.65	Sandy clay loam
S/12/5912	Pit 4 S. Bank	Horizon C	6.4	19.8	0	0.6	0.09	5.0	976.75	1013.00	122.24	trace	27.79	5.60	0.87	7.32	85.7	11.0	3.3	1.56	Sandy loam
S/12/5913	Pit 5 S. Bank	Horizon A	5.8	30.6	0	3.8	0.20	4.4	1771.27	1346.16	187.07	trace	74.90	52.63	2.26	6.62	49.7	35.0	15.3	1.38	Sandy clay
S/12/5914	Pit 5 S. Bank	Horizon B	6.2	39.1	0	3.2	0.18	4.3	1915.73	1410.26	208.36	trace	32.50	54.47	3.30	8.16	45.7	41.0	13.3	1.55	Sandy clay
S/12/5915	Pit 6 S. Bank	Horizon A	5.8	24.0	0	2.6	0.15	4.3	1410.13	788.46	150.20	trace	0.02	8.37	0.01	9.29	57.7	33.0	9.3	1.56	Sandy clay loam
S/12/5916	Pit 6 S. Bank	Horizon B	5.9	20.9	0	1.6	0.12	4.3	1012.86	897.44	157.51	trace	0.02	30.50	4.00	8.59	45.7	49.0	5.3	1.56	Sandy clay
S/12/5917	Pit 7 S. Bank	Horizon A	5.7	22.4	0	2.9	0.16	5.0	1542.55	1314.10	170.38	trace	67.83	35.89	2.26	8.87	65.7	21.0	13.3	1.48	Sandy clay loam
S/12/5918	Pit 7 S. Bank	Horizon B	5.9	20.1	0	2.4	0.16	4.3	1578.66	1487.18	152.11	trace	65.48	37.74	5.04	8.73	65.7	29.0	5.3	1.62	Sandy clay loam
S/12/5919	Pit 7 S. Bank	Horizon C	6.5	36.2	0	2.1	0.14	4.4	1687.01	1705.12	164.98	trace	77.25	4.68	3.30	9.71	65.7	21.0	13.3	1.48	Sandy clay loam
S/12/5920	Pit 8 S.	Horizon A	5.8	18.4	0	3.0	0.17	4.9	1241.59	871.80	160.37	trace	74.90	0.05	5.39	11.95	71.7	21.0	7.3	1.49	Sandy clay

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm^3)	Textural class
	Bank																				loam
S/12/5921	Pit 8 S. Bank	Horizon B	6.2	18.4	0	1.3	0.10	4.9	1482.36	1115.38	145.60	trace	39.57	85.82	0.01	9.29	59.7	31.0	9.3	1.58	Sandy clay loam
S/12/4745	Pit 1 N. Bank	Horizon A	5.8	36.7	0	1.5	0.11	2.67	1118.9	1351.8	144.9	<0.01	178.0	105.2	5.20	25.4	61.1	30.3	8.6		Sandy clay loam
S/12/4746	Pit 1 N. Bank	Horizon B	7	183.2	0	0.2	0.07	1.07	1265.2	940.1	91.2	<0.01	190.0	41.3	1.87	19.8	89.1	6.3	4.6		Sand
S/12/4747	Pit 1 N. Bank	Horizon C	7.5	175.4	0	0.3	0.07	1.34	1209.5	956.9	148.5	<0.01	156.1	111.4	8.39	16.0	81.1	12.3	6.6		Loamy sand
S/12/4748	Pit 2 N. Bank	Horizon A	6.8	46	0	2.1	0.14	9.63	481.5	861.6	195.4	<0.01	293.5	68.8	7.83	23.6	75.1	16.3	8.6	1.64	Sandy loam
S/12/4749	Pit 2 N. Bank	Horizon B	6.3	36.7	0	2.7	0.16	1.60	589.5	1049.3	167.1	<0.01	224.5	11.5	5.75	25.4	61.1	26.3	12.6	1.63	Sandy clay loam
S/12/4750	Pit 2 N. Bank	Horizon C	6.1	36.7	0.1	2.2	0.14	2.94	582.5	987.7	43.2	<0.01	238.9	13.5	10.74	6.6	67.1	22.3	10.6	1.63	Sandy clay loam
S/12/4751	Pit 3 N. Bank	Horizon A	5.8	36.4	0	2.5	0.15	1.07	694.0	1774.8	174.2	<0.01	228.9	8.8	14.91	21.7	67.1	26.3	6.6	1.84	Sandy clay loam
S/12/4752	Pit 3 N. Bank	Horizon B	6.8	60	0	1.2	0.11	0.80	721.9	1447.1	164.0	<0.01	173.0	46.0	6.44	33.0	69.1	26.3	4.6	1.36	Sandy clay loam
S/12/4753	Pit 4 N.	Horizon A	6.5	12.6	0	1.3	0.10	1.87	1324.9	1881.2	92.1	<0.01	151.1	220.1	5.61	19.8	27.1	56.3	16.6	1.69	Clay

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm^3)	Textural class
	Bank																				
S/12/4754	Pit 4 N. Bank	Horizon B	6.4	38.8	0	3.1	0.18	0.80	1274.6	1231.4	62.4	<0.01	184.9	179.1	4.50	19.8	49.1	36.3	14.6	1.51	Sandy clay
S/12/4755	Pit 4 N. Bank	Horizon C	6.4	16.4	0	1.8	0.12	2.14	1343.7	1755.2	137.1	<0.01	135.4	117.2	6.86	25.4	25.1	68.3	6.6	1.32	Clay
S/12/4756	Pit 5 N. Bank	Horizon A	6.6	20.8	0	2.0	0.13	2.14	1029.6	1161.3	151.1	<0.01	188.7	115.6	2.01	19.8	49.1	44.3	6.6	1.39	Sandy clay
S/12/4757	Pit 5 N. Bank	Horizon B	6.2	16.2	0	1.6	0.12	1.07	809.8	875.6	161.5	<0.01	187.5	65.7	<0.05	34.9	51.1	40.3	8.6	1.40	Sandy clay
S/12/4758	Pit 6 N. Bank	Horizon A	6.3	19.5	0	1.9	0.13	0.80	1368.8	825.2	95.5	<0.01	223.2	59.5	1.31	25.4	55.1	34.3	10.6	1.59	Sandy clay loam
S/12/4759	Pit 6 N. Bank	Horizon B	6.6	19.2	0	2.4	0.14	1.34	1199.2	758.0	148.4	<0.01	195.0	183.7	<0.05	2.8	51.1	40.3	8.6	1.65	Sandy clay
S/12/4760	Pit 7 N. Bank	Horizon A	6.2	16.6	0	1.4	0.11	1.60	1494.5	1029.7	93.8	<0.01	212.5	28.9	4.36	34.9	53.1	36.3	10.6	1.57	Sandy clay
S/12/4761	Pit 7 N. Bank	Horizon B	6.7	28.9	0	2.3	0.15	2.14	1682.9	1407.8	174.2	<0.01	190.6	49.1	1.59	21.7	41.1	52.3	6.6	1.64	Clay
S/12/4762	Pit 8 N. Bank	Horizon A	6.3	23.8	0	0.3	0.08	5.08	753.3	903.6	110.1	<0.01	218.2	25.1	2.98	17.9	81.1	16.3	2.6	1.77	Sandy loam
S/12/4763	Pit 8 N.	Horizon B	6.4	21.4	0	1.6	0.12	1.07	1061.0	794.4	115.8	<0.01	188.7	46.7	5.89	10.3	53.1	34.3	12.6	1.76	Sandy clay

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm^3)	Textural class
	Bank																				loam
S/12/4764	Pit 9 N. Bank	Horizon A	6.4	19.6	0	1.3	0.11	1.07	973.1	987.7	63.1	<0.01	180.6	76.2	<0.05	16.0	77.1	16.3	6.6	1.37	Sandy loam
S/12/4765	Pit 9 N. Bank	Horizon B	8.3	107.6	0	2.5	0.15	1.34	5439.1	1833.6	398.2	<0.01	131.6	229.0	<0.05	23.6	41.1	48.3	10.6	1.58	Clay
S/12/4766	Pit 10 N.Bank	Horizon A	6.6	28	0	1.7	0.12	1.34	1155.3	1587.1	88.0	<0.01	168.0	36.3	0.62	40.6	53.1	32.3	14.6	1.64	Sandy clay loam
S/12/4767	Pit 10 N.Bank	Horizon B	7	87.9	0	2.8	0.16	1.07	1758.3	2105.3	172.1	<0.01	142.9	73.8	4.09	38.7	51.1	40.3	8.6	1.62	Sandy clay
S/12/4768	Pit 11 N.Bank	Horizon A	7	31.8	0	2.2	0.14	1.34	1343.7	1158.5	92.5	<0.01	141.0	26.6	3.39	29.2	55.1	32.3	12.6	1.56	Sandy clay loam
S/12/4769	Pit 11 N.Bank	Horizon B	7.8	36.1	0	1.1	0.09	1.87	2059.8	1024.1	191.2	<0.01	168.6	130.0	5.06	44.3	51.1	36.3	12.6	1.57	Sandy clay
S/12/5922	Pit 12 N.Bank	Horizon A	6.3	41.7	0	1.6	0.12	7.2	1987.96	1583.34	148.14	trace	72.54	35.89	0.01	9.99	59.7	31.0	9.3	1.51	Sandy clay loam
S/12/5923	Pit 12 N.Bank	Horizon B	6.7	53.7	0	1.0	0.10	9.5	2228.73	1775.64	189.77	trace	56.06	35.11	1.22	10.13	69.7	21.0	9.3	1.54	Sandy clay loam
S/12/5924	Pit 13 N.Bank	Horizon A	5.1	15.9	0	2.7	0.15	7.5	1277.70	865.38	155.60	trace	133.78	21.28	4.70	11.11	59.7	29.0	11.3	1.41	Sandy clay loam
S/12/5925	Pit 13 N.Ban	Horizon B	5.1	16.2	0	1.8	0.12	6.1	1446.24	788.46	141.47	trace	107.87	1.91	7.48	12.80	59.7	33.0	7.3	1.42	Sandy clay

Lab No.	Client's ref	Layer	pH	EC (uS/cm)	Salinity (ppt)	O.M (%)	N (%)	P (ppm)	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	Sand (%)	Clay (%)	Silt (%)	Bulk density (g/cm^3)	Textural class
	k																				loam
S/12/5926	Pit 13 N.Bank	Horizon C	5.7	18.6	0	1.7	0.12	5.0	1482.36	769.24	119.70	trace	122.01	14.82	3.30	11.81	57.7	35.0	7.3	1.51	Sandy clay
S/12/5927	Pit 14 N.Bank	Horizon A	5.2	21.4	0	3.5	0.19	4.4	1903.70	1205.12	155.12	trace	77.25	50.78	1.57	12.52	53.7	35.0	11.3	1.40	Sandy clay
S/12/5928	Pit 14 N.Bank	Horizon B	5.7	30.0	0	2.3	0.14	4.7	2000.00	1240.00	133.04	trace	65.48	123.63	2.61	14.06	49.7	37.0	13.3	2.43	Sandy clay
S/12/5929	Pit 14 N.Bank	Horizon C	5.5	20.9	0	1.6	0.11	4.6	1867.58	1006.42	130.02	trace	93.74	138.38	1.91	11.81	39.7	53.0	7.3	1.36	Clay
S/12/5930	Pit 15 N.Bank	Horizon A	5.5	15.0	0	2.8	0.17	29.0	1361.97	628.20	139.08	trace	107.87	26.67	0.87	15.04	63.7	25.0	11.3	1.58	Sandy clay loam
S/12/5931	Pit 15 N.Bank	Horizon B	5.5	11.9	0	1.9	0.12	6.1	1313.82	608.98	132.56	trace	86.68	59.08	4.00	13.64	43.7	49.0	7.3	1.52	Clay
Critical values			**5.2**			**3.0**	**0.20**	**<90**	**350.0**	**100.0**	**150.0**		**50.0**	**20.0**	**20.0**	**5.0**					
Sufficient levels			**5.2 - 7.0**	**<200**		**6.0**	**0.30**	**90-230**	**2000.0**	**600.0**	**500**										

Source: Adapted from the feasibility Study for the Ayago Hydro Power project

5.2.5 Transportation

This section presents the results of the traffic/transportation survey carried out by the feasibility team in the MFNP. Traffic survey was conducted at four junctions along routes entering into the MFNP. The routes considered will have a high possibility of supporting project traffic during development. The locations for the junctions are presented in Figure 18.

- Junction at Nanda road and Gulu highway,
- Junction at the route to Chobe lodge and Gulu highway,
- Junction at Purongo and Arua highway, and;
- Junction at Kiyanja trading center and Masindi-Kigumba road.

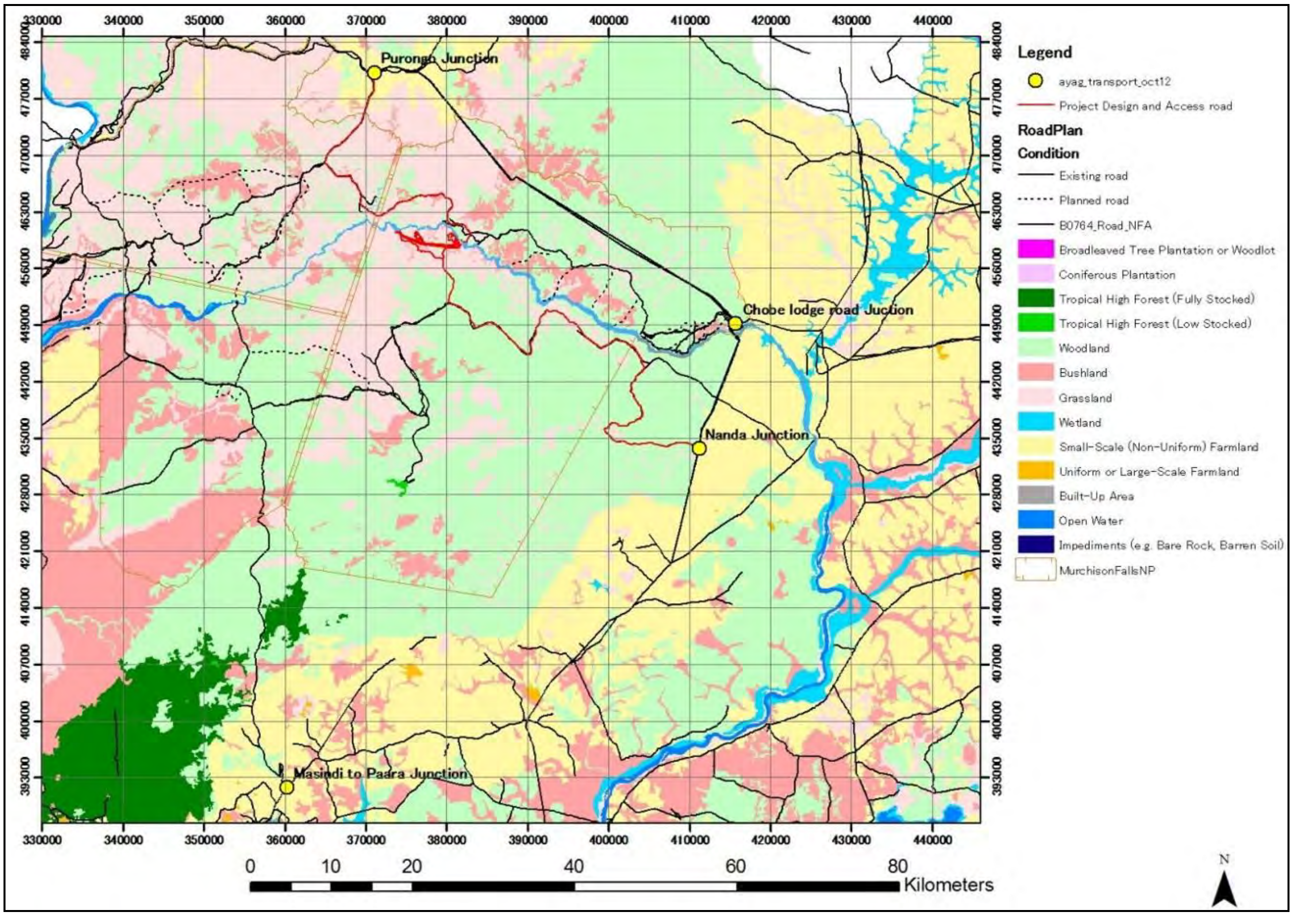

Figure 17: Traffic Survey points in MFNP

a) Data Validation

The traffic surveys were undertaken over a period of four days for each location to determine whether the traffic flows recorded were typical of those observed daily. The four days included Saturday, Sunday and other two week days to account for weekend traffic variations. To account for potential variations due to tourists' increment, the surveys were carried out in October 2012, January 2013 and April 2013.

Results

I. Vehicle Type

The recorded values are given in Table 41 and the proportions of the vehicle types at each counting station are presented in Figure 22 for the three months. Generally, at all junctions (counting stations) for the survey periods, the non-commercial vehicles were far more than the commercial vehicles. On average, the junction at Purongo and Arua highway had the highest percentage of commercial vehicles of 35% while the junction at Kisanja trading center and Masindi-Kigumba road had the highest percentage of non-commercial vehicles at 96%.

II. Average Daily Traffic (ADT)

On average, ADT at junctions at Nanda road and Gulu highway and at Purongo along Arua Highway was higher on weekends than on week days. This can be attributed to tourists visiting the park and traffic from Kampala to upcountry areas during weekends. The junction at Kiyanja trading center along Masindi-Kigumba road had the highest ADT of 1350 on weekdays compared to the lowest of 487 observed on weekdays at the junction at Purongo along Arua highway. Observed ADT is presented in Table 40. During construction and operation of the hydropower project, the movement of vehicles associated with activities of the plant on any day is expected to have minimum impact on the existing traffic flow at all junctions.

III. Average Hourly Traffic (AHT)

The AHT results are shown in Table 40. Generally, at all junctions, AHT increased from morning to evening along the main roads and access routes in all the three months. Thus to minimize the impact on traffic flow during the construction phase of the hydropower plant, scheduling for movement of materials should take advantage of the low AHT during the morning period of 7am to 11am.

IV. Access routes

Four access routes into the park were considered for this traffic study; access routes from Purongo town, Kisanja trading center and through Nanda road and route to Chobe Safari lodge just after Karuma bridge. The analysis of collected traffic field data reveals that the mostly used access routes are; access routes from Purongo town along Karuma – Packwach road and Kisanja Trading center along Masindi town – Kigumba road. Karuma – Packwach road is a tarmacked national road while Masindi town – Kigumba road is a murram road. Information from UNRA reveals that this road is under plan to be upgraded to tarmac. There is a difference, in terms of ADT, observed between the mostly used access routes and the remaining two routes. From collected data and field observations, Nanda road is entirely out of use except for the occasional Ayago HPP related vehicles despite being the shortest route to the southern bank from Karuma. This scenario may change after the road is upgraded for either project activities or UWA operations. The latter is now a realistic possibility since our biological surveys have established quantities of game that was previously under estimated.

Most of the traffic flow along the Chobe route from Karuma falls is associated with activities related to Chobe safari lodge. The route from Kisanja trading center is the mostly used access route though most of the traffic flow is not associated with activities related to the park. Most of the traffic flow serves the villages around Kisanja trading center center while most traffic flow along the route from Purongo town on Arua highway is to the park.

Table 39: Observed ADT at the count locations

Month	October		January		April		Average	
Location	ADT		ADT		ADT		ADT	
	Along the Main Road		Along the Main Road		Along the Main Road		Along the Main Road	
	Week days	Week-ends	Week days	Week-ends	Week days	Week-ends	Week days	Week-ends
Junction at Nanda Road and Gulu Highway	851	1052	1372	1490	1144	1199	1122	1247
Junction at the route to Chobe and Gulu Highway	917	1035	1346	1294	1188	1093	1150	1140
Junction at Kiyanja Trading Center and Masindi-Kigumba Road	1389	1329	1395	1262	1268	1076	1350	1222
Junction at Purongo and Arua Highway	468	427	434	597	559	683	487	569

V. National Data (UNRA)

Data associated with the main roads considered in this traffic study was obtained from Uganda National Roads Authority (UNRA report) for the year 2009. Karuma – Purongo section along Karuma-Packwach road had AADT of 427 while Masindi-Kigumba road had AADT of 944. The growth rate is taken as 6%. All collected traffic survey data is given in Table 41.

VI. Heavy/Commercial Vehicles

Generally, at all junctions (counting stations), the non-commercial vehicles were far more than the commercial vehicles. The junction at Purongo and Arua highway had the highest percentage of commercial vehicles of 35% while the junction at Kisanja trading center and Masindi-Kigumba road had the lowest percentage of commercial vehicles at 4%.

VII. Pedestrian and Bicycle Facilities

The considered roads currently have no specific facilities for pedestrians and cyclists within the Study area. Pedestrians and cyclists currently use the highway/road shoulders and informal verge where available; however, pedestrian volumes are low though cyclists' volumes are high.

Table 40: Number of vehicles and vehicle type observed

Month/Year		Oct-12		Jan-13		Apr-13		Average	
Location	Vehicle Type	No. of Vehicles in 4 days		No. of Vehicles in 4 days		No. of Vehicles in 4 days		No. of Vehicles in 4 days	
		Alo ng the Mai	From/In to the Park	Alo ng the Mai	From/In to the Park	Alo ng the Mai	From/In to the Park	Alo ng the Mai	From/In to the Park

		n Road		n Road		n Road		n Road	
Junction at Nanda Road and Gulu Highway	Motorbike	717	4	1875	-	1278	-	1290	1
	Car + Taxis	964	-	848	-	799	-	870	-
	Small bus	929	5	918	-	765	-	871	2
	Small truck	39	-	493	-	474	-	335	-
	Large bus	272	-	373	-	314	-	320	-
	Medium truck (2 axles with twin rear tyres)	461	-	493	-	513	-	489	-
	Heavy truck (3 axles)	161	-	259	-	194	-	205	-
	Heavy truck (4 or more axles)	277	-	497	-	378	-	384	-
Junction at the route to Chobe and Gulu Highway	Motorbike	877	26	1118	25	1149	30	1048	27
	Car + Taxis	988	28	1452	37	653	9	1031	25
	Small bus	846	54	654	39	812	22	771	38
	Small truck	41	3	362	10	560	6	321	6
	Large bus	268	-	373	-	295	-	312	-
	Medium truck (2 axles with twin rear tyres)	453	5	436	3	497	-	462	3
	Heavy truck (3 axles)	161	-	294	-	213	-	223	-
	Heavy truck (4 or more axles)	269	-	532	-	378	-	393	-
Junction at Kiyanja Trading Center and Masindi-Kigumba Road	Motorbike	4474	3238	4060	2956	3996	2702	4177	2965
	Car + Taxis	553	143	510	64	358	76	474	94
	Small bus	172	106	306	162	270	81	249	116
	Small truck	77	31	186	78	136	53	133	54
	Large bus	8	8	20	3	13	9	14	7
	Medium truck (2 axles with twin rear tyres)	241	33	257	45	163	25	220	34
	Heavy truck (3 axles)	14	5	20	4	16	-	17	3
	Heavy truck (4 or more axles)	9	-	11	-	8	1	9	-
Junction at Purongo and Arua Highway	Motorbike	457	327	861	448	2476	1401	1265	725
	Car + Taxis	207	6	149	2	207	31	188	13
	Small bus	322	49	175	17	289	45	262	37
	Small truck	26	27	160	12	251	52	146	30
	Large bus	116	2	96	-	86	-	99	1
	Medium truck (2 axles with twin rear tyres)	287	2	160	3	250	102	232	36
	Heavy truck (3 axles)	113	9	115	2	96	5	108	5
	Heavy truck (4 or more axles)	261	8	307	2	296	2	288	4

Adopted from the feasibility study developed for the Ayago HPP between October 2012 and January - April of 2013

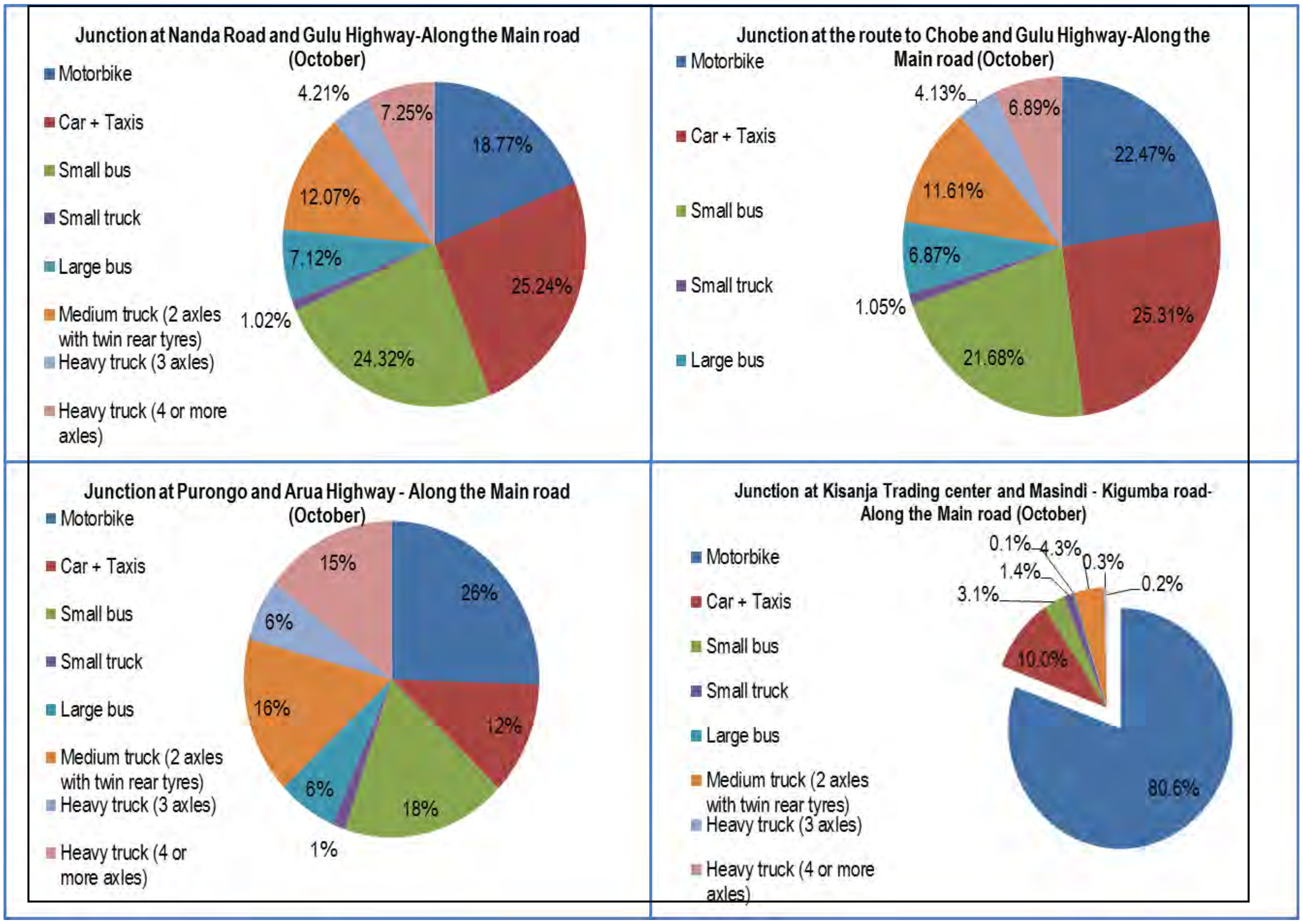

Figure 18: Proportions of the vehicle types at each counting station

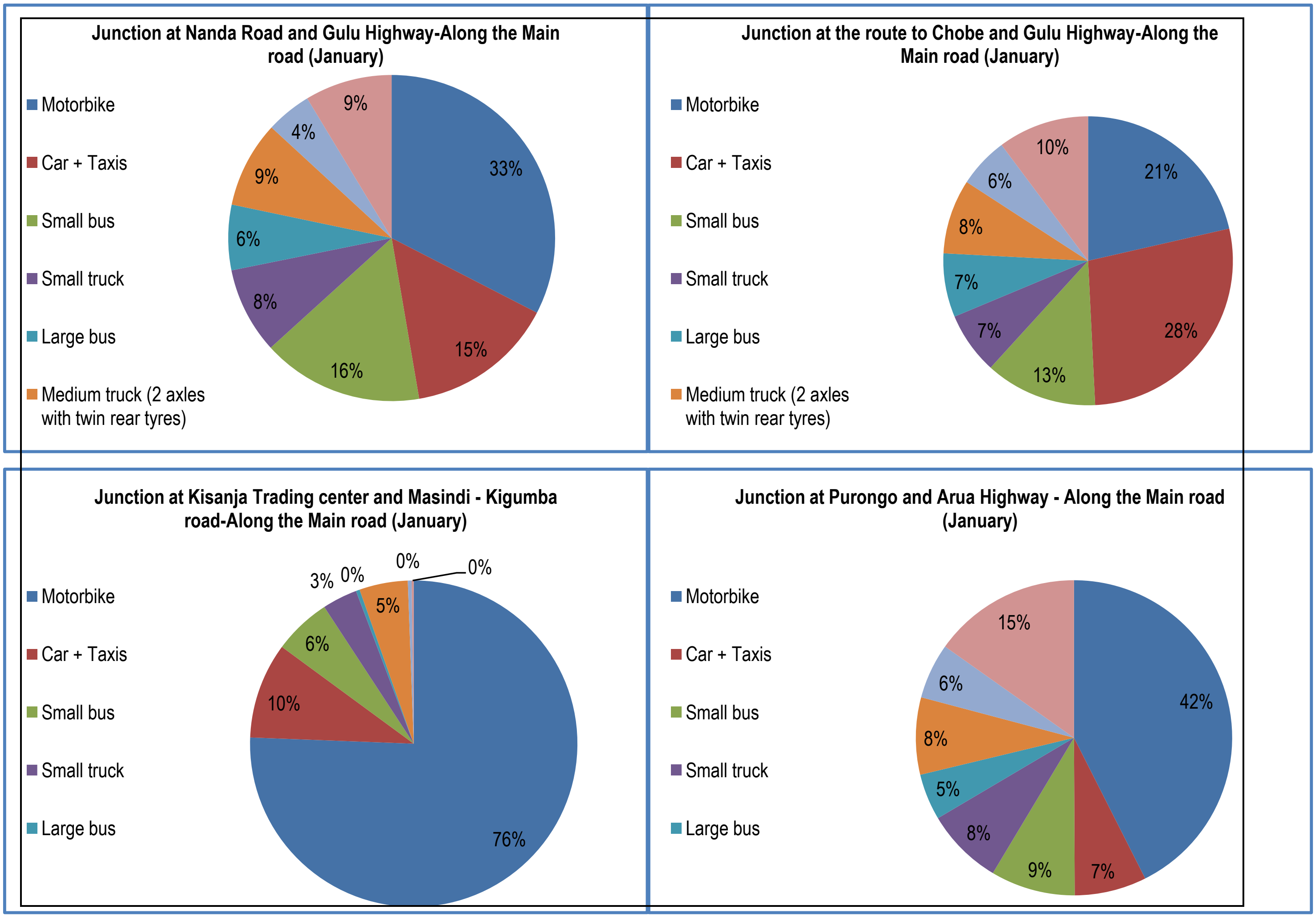

Figure 19: Proportions of the vehicle types at each counting station

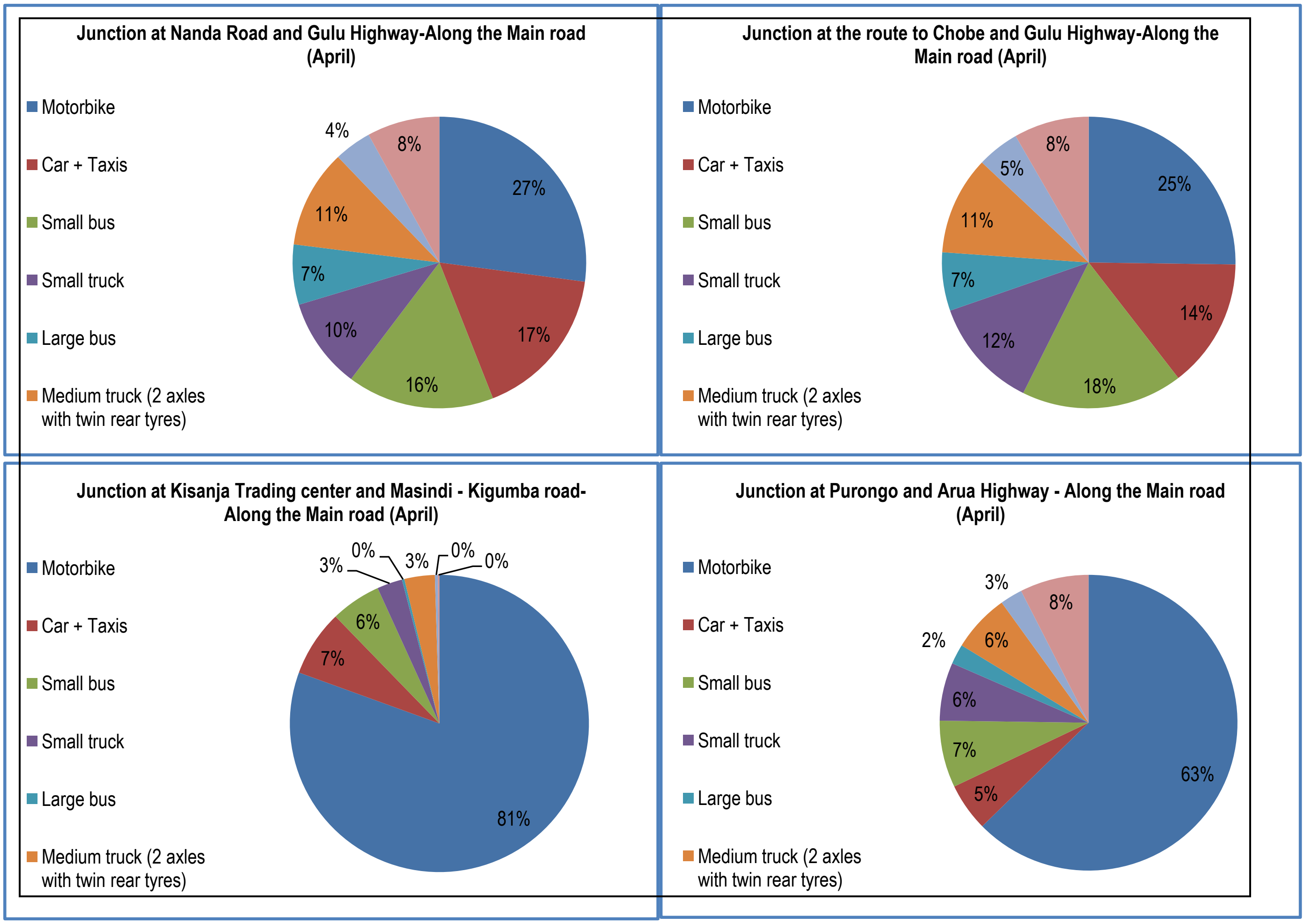

Figure 20: Proportions of the vehicle types at each counting station

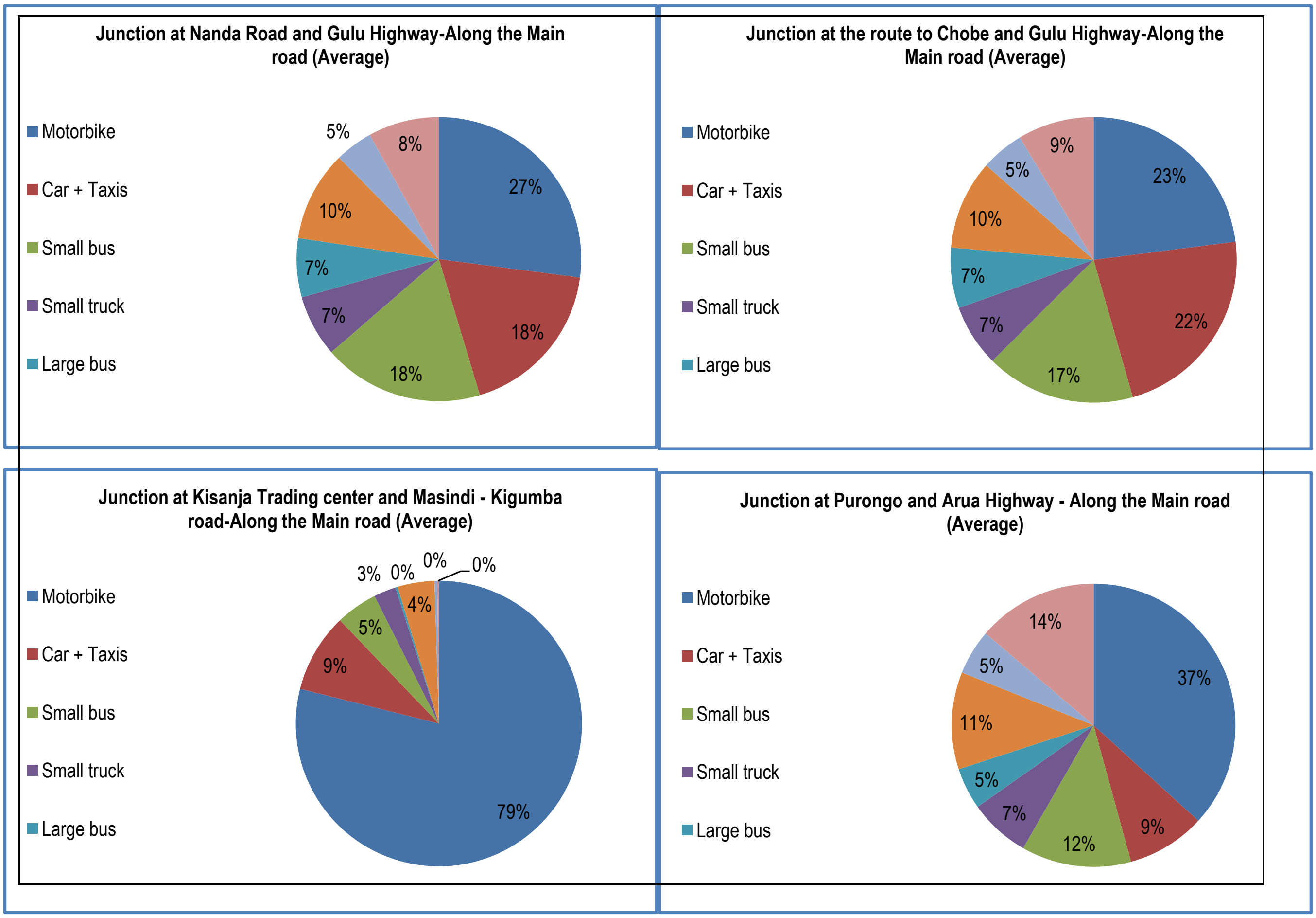

Figure 21: Proportions of Observed vehicle types

Table 41: Observed Traffic at the count locations

Month	Location	Date	Time Period (Hours)	No. of Vehicles								Comments
				Along the Main Road				From/Into the Park				
				To Kampala		To Gulu		From		To		
				Non-Commercial	Commercial	Non-Commercial	Commercial	Non-Commercial	Commercial	Non-Commercial	Commercial	
October	Junction at Nanda Road and Gulu Highway	Sat 13th	7am to 11am	137	40	106	56	1	-	1	-	Dry
			11am to 3pm	171	66	117	44	1	-	1	-	Dry
			3pm to 7pm	103	77	101	52	-	-	-	-	Dry
		Sun 14th	7am to 11am	60	30	86	71	-	-	-	-	Dry
			11am to 3pm	130	68	110	46	-	-	-	-	Dry
			3pm to 7pm	130	70	172	60	-	-	-	-	Heavy Rains
		Mon 15th	7am to 11am	82	23	82	29	2	-	-	-	Dry
			11am to 3pm	114	60	128	23	2	-	-	-	Dry
			3pm to 7pm	106	55	146	35	-	-	-	-	Heavy Rains
		Tue 16th	7am to 11am	79	29	100	43	-	-	4	-	Dry
			11am to 3pm	98	65	115	41	-	-	-	-	Dry
			3pm to 7pm	70	51	89	38	-	-	-	-	Dry
	Junction at the route to Chobe	Sat 13th	7am to 11am	129	37	80	56	5	-	4	-	Dry
			11am to 3pm	162	51	116	42	11	-	10	-	Dry
			3pm to 7pm	102	83	96	39	4	-	2	-	Dry

	and Gulu Highway	Sun 14th	7am to 11am	64	27	87	62	10	-	4	-	Dry
			11am to 3pm	148	66	118	45	3	-	2	-	Dry
			3pm to 7pm	143	74	187	56	3	-	5	-	Heavy Rains
		Mon 15th	7am to 11am	91	34	97	36	6	-	3	1	Dry
			11am to 3pm	102	58	111	19	3	2	3	1	Dry
			3pm to 7pm	86	62	145	41	6	-	5	1	Heavy Rains
		Tue 16th	7am to 11am	90	26	79	43	3	-	3	-	Dry
			11am to 3pm	112	62	130	37	3	-	3	-	Dry
			3pm to 7pm	115	61	151	46	5	-	5	-	Dry
	Junction at Kiyanja Trading Center and Masindi-Kigumba Road			To Masindi Town		To Kigumba Town						
		Thur 18th	7am to 11am	230	6	169	18	143	-	95	1	Dry
			11am to 3pm	207	11	196	14	117	5	113	2	Dry
			3pm to 7pm	196	20	240	10	126	1	125	5	Dry
		Fri 19th	7am to 11am	240	7	197	15	136	1	98	2	Dry
			11am to 3pm	215	10	203	20	159	3	117	4	Dry
			3pm to 7pm	243	20	281	9	130	1	160	2	Dry
		Sat 20th	7am to 11am	206	5	196	24	148	-	132	1	Dry
			11am to 3pm	241	13	263	11	131	3	143	2	Dry
			3pm to	244	13	246	12	152	3	151	-	Dry

			7pm									
		Sun 21st	7am to 11am	177	6	157	8	146	2	142	6	Dry (Market Day)
			11am to 3pm	192	6	196	15	152	2	125	1	Dry (Market Day)
			3pm to 7pm	201	6	203	17	161	2	126	5	Dry (Market Day)
	Junction at Purongo and Arua Highway			To Kampala		To Packwach						
		Thur 18th	7am to 11am	48	22	59	25	27	-	13	2	Dry
			11am to 3pm	54	45	36	25	22	1	18	1	Dry
			3pm to 7pm	60	21	47	23	20	3	29	-	Dry
		Fri 19th	7am to 11am	36	17	26	54	14	-	15	1	Dry
			11am to 3pm	56	30	56	41	10	-	12	-	Dry
			3pm to 7pm	42	28	43	42	8	3	17	1	Dry
		Sat 20th	7am to 11am	21	25	22	34	20	1	20	1	Dry
			11am to 3pm	46	26	37	28	12	-	11	-	Dry
			3pm to 7pm	51	43	44	35	21	6	15	1	Dry
		Sun 21st	7am to 11am	29	22	31	46	15	-	7	-	Dry
			11am to 3pm	42	38	44	36	26	1	18	-	Dry
			3pm to 7pm	40	30	42	41	16	-	12	-	Heavy Rain

Adopted from the feasibility study developed for the Ayago HPP between October 2012 and January - April of 2013

I. Traffic Noise Analysis

Noise will be generated during both the construction and operation of the dam. Thus noise and vibration assessment criteria apply to both the construction and operational phases of the HPP dam development.

During construction works, airborne noise is generated by construction equipment such as bulldozers, rock-breakers, compactors and generators. In the operational phase, road traffic generates airborne noise, due to both the rolling noise of vehicle wheels on the road surface, and engine/exhaust noise of vehicles (especially heavy vehicles such as articulated truck/trailer units). Airborne noise spreads concentrically from the source, with sound levels reducing progressively with increase in distance. For a source of significant length, such as a many vehicles travelling along the same stretch of road, the attenuation of sound with distance is less than for a "point" source such as a stationary vehicle or an item of construction plant.

Some noise sources have particular directivity characteristics, i.e. the noise is radiated more intensely in certain directions. For example, exhausts from earth moving machinery are often noisier in the direction that their exhaust is pointing. The height of the source above ground levels can also be relevant. Elevated sources such as the exhaust of a heavy diesel truck may result in a sound propagation path that is less obstructed by topographical features or noise barriers, resulting in higher noise levels at a given distance.

Features that block the sound propagation path, such as ridge lines or man-made objects such as buildings or noise barriers, result in the attenuation of noise relative to an uninterrupted path. Care must be taken as large sound reflecting surfaces, such as construction site buildings, can also result in the reflection of additional sound that can adversely impact on noise sensitive receivers. Airborne noise is generally assessed in terms of the external noise level at a receiver position. Resulting noise levels within buildings will be lower as a result of the sound attenuation provided by the building envelope. The extent of this noise reduction depends on the building construction; with windows open, internal noise levels are typically approximately 10 dB (A) lower than external levels. With windows closed, external levels may be attenuated by 20 dB (A) or more.

Noise and vibration impacts on the community especially during material transportation may be categorized as follows, in order of increasing severity:

- Community/resident annoyance,
- Disturbance to community/resident activities (e.g. sleep disturbance) and
- Adverse effects on human health (e.g. increased blood pressure, heart rate or impaired performance due to lack of sleep).

Airborne noise has been known to have other adverse effects, such as sleep disturbance for humans, and effects on wildlife, but less research has concentrated on these impacts, and the evidence demonstrating the extent of the impacts is not clear. Attended ambient noise measurements were conducted at locations of Nanda and Chobe junctions using an Extech Noise meter for a trailer (6-axles) and bus during the day. The sound level meter were mounted on tripods 1.5 m above ground level and set to fast time response for all measurements. The LAeq indices were measured in free-field conditions (i.e. away from noise reflecting structures) with a sample period of 15 minutes. Weather conditions were noted throughout the measurement periods and noise measurements were discarded where weather conditions were not suitable for noise monitoring (i.e. rain, wind speed > 5m/s).

The 15-minute attended ambient noise measurement results are presented in Table 43.

The measurements indicate that the 'acute' noise level of 55 dBL_{Aeq} specified for the general environment in a mixed residential (with some commercial and entertainment) levels for day time is currently exceeded at the measurement locations. Further away from the highway traffic, noise levels are generally high and above the target level of 50 dBL_{Aeq}. Therefore there is current traffic noise exposure at these locations. The highest sound level measured at a location is 85.8 dB(A) which is 30.8 dB higher than the national criterion.

Table 42: Noise Measurements

Measurement point	Noise measurement location and coordinates (WGS 84 UTM 36N)	Sound pressure level dBA (Trailer – 6 axles passing)	Sound pressure level dBA (Bus passing)	Meet NEMA standards (Day – time limits 55 dBA)
		LAeq	LAeq	
1	Chobe Safari Lodge Junction 415778: 249241	80.2	68.5	No/No
2	Chobe Safari Lodge Junction 415787: 249193	68.8	61.6	No/No
3	Chobe Safari Lodge Junction 415795: 249144	62.6	58.2	No/No
4	Nanda Junction 411212: 233719	85.8	74.5	No/No
5	Nanda Junction 411257: 233699	65.2	58.5	No/No
6	Nanda Junction 411298: 233698	64.0	54.2	No/Yes

Source: Feasibility baseline survey for the Ayago Hydropower plant

As the proposed HPP dam is not expected to increase traffic flow more than 30%, the noise exposure of most residences is expected to change only marginally.

Future Traffic Growth

I. Selected Forecast Years

For the purposes of analysis, a planned starting year of 2016 for construction of the proposed project has been used. It should be noted however that this is a planning starting date of construction and the actual year of opening of the constructed dam will be dependent on project approval and the availability of funding.

II. Highway Traffic Growth Rate

A forecast traffic growth rate of six percent (average value) has been adopted, based on the UNRA report of 2009. A base year of 2009 has been adopted for analysis as this corresponds to the obtained UNRA traffic counts data of 2009. According to the UNRA, Masindi-Kigumba road had AADT of 944; with a growth rate of 6% the road should have an AADT of 1114 in 2013. However, according to the baseline surveys carried out in the three months, Masindi-Kigumba road had maximum ADT of 1350 (average) during the week days corresponding to a growth rate of 10.8%. The difference in the growth rates may be partly attributed to the discovery of petroleum deposits in the Bunyoro region leading to increased economic activities.

Similarly, according to the UNRA report of 2009, Karuma-Purongo section along Karuma-Packwach road had AADT of 427; with a growth rate of 6% the section should have an AADT of 504 in 2013. However, according to the baseline surveys carried out in January 2013, Karuma-Purongo section had maximum ADT of 569 on weekends corresponding to a growth rate of 9.5%. Again the difference in the growth rates may be partly attributed to the discovery of petroleum deposits in the park and increased tourism activities. To account for these effects, an interim growth rate of 10 percent has been adopted over the 13-year period between 2013 and 2026.

III. Future Highway Traffic Volumes

ADT volumes along the highways at the count stations have been forecast for 2016 and 2026 as shown in Table 44. These represent traffic volumes along the highways with no effect of the proposed project. These volumes indicate that current traffic volumes will have more than doubled by 2026.

Table 43: Forecast Traffic Volumes – No Effect of Proposed Project

Location	Forecast Year	AADT
Junction at Nanda Road and Gulu Highway	2009 (Base)	-
Junction at the route to Chobe and Gulu Highway		-
Junction at Kiyanja Trading Center and Masindi-Kigumba Road		944
Junction at Purongo and Arua Highway		427

Location	Forecast Year	AADT	
		Week days	Weekends
Junction at Nanda Road and Gulu Highway	2013	1122	1247
Junction at the route to Chobe and Gulu Highway		1150	1140
Junction at Kiyanja Trading Center and Masindi-Kigumba Road		1350	1222
Junction at Purongo and Arua Highway		487	569
Junction at Nanda Road and Gulu Highway	2016	1459	1621
Junction at the route to Chobe and Gulu Highway		1495	1482
Junction at Kiyanja Trading Center and Masindi-Kigumba Road		1755	1589
Junction at Purongo and Arua Highway		633	739
Junction at Nanda Road and Gulu Highway	2026	2917	3241
Junction at the route to Chobe and Gulu Highway		2990	2965
Junction at Kiyanja Trading Center and Masindi-Kigumba Road		3511	3178
Junction at Purongo and Arua Highway		1265	1479

5.2.6 Natural Disasters

The major naturally triggered disasters that Uganda faces include: floods, landslides, earthquakes, drought, disease epidemics and pest infestations[2]. The MFNP in particular is prone to wild fires which occur on an annual basis. The historical records of natural disasters in Uganda as a whole are generally scarce and where available are not adequately detailed.

Results
The natural disasters for which the following sections detail in relation to the Ayago HPP area include wild fires, earth quakes and landslides, floods, disease epidemics and droughts.

I. Wild Fires

The MFNP experiences annual fires during the dry seasons some of which are wild and uncontrolled while others are controlled fires by UWA. Wild fires are known to ravage the park ecosystems. The onset of wildfires is common towards the beginning of dry seasons. The areas within the Park that are prone to annual fires include areas stretching from Purongo-Latoro-Tangi, Delta-Buligi on the North Bank of River Nile which has open grassland areas dotted with borossus palm. The Mubako-Bugana stretch on the western border of the Park and Kichumbanyobo-Nyakorongo-Nyamahasa stretch in Karuma Wildlife reserve are characterized by woody vegetation on the west and forested on the south and are all prone to wild fires. Fire is also used as a management tool. Park Management does early burning, that is, sets prescribed fires at the beginning of the dry season before the vegetation completely dries out to avoid hot fires that devastates the park.

Culturally, in Acholi fires are used by the local community for hunting small animals like African giant rats, cane rats and these fires end up reaching the protected area. The poachers set early fires to encourage growth of young green and lush vegetation that can attract wild animals to the Park periphery. Murchison Falls National Park has many access roads where people moving through carelessly throw cigarette butts ending up causing fire. Thickets opened up by the elephants are especially vulnerable to the hot annual fires sweeping through the park (UWA, 2012). Fire climax species which grow to 1-3 m in the wet season, form fuel for these hot fires.The very slow growing species are especially adversely affected by fires, for example younger trees of *Borassus aethiopum* palms need a period free of fires to survive and form a stem. Thus development activities of Ayago HPP project need to minimize impact on fire vulnerable species, avoid activities that may enhance fires in the park and protect operational zones from wild fires.

II. Earth Quakes and land slides

Uganda is located in the between the Eastern and Western Rift Valleys. Many parts of Western Uganda are prone to seismic activity. The Ayago HPP site is located in seismic Zone 1, as shown in Figure 23. Zone 1 is the most seismically active region in Uganda. The majority of the seismicity is recorded to be related to the major rift faults flanking the rift valley. However, a number of earthquakes have been attributed to faults within the rift valley trough. In Uganda, areas prone to landslides include the mountainous regions of Kabale and

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2 Review and Analysis of Existing Drought Risk Reduction Policies and Programmes in Uganda:
http://www.unisdr.org/files/8160_UgandaDroughtRiskReductionPolicyAnalyticalReport.pdf

Kisoro (Western Uganda), Mbale, Sironko and Kapchorwa (Eastern Uganda). There are neither earth quakes nor landslides recorded for the Ayago HPP site area.

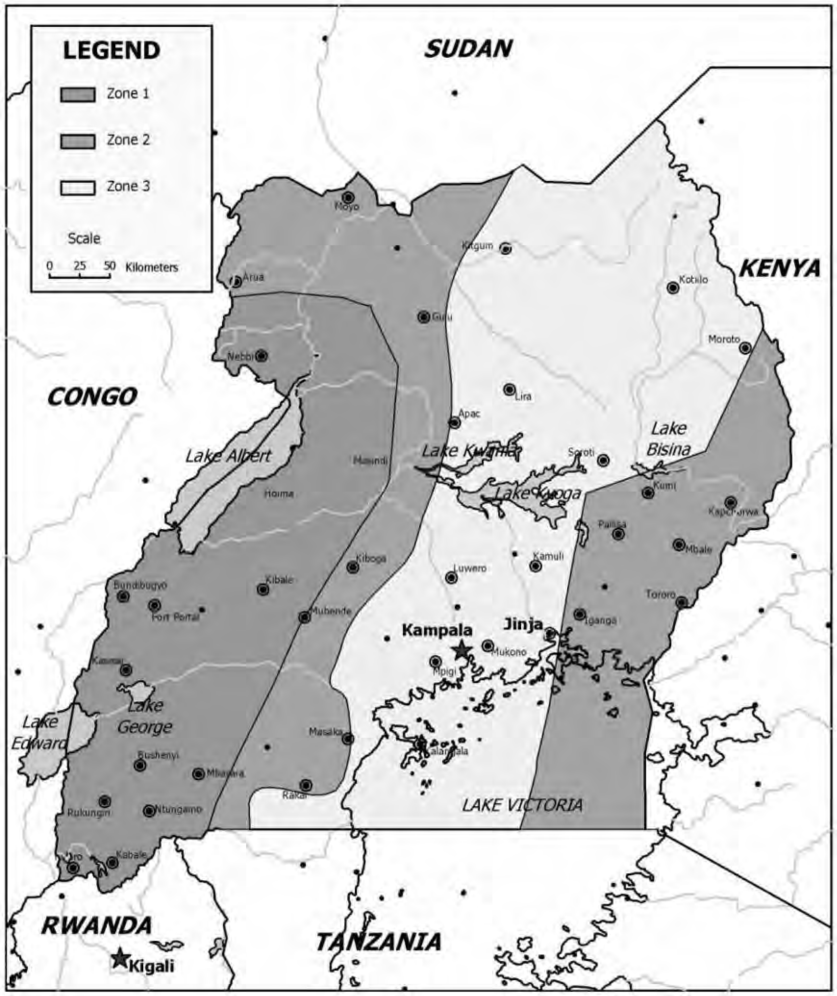

Figure 22: Seismic Zones of Uganda

Source: Department of Geological Survey and Mines

III. Floods

Floods are relatively common in different parts of the country, especially during the cycle of adverse weather that follows the El-Niño years (East Africa HEALTH Alliance)[3]. Floods in Uganda are exacerbated by the heavy El Niño rains, which swell many rivers and inundate the relatively low-lying flat areas of the country. The regions which are most prone to floods in Uganda are Kampala in central Uganda, the Lake Victoria basin, and the eastern and northern parts of the country[4]. There are no flood records to indicate that the Ayago project

3East Africa HEALTH Alliance; http://open.umich.edu/sites/default/file...alysis_for_uganda-final.rt

4http://www.preventionweb.net/files/21032_ugandanationalpolicyfordisasterprep.pdf area was inundated in the recent past although there tales of large flooding of the River Nile that resulted in washing of a bridge above the Murchison Falls.

IV. Droughts and Famine

Droughts are the most frequent and widespread risk disaster in Uganda. More people have been affected by drought in Uganda than by any other kind of natural disaster. Parts of the country are affected by famine due to prolonged periods of drought that normally occur in a cyclic pattern of every three to five years, for example seven droughts were experienced between 1991 and 2000. Given the well documented global changes in weather patterns however, drought cycles in Uganda are now occurring every two years instead of five years; the increase in frequency and severity is more evident in the northern and eastern parts (semi-arid areas) of the country, with resultant drop in water tables. Drought normally occurs in the regions, where the land is semi-arid in nature. The northern parts of Uganda suffered from drought in 1985, 1994, 2000, 2005 and 2006[5]. Other parts of the country are also hit by sporadic drought, especially along the 'cattle corridor' of the mid-western districts (IRIN)[6]. Uganda is under a threat of annual droughts, which is likely to expose a large part of the population to food insecurity and famine.

V. Disease epidemics

Disease epidemics are the single most important public health emergency in the country. South-western Uganda, where temperatures have risen by 0.3 degrees in a decade, is one of the hardest-hit areas in terms of disease outbreaks, especially malaria (IRIN). About 90% of the country is hyper-endemic for malaria, some high altitude regions in Western Uganda are continually threatened by epidemics of un-stable malaria (East Africa HEALTH Alliance).

There are repeated propagated epidemics of cholera especially around the rift valley areas of western Uganda, the Internally Displaced Camps (IDP) of Northern Uganda, and parts of Kampala City, where human settlement in wetlands has disrupted storm water flow and has led to extensive contamination of underground aquifers. Records show outbreaks of meningitis in the West Nile, hepatitis in Kitgum and Plague in Nebbi and Apac Districts. In the last 10 years, Uganda has had three outbreaks of Hemorrhagic fever, two of which have been due to Ebola, with the most recent outbreak in Bundibugyo District had 134 cases, with a case fatality rate of 25%, including four (4) health workers.

Several outbreaks of the Mouth and Foot Disease were reported throughout the country: Isingiro District, Rakai District, Ntungamo district and Kiruhura District which are South Western Uganda, close to Tanzania border. An outbreak was reported in Wakiso district which is very close to the capital city of Kampala. Although there are no records to indicate that the Ayago project area was engulfed by a disease epidemic outbreak, given the dynamic interaction of communities in Uganda, occurrence of a disease epidemic may pose some degree of risk to the human resource of the Ayago HPP. Thus, since the Ayago HPP site in located in the MFNP which is

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5 IDRL in Uganda: http://www.ifrc.org/PageFiles/41164/UGANDA-report.pdf

6 UGANDA: Rising temperatures threatening livelihoods http://www.irinnews.org/report/83267/uganda-rising-temperatures-threatening-livelihoods

not inhabited, extra care should be focused on protecting the human resource involved in the development and operation of the HPP who will be staying and therefore interacting with communities out site of the MFNP.

5.3 Biological Environment

The main aim of the study was to provide baseline information about the vegetation of the project area. This was necessary in light of the impact of the proposed hydropower project activities may have on vegetation species in the area.

5.3.1 Vegetation

Survey points for the study are shown in Figure 24.

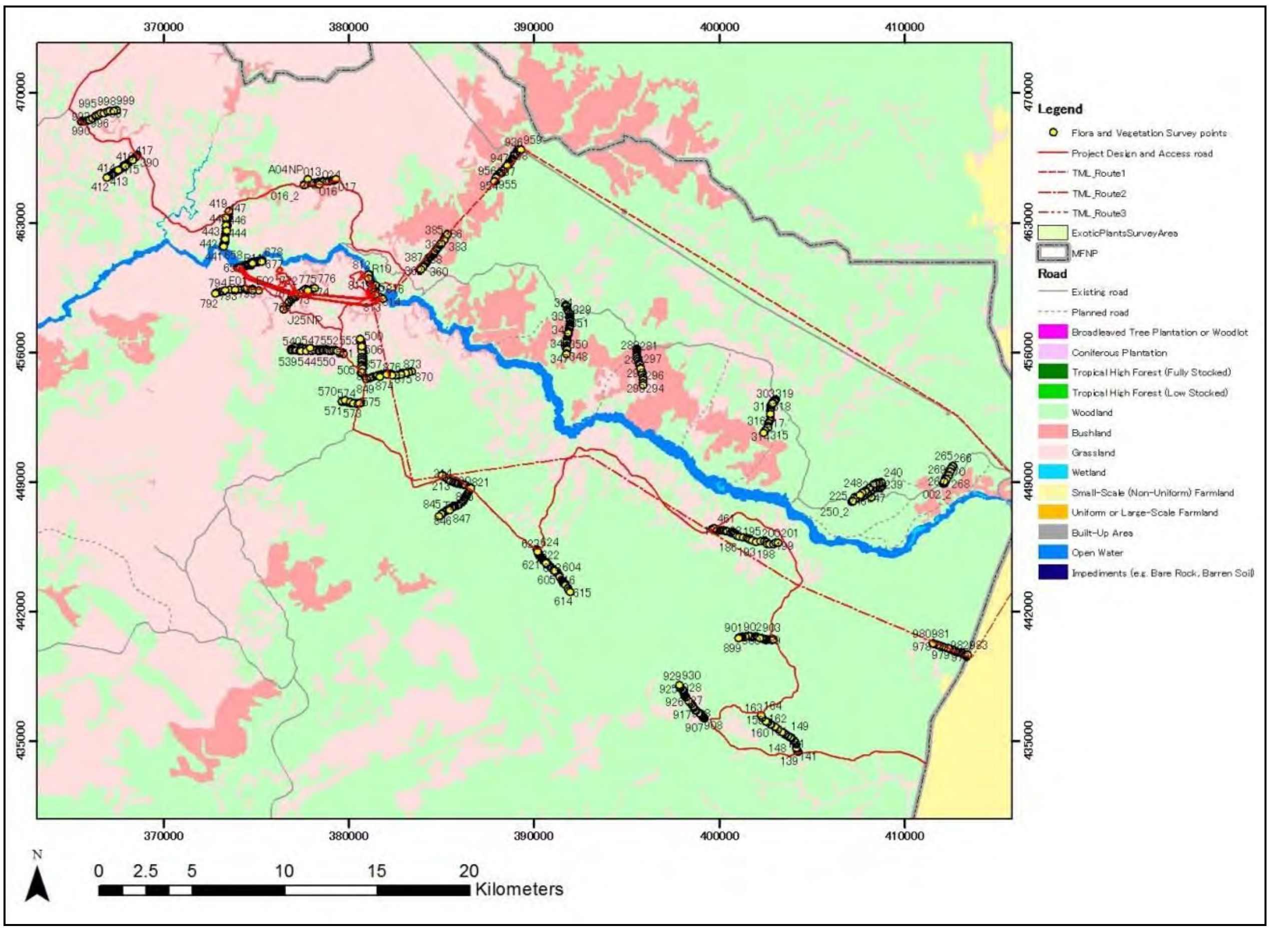


Figure 23: Survey Points of vegetation (October 2012)

Results

Vegetation types

The areas that were surveyed are covered in six broad natural vegetation types described below:

a) Wetland

This kind of vegetation type was limited in distribution. They were found in valley bottoms along big streams and rivers. It is a special habitat with terrestrial and aquatic affinities, supporting flora tolerant to flooding whose regime may be permanent or temporary. The main type of wetland observed was *Loudetia phragmitoides* and *Leersia hexandra* marshes with *Triumfetta macrophylla*. These are often mixed with *Dissotis* spp. and occasionally the tall *Phragmites mauritianum*. Along the Nile were isolated wetlands of *P. mauritianum* as small islands. It was always along river or stream valleys where permanence of water could permit a permanent wetland. Some of those encountered were permanent wetland ecosystems, under constant water logging conditions all year round, while the others were only seasonally flooded. Smaller pockets of wetland were observable in some areas as small localized pools of water with floating communities such as *Nymphaea nouchalii* var. *caerulea* in water wallows.

b) Riverine Forest

This is the kind of vegetation often with tall trees to c.35m high, forming a continuous canopy cover and having a vertically stratified structure. Dominant species recorded included *Kigelia africana*, *Trichilia emetica*, *Khaya anthotheca*, while *Vepris nobilis* and *Monanthotaxis buchananii* are frequent in the understorey. The intermediate layer usually supports a tangle of shrubs and unbranched vines, forming a dense tangle. The floor is devoid of any cover in most cases, or with sparse cover of shade-tolerant grasses such as *Oplismenus hirtellus*. Succulent *Sansevieria* spp. are common under the heavy shade conditions of the tangle. In the surveyed project area, this vegetation type is of very limited distribution, occurring mainly along the bigger rivers, particularly the Nile and Ayago.

c) Riverine Thicket

This kind of habitat was along the bigger Victoria Nile. It fronts the riverine forest on the drier end, separating riverine forest from the wooded grassland. Dominant woody species were *Carissa spinarum*, *Harissonia abyssinica*, *Maytenus undata* and *Capparis* spp. This vegetation type was mainly along Victoria Nile.

d) Woodland

This is vegetation often > 8 m high, with trees whose canopy is fairly dense but not closing. The dominant species of trees in the project area were variable. In most cases, *Terminalia glauscecens* and *Albizia grandibracteata* dominated, especially in the south part in Karuma Wildlife Reserve where they formed a dense tangle variably of *Dioscorea* spp., *Aframomum alboviolaceum*, *Piper umbellata*. *Acacia polyacantha* was dominant in the moist valleys. *Combretum collinum, Acacia sieberiana,* and *Piliostigma thonningii.* This kind of vegetation was very widespread, covering vast areas in the project area, particularly on the south side of the Nile along the Nanda road, off the Kafu-Karuma highway. The herbaceous layer was mainly composed of *Dioscorea* spp. forming dense tangle, *Pennisetum unisetum*, *Rottboellia cochinchinensis, Piper umbellata.* In moister areas, e.g. along stream valleys, *Acacia sieberiana* forms near-pure stands in places, e.g. near Chobe Safari Lodge. These *Acacia* woodlands are sparsely covered with a grassy layer of low stature in places owing to overgrazing.

e) Wooded Grassland

These are vegetation types with dominance of grasses in the herbaceous layer, and a canopy cover of woody plants often 10-50% (Langdale-Brown *et al*. 1964). In the area surveyed, these communities were variable in composition and structure. However, the common and dominant species in different mixtures included *Stereospermum kunthianum, Combretum collinum, Grewia mollis, Bridelia scleroneura, Piliostigma thonningii,* with *Hyparrhenia filipendula, H. pilgeriana, Imperata cylindrical* and *Loudetia arundinacea* as the main grass species.

f) Open Grassland

This kind of vegetation is composed of communities with a high coverage of the grass layer, with a much smaller percentage of woody species often <5% (Langdale-Brown *et al*. 1964), with only sparse occurrence of trees and shrubs. This kind of vegetation is more common on the northern bank of Victoria Nile, but some sizeable expanses are also found on the southern bank of the project area, including parts of the core grid area with a dense coverage of game cameras in the Direct Impact Zone. Grasses common here include: *Sporobolus pyramidalis*, *Hyparrhenia filipendula* and *H*. *rufa.* The grass height is often up to 2 m but may be a little higher.

Floristics

Species Richness

The area was found to be rich judging from earlier studies in the area and other parts of the park. A total of 557 plant species were recorded from the entire project area during the field survey. The woody species altogether contributed 31.2% by species richness as compared to 68.8% of the non-woody species.

Life Forms

Figure 28 shows the relative frequency of the different forms by number of species. By far, most species were herbs. In total, there were 170 species of woody plants versus 387 of non woody species. In terms of abundance, the woody species contributed 44.3% in comparison to non-woody 55.7%. The highest abundance (estimated by cover on the DAFOR scale) was of trees followed by herbs and grasses (Figure 25).

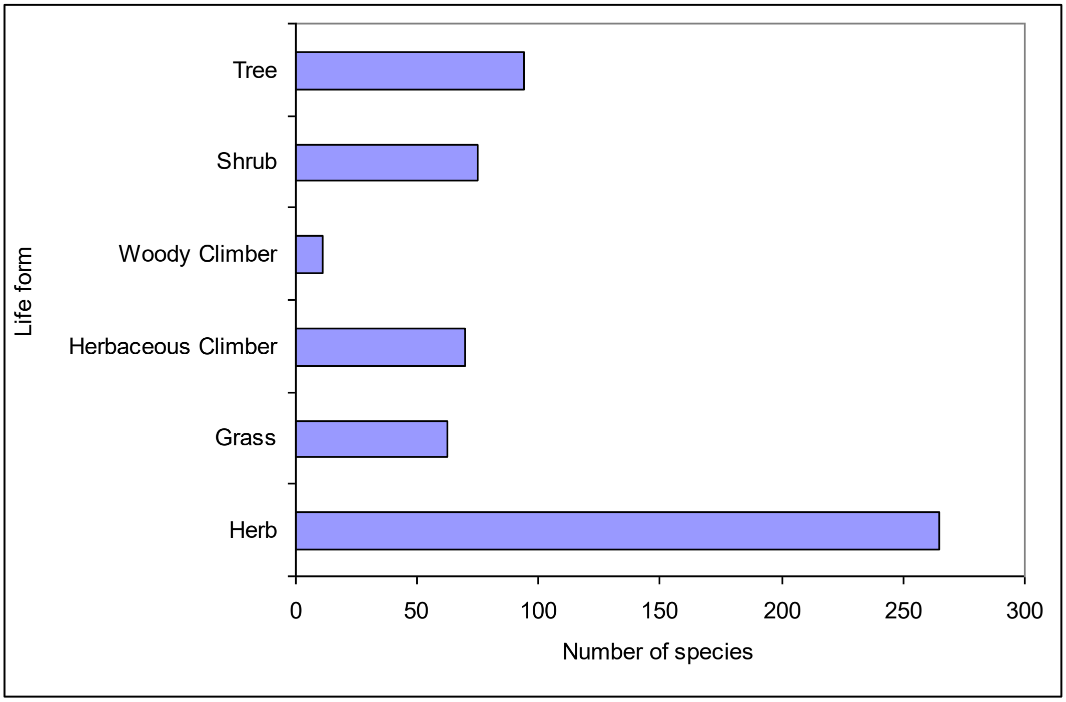


Figure 24: Distribution of Plant species by Life form

Source: Feasibility study for the Ayago Hydropower Plant, 2012

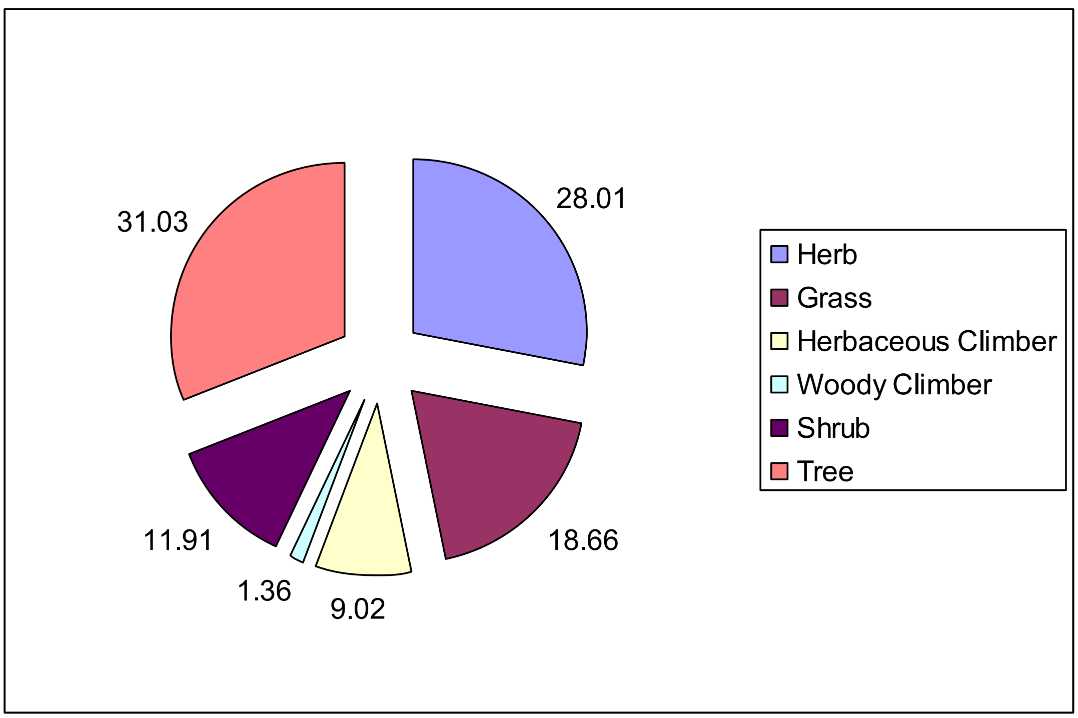


Figure 25: Percentage abundance score on the DAFOR scale by Life form

Relative Abundance and Frequency

The DAFOR scale used was transformed to estimate the relative abundance of the species. This is a crude method but gives a good picture about the relative abundance of the species. Accordingly, *Combretum collinum* subsp. *binderanum* registered the highest relative abundance across all survey sites followed by *Piliostigma thonningii* and *Terminalia glaucescens* (Table 45). A total of 138 species registered a very low abundance level, each having been scored as 'Rare' on the DAFOR scale in the quadrat and recorded from a single site. Uncommon species were 189, having had a frequency of one (1) that is, occurred in only one quadrat over all the surveyed areas.

Table 44: The Top Ten Most Frequent and Abundant Plant Species in the Surveyed Area

Rank	Frequency	Relative Abundance
1	*Piliostigma thonningii* (T) *Combretum collinum* subsp. *binderanum* (T) *Terminalia glaucescens* (T) *Urena lobata* (SH) *Grewia mollis* (T) *Stereospermum kunthianum* (T) *Philenoptera laxiflora* (T) *Vitex doniana* (T) *Bridelia scleroneura* (T) *Hyparrhenia filipendula* (G)	*Combretum collinum* subsp. *binderanum* (T) *Piliostigma thonningii* (T) *Terminalia glaucescens* (T) *Grewia mollis* (T) *Hyparrhenia filipendula* (G) *Brachiaria brizantha* (G) *Philenoptera laxiflora* (T) *Aframomum alboviolaceum* (H) *Imperata cylindrica* (G) *Loudetia arundinacea* (G)

Source: Feasibility study for the Ayago Hydropower plant (T=Tree, SH=Shrub, G=Grass, H=Herb)

Sepcies of Conservation Concern

The following species are worth noting because of their conservation status. Some are globally or nationally threatened mainly because they are heavily exploited and hence getting rare and have been 'Reserved' by the Forestry authorities in Uganda, some are highly restricted in their range of geographical distribution, while others are extremely rare in Uganda.

Afzelia africana (Afzelia) – This species is globally threatened and has been assessed by IUCN as vulnerable. In Uganda, it is known only from West Nile, Acholi, Bunyoro and Madi, hence only a northern Uganda species. The Murchison Falls National Park sub-population is probably the best, if not the only, protected one. It is also on Uganda's National Forestry Authority Reserved Species List and is therefore protected from exploitation and threat to its habitats (Government of Uganda 2003, The National Forestry and Tree Planting Act, 2003, Section 30 (1&2). Such species may not be cut, damaged, destroyed, disturbed or removed, collected, transported, exported, purchased, sold, or donated without the written consent of the Minister of District Council (The National Forestry and Tree Planting Act 2003, Section 31, section 4a&b).

Afzelia africana is most common and abundant along the Nile in the project area. Several large mature trees may be observed in the riverine forest and thickets. It was most abundant along the River Nile area in riverine forest and thicket. Big mature trees with diameter at breast height of over 100 cm were observed. The area of its concentrated occurrence in the project area coincides with the area where the main construction activities will be, i.e. the area from the inlet to the outlet.

The following species are not threatened in IUCN or NFA sense but deserve attention for various reasons.

a) *Baphia wollastonii* is a Range-Restricted species, found in Uganda, DRC and possibly Sudan (Kalema & Beentje, 2012). It is uncommon in the project area, having been recorded on only one transect in riverine forest.
b) *Khaya anthotheca*: These are very large trees only encountered in riverine forest along the Nile. Whereas it is not globally threatened and hence not on the IUCN and Kalema & Beentje (2012) redlists, in Uganda it is on NFA does Reserved Species List owe to its heavy commercial exploitation for high quality timber.
c) *Tamarindus indica* is on Uganda's National Forestry Authority Reserved Species List owing to its commercial use for food in many parts of northern Uganda and Teso (Katende *et al*, 1995) and fuelwood. It is only occasional in the survey area, recorded from the riverine forest and riverine thicket along the Nile.
d) *Pennisetum hohenackeri*: This is a restricted-range species of grass with a highly disjunct distribution, known only from India, East Africa and Madagascar. In Uganda, it is such a very rare species. Its record in Karuma Wildlife Reserve is the first record of it in the whole of Murchison Falls Conservation Area. The proposed power transmission line in the south (in Karuma Wildlife Reserve) will traverse part of its range of occurrence. This will cause a reduction to its already small and severely fragmented population in Uganda.
e) *Coelorhachis afraurita*: this grass species is also very uncommon in Uganda, known from very restricted parts of Nabugabo, Madi and Ayago. It was recorded only once in this study in a marshy grassland with prolonged presence of water logging. Its record during this study is only the second of this species from this area, the last one having been recorded in 1965.
f) *Hyparrhenia umbrosa* is a very rare grass species in Uganda, in this survey recorded only once in the project area. In Uganda, it is known only from the Acholi and Toro areas. It had not been collected in Uganda for decades (since the late 1960's) until this study, emphasizing its extreme rarity in the country.
g) *Markhamia lutea* is on Uganda's National Forestry Authority Reserved Species List.
h) *Milicia excelsa*: Under IUCN, it is listed as Near Threatened (NT) and is also on Uganda's National Forestry Authority Reserved Species List due to its heavy commercial use as a source of high quality timber. It is therefore a species of conservation concern in Uganda. It was occasional, occurring on nine transects. Isolated individuals were recorded from the riverine forest along the Nile and the southern *Terminalia-Acacia* woodlands. In the south, trees with diameter at breast height (dbh) to 30 cm were encountered.

Invasive and exotic plants survey

Invasive Alien Species (IAS) are defined by the CBD as species, subspecies or lower taxa, (including any part, gametes, seeds, eggs, or propagules of such species), introduced outside their natural past or present distribution and whose introduction and/or spread threaten biological diversity (CBD 2001). The IUCN also underscores the importance of damage caused by such species in the new areas they invade (IUCN/PACO 2013). Arroyo, *et al*. (2000) defines invasive alien plants as species establishing in the wild beyond their natural range of distribution following intentional or accidental transportation of whole plants or propagules by humans or human-related activities. Anthropogenic activities contribute a lot in this respect (Rawlins *et al*. 2011, IUCN/PACO 2013). Vehicle access roads have been pointed out as some of the most common pathways for the spread of alien species.

Invasions by plants have been identified as one of the most serious threats to global biodiversity conservation (Heywood, 1989; Drake, *et al*., 1989, van Wilgen *et al*. 2001, CBD 2002, Colautii & MacIsaac 2004, Winterbottom & Eilu, 2006, Ordonez *et al*. 2010, IUCN/PACO 2013). They have a potential to alter ecosystem structure and function by displacing native biota. Invasive alien species are now considered to be the second greatest cause of biodiversity loss on planet earth, after habitat destruction (Simberloff 2003, Sharma, *et al.2005a, b)*

A survey was carried out in and around the proposed Ayago HPP area (Figure 27) for species of plants that may get invasive and spread further.

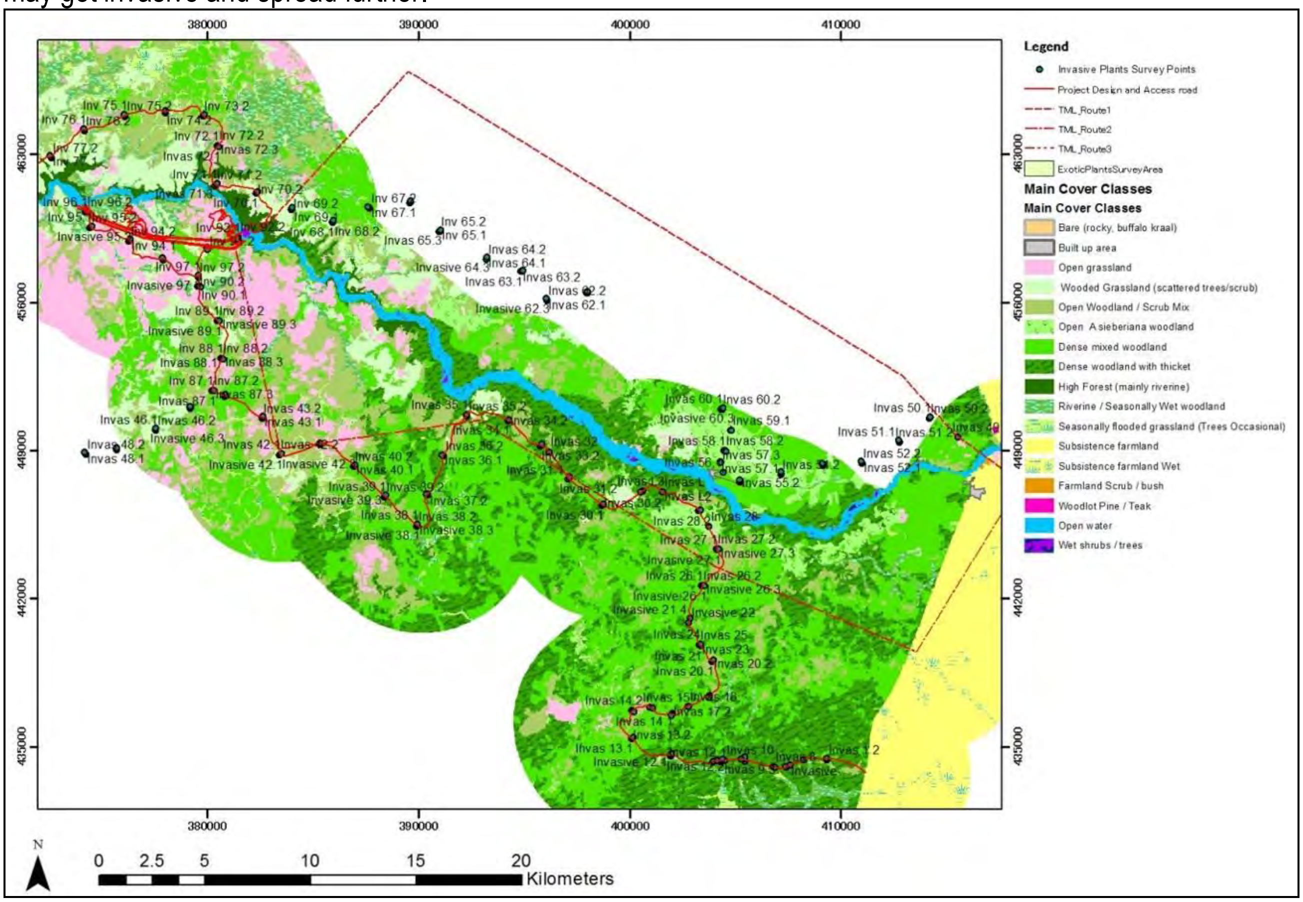


Figure 26: Survey area for Invasive Plant species

Source: Feasibility survey for the Ayago Hydropower plant

Results

Species Composition and Life forms

A total of seven species of both invasive and exotic species of plants were registered in the surveyed area. These altogether, belonged to six genera and four families Table 40. The best represented family in terms of species richness was Fabaceae (42.9%) followed by Verbenaceae (28.6%) (Table 46). Each of Apocynaceae and Pontederiaceae was represented by only one species. Most invasive and exotic species were shrubs by life form (Table 47).

Table 45: Species of invasive and exotic species of plants in the proposed Ayago dam area

Family	Species	Life form
Apocynaceae	*Thevetia peruviana*	Shrub
Fabaceae (Caesalpinioideae)	*Senna spectabilis*	Tree
Fabaceae (Caesalpinioideae)	*Senna* sp.	Tree
Fabaceae (Mimosoideae)	*Mimosa pigra*	Shrub
Pontederiaceae	*Eichhornia crassipes*	Herb
Verbenaceae	*Duranta erecta*	Shrub
Verbenaceae	*Lantana camara*	Shrub

Table 46: Distribution of the invasive and exotic species by family

Family	Number of species	Percentage number of species
Fabaceae	3	42.8
Verbenaceae	2	28.6
Apocynaceae	1	14.3
Pontedariaceae	1	14.3
TOTAL	**7**	**100**

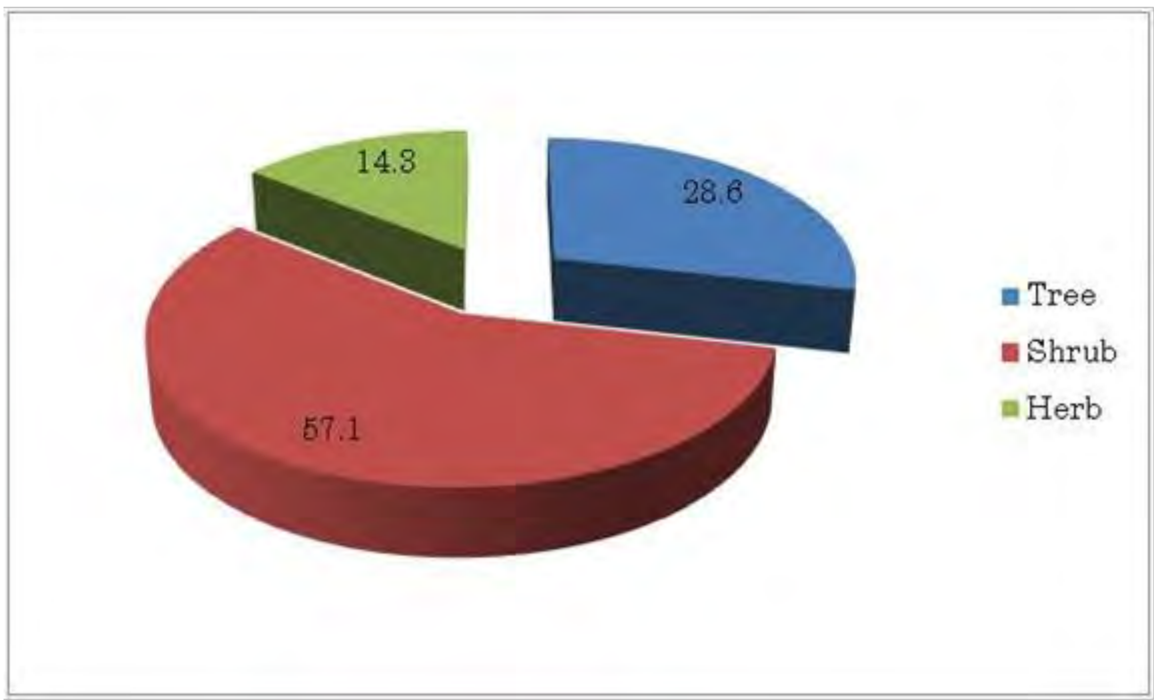


Figure 27: Percentage number of species by life form

The following species of invasive and/or alien plants were encountered in the project area. They have a potential to spread further with disturbance (Cronk & Fuller 1995) even though some are still uncommon in the project area. Some parts on the south side of the Nile were under considerable coverage of *L.camara* forming very dense, impenetrable stands.

i. *Lantana camara*

This alien invasive species has so far been recorded from thicket, some wooded grasslands and *Terminalia* woodland. It has already invaded some parts of the Ayago project area, e.g. at 36 N 403268 239784, and 00º 04’ 29.8’’ N 30º 19’ 33.2 E’’ and 00º 04’ 33.6’’ N 30º 19’ 38.3 E’’. By far, the greatest cover of this species was along parts of the Nanda road in Karuma Wildlife Reserve in dense woodland. It has caused serious impact badly chocking the native flora impairing their growth in some parts. *Lantana camara* is considered to be one of the world’s 100 worst invasive alien species (GISP, 2003). It grows on all types of well-drained soil in areas that receive from about 250 mm to 2900 mm of rainfall (Sharma, *et al.,* 2005b), thus widely distributed. It can undergo rapid vegetative growth to form numerous impenetrable clumps (van Oosterhout *et al*., 2004). It tends to proliferate further with disturbance producing an enormous amount of seed, thriving in areas that may not be favourable for other species. It is known to be a native shrub of tropical America, which has been introduced in many parts of the world, where it is invasive (Cronk & Fuller 1995, Binggeli 1998, Weber 2003, Walton 2006). It is mainly dispersed by birds that eat the berries (Aravind *et al*. 2010). There are several varieties, some of which are cultivated as ornamentals (Lonare *et al.* 2012). The shrub does not invade intact rainforests, but is found on its margins.

The leaves contain toxins that affect grazing animals (Barceloux 2008). Extracts of the fresh leaves have been found to have antibacterial properties and are traditionally used in Brazil in the treatment of respiratory system infections (Barreto *et al*. 2010). It is known to have allelopathic effects on other species, virtually excluding them from its vicinity (IUCN/PACO 2013), thus reducing biological diversity. Its scrambling habit can facilitate spread of wild fire into the tree crown, increasing fire damage (IUCN/PACO 2013).

ii. *Eichhornia crassipes* (Water Hyacinth)

This is a floating aquatic alien herb native to the Amazon Basin. It is on IUCN list of the top 100 most notorious invasive species (Tellez *et al*. 2008). It is restricted to slow-moving or standing water environments. In the Ayago dam project area, it is mainly along the Nile and Ayago rivers, and, to a lesser extent, in smaller rivers. It has had considerable impact on biodiveristy of the freshwater bodies in Uganda. Integrated approaches including biological and mechanical means for its management have been advocated.

iii. Senna spectabilis

This is a tree originally from tropical America, now introduced in Uganda, getting fully naturalized. It is planted in many parts of Uganda mainly for building poles. It is a notable invasive species in Budongo, Matiri and other Forest Reserves in Uganda and in the Mahale Mountains National Park in Tanzania (IUCN/PACO 2013). It has the potential to spread its coverage with opening up of the woodland habitats as it grows fast. In the Ayago project area this still of limited distribution, the largest stand being known around the former ‘Nanda Gate’ along Nanda road in Karuma Wildlife Reserve around 36 N 404366 234342 closer to the main Karuma-Kafu highway, forming groves in parts. Another one was registered close to Chobe Safari Lodge around 36 N 404304 248451 and 36 N 404415 247962. It tends to dominate the understorey layers, in woodlands and even forests, affecting food supply for animals (IUCN/PACO 2013). *Thevetia peruviana* registered the least level of abundance and spread, having been recorded only in one isolated spot along Nanda road. The vegetation it occupies is *Terminalia* woodland in the Karuma Wilidlife Reserve.

iv. *Senna* sp.

This shrub/small tree was found scattered in small clusters in a number of places, although it seemed to be more in the south part of project area.

v. *Duranta erecta*

This is an introduced shrub. It is more common in bushed grassland and riverine thicket, especially north of the Nile.

Abundance

By far the most abundant species is *Lantana camara*, covering over 4 sq. km, followed by *Senna spectabilis* with about 0.14 sq. km (Table 48). The rest were all with far less coverage, estimated at less than 0.01 sq km of coverage in the project area.

Table 47: Estimated cover of invasive and exotic plant species in the Ayago HPP area

Species	Total area (m^2)
Lantana camara	4,012,501
Senna spectabilis	140,565
Senna sp.	38,627
Thevetia peruviana	1,095
Mimosa pigra	186
Eichhornia crassipes	64
Duranta erecta	17

Source: Ayago hydropower feasibility study

Distribution

Figure 29 shows the distribution of all invasive and exotic species recorded. In general terms, the southern side of the Nile had more coverage of the invasive and exotic species than the northern side. *Lantana camara*, *Senna spectabilis* and *Senna* sp. were more concentrated in the Karuma Wildlife Reserve part of the project area, the first two covering vast expanses in the woodland areas. *Mimosa pigra* was mainly distributed at the edges of the Nile and some streams while the aquatic *Eichhornia crassipes* was restricted to the water environments, mostly along the Nile. *Duranta erecta* was found in small, very scattered clumps on both the northern and southern sides of the Nile.

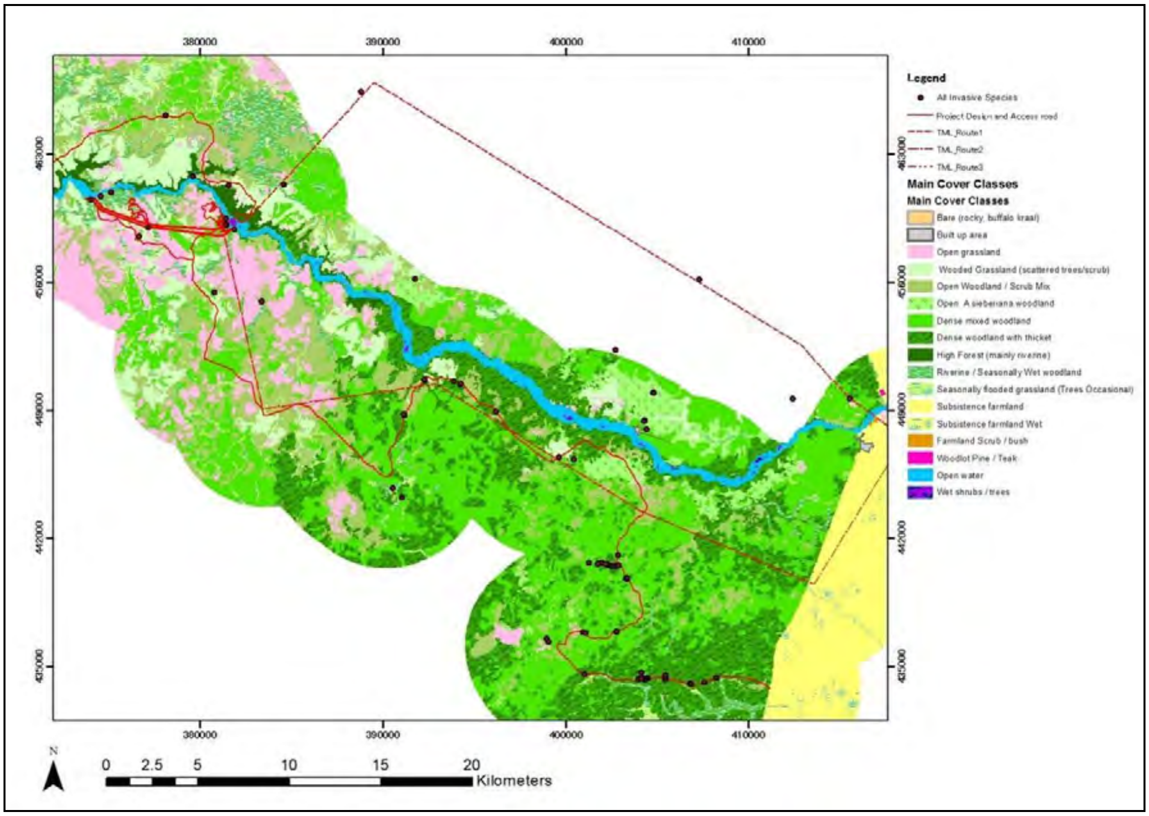


Figure 28: Distribution of Invasive Species in Project area

Source: Ayago Hydropower plant Feasibility Study

vi. *Mimosa pigra* – (Bashful plant)

This is an erect, much branched, prickly shrub reaching a height of 3 to 6 m. It is invasive and reproduces via buoyant pods that can be spread long distances in flood waters. It can spread through natural ecosystems and pasturelands, converting them into unproductive scrubland, reducing biodiversity. It usually grows in open, moist sites such as floodplains and river banks. In Uganda, it is becoming a major notorious invasive plant in wetland ecosystems and has been registered in riparian environments of many Ramsar Sites and Important Bird Areas such as Nabugabo, Mabamba, Nakuwa, Lutembe, Bisina, Doho, and Lutoboka (Kalema 2005, Kalema & Ssegawa 2007). In the Ayago project area, it is still of limited spread, but has been recorded mostly along the water courses of Rivers Nile and Ayago in the Direct Impact Zone, and some of the smaller rivers and streams in small stands. It was also recorded in a wetland traversed by one of the proposed transmission routes which runs southwards through dense woodland. It may not spread much farther away from the river and stream courses since it is a high moisture species requiring proximity to water. Some of the re-known impacts of *Mimosa pigra* invasion include:

- Reducing water flow and increasing silt levels, as it commonly colonizes water course edges. This may threaten the sustainability of reservoirs and canals
- The weed reduces the number of birds, lizards, herbaceous plants and tree seedlings in areas of its growth

- It can reduce the area of grazing land for animals and the carrying capacity of the land
- It can block access of animals to natural watering points when in dense coverage. This may affect survival of animals especially in dry spells, but also force them into particular areas where they may over use the resources, causing fast degradation
- It has been noted to increase the costs of maintaining power poles and cables used for electricity transmission

5.3.2 Fire and Vegetation trends

It is widely believed that the structure and composition of vegetation in the Murchison Falls National Park is a product of burning and herbivory besides the physical aspects such as precipitation, soils and topography (UWA 2008). The survey area for the fire study is presented in Figure 30.

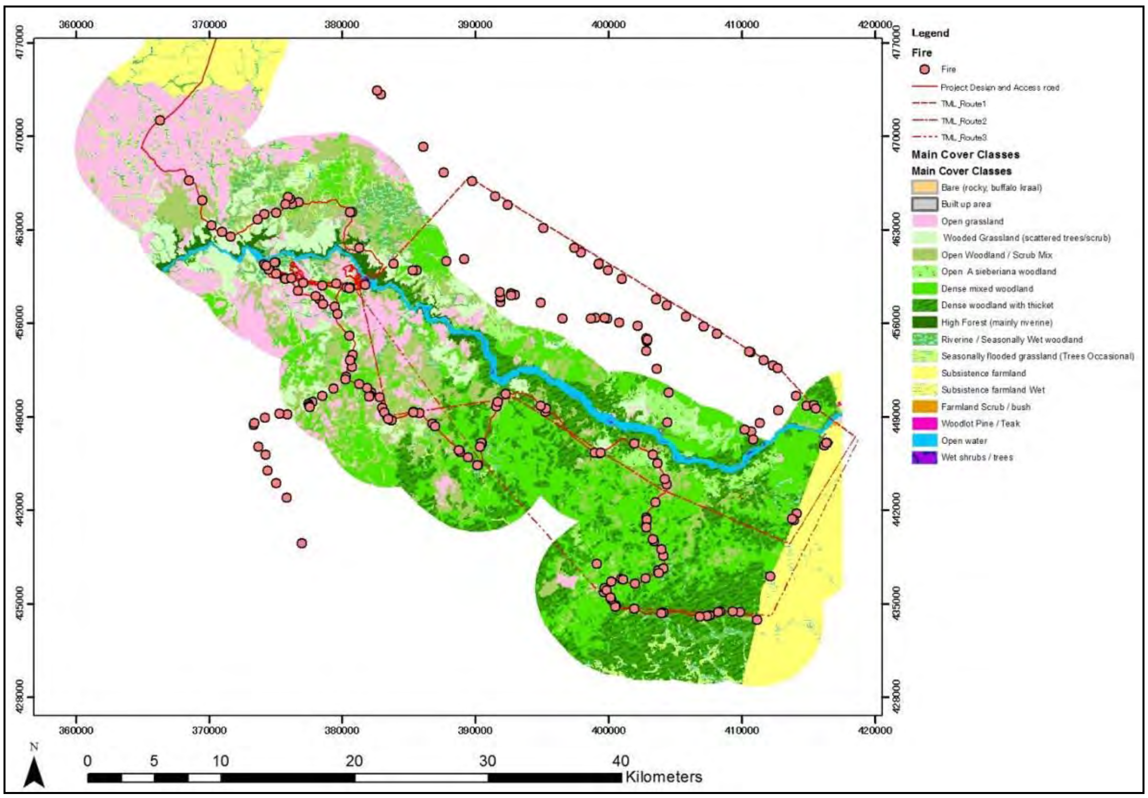


Figure 29: Fire Survey Area

Source: Ayago feasibility study for fire risk, February 2013

Timing and source of burning

There does not appear to be a definite burning regime in the park and wildlife reserve by UWA authorities as there are no clear fire management plans in UWA protected areas (UWA 2008). What seems to be the routine is burning any grassy parts in most dry seasons, reportedly early in the dry season. This results into many fire fronts during most dry spells. It needs to be noted that some fires are set by poachers while others originate from the adjacent community lands. The purpose of the burning ranges from improving visibility for hunting to rejuvenation of pastures for grazing. It is reported that burning has been going on in this area from time immemorial (Buechner & Dawkins 1961).

Extent of Burning

Burning was observed in virtually all vegetation types in the project area, except riverine forest and thicket and permanent wetlands in both of which moisture level is very high. The most commonly burnt vegetation types are however Open grasslands, Wooded Grassland and Open Woodland. There is no planned system of fire breaks in the whole park except for the roads/tracks and natural features such as big and permanent water courses. In all these commonly burn vegetation types, there are species of plants that are tolerant to fire. The most notable are *Combretum molle* and other *Combretum spp*., *Terminalia glaucescens*. The burning covers extensive areas, leaving vast lands with virtually no herbaceous cover for some time.

Trend of the Plant succession influence by fire and herbivory

No recent studies are readily available about the impact of burning and herbivory on the vegetation structure and species composition in Murchison Falls National Park. Buechner & Dawkins (1961) and later Spence & Angus (1971) concluded that in many parts of the park in the south Terminalia woodland was being replaced by Grassland and Wooded Grassland. Lock (1977) also found that both grazing and burning impaired regeneration of woody plants. Buechner & Dawkins (1961) report that the continued occurrence of fire leads to destruction of large trees, either directly e.g. by damaging the bark, or indirectly by the secondary impact of animals that rub against the boles, killing the tissues. Elephant incursion into woodland and riparian forest was reported to be causing removal and disappearance of woody vegetation. The impact of grazing and fire has also been studied by Hobbs & Huenneke (1992).

The patterns of change in vegetation in the park in general have been documented even before 1900. It is reported that the area south of the Victoria Nile was predominantly grassland in 1864 during the British Explorers' expeditions (Buechner & Dawkins (1961). But there are also areas that changed from woodland to grassland. E.g. around Wairingo area, while in others changes in species composition have been registered e.g. around Pandera. The area south of the Victoria Nile has reportedly changed to the more fire-tolerant Philenoptera laxiflora (Buechner & Dawkins (1961) through the 1950's to the early 1960's. Lock (1977) also concluded that the two factors and fire and herbivory strongly impaired regeneration of the trees.

Smart et al. (1985) studied the influence of herbivory on structural and floristic aspects in the same park and found that herbivores impaired tree regeneration. This reduction in woody species was accompanied by increase in grass species, favouring fire incidence the more. The decline in elephant and other herbivore population in the 1970's (Eltringham & Malpas 1980) due to political instability favoured invasion of Acacia spp. (Smart et al. 1985). The vegetation changes in the park from the period 1958 to 2004 were studied by Nangendo et al. (2006) who found changes, particularly in species composition and woody plant cover. Their studies concentrated around the Wairingo area though. Wildlife Conservation Society (WCS) has studied and analyzed the changes in vegetation in the project area that occurred during the period from 2000 to 2011. The comparisons are based on the vegetation change map 2000 to 2011. Tables and Figures below provides a summary of these changes. The following are key findings from this analysis:

i. In the south, the vegetation mainly changed from Open Woodland to more Closed Woodland between 2000 and 2011 while smaller patches changed from Grassland to Open Woodland. The resultant effect is a net increase in coverage of both Closed Woodland and Open woodland, and a decline in coverage of Grassland. This implies a higher tree density and crown cover in the south part of the project area. This change in structural features of the vegetation is often associated with change in faunal composition and density. A dense tangle of herbaceous vegetation in the lower storey which is observable in the Karuma Wildlife Reserve tends to attract higher densities of rodents, for example.

ii. Areas covered with bare ground apparently increased from nearly nothing in 2000. This apparent increase in bare ground may be explained by a multiplicity of factors though. One possible explanation is the influence of seasonality at the time the images were taken in 2011. If this was done in the dry season, especially after burning or very heavy grazing, this could give an illusionary picture of increased bare ground. Drying up of the herbaceous vegetation and burning can also reveal features such as exposed rock surfaces, thus causing an apparent increase in bare ground. There is no likelihood or history of extensive excavations in the area, this being a National Park. Within the protected area, there are only very few and small patches where this apparent increase in bare ground seems to have occurred. These are best explained in terms of seasonality and timing of imagery. The extensive ones in the north and south east are outside the protected area system of Murchison Falls Conservation Area. These are typically cultivated areas whose cover is quite variable depending on seasons and human activities.

iii. Vast areas surrounding the proposed canal route from the intake all through the outlet appear to have changed from ‘Shrubs’ to Grassland between 2000 and 2011. A few patches within this area of heaviest intensity of dam construction activity changed from ‘Shrub’ to Closed Woodland and Open Woodland in the same period. Increased incidence of burning could have caused this change as fire tends to favour grasses and impart a control factor on proliferation of woody species, but information about fire incidence and fire regimes in the whole of the park is only too scanty.

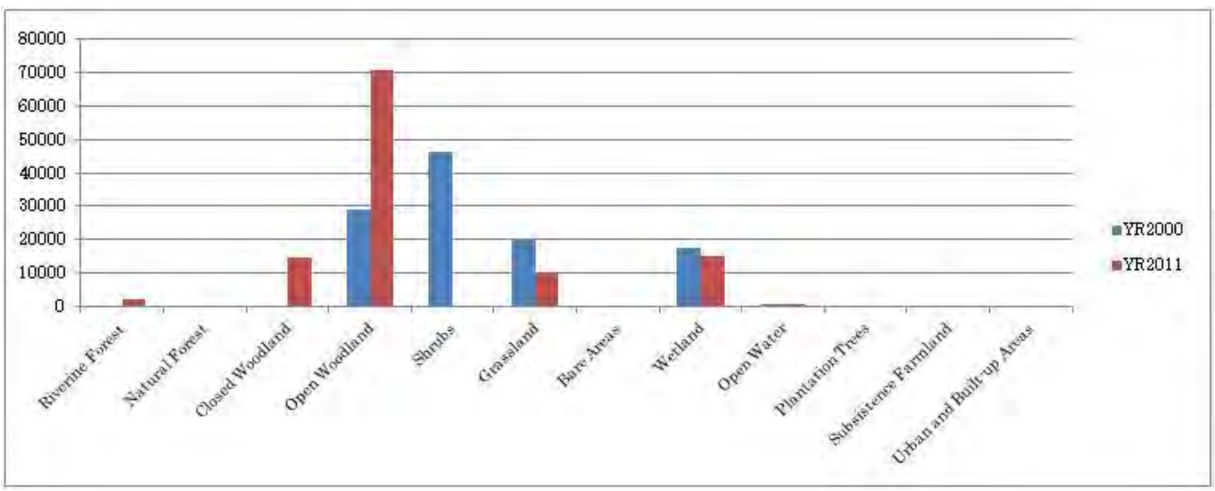


Figure 30: Area by Vegetation type 2000-2011 (ha)

Table 48: Area by Vegetation type 2000-2011

Item	YR2000	YR2011
Riverine Forest	33.12	2084.4
Natural Forest	215.46	
Closed Woodland	185.94	14888.16
Open Woodland	29036.61	70830.9
Shrubs	46415.61	
Grassland	20106.63	9929.61
Bare Areas		478.17

Wetland	17605.17	15169.59
Open Water	770.94	662.4
Plantation Trees		0.9
Subsistence Farmland	109.17	411.48
Urban and Built-up Areas	6.39	29.43

The northern area along the River Nile was Closed Woodland in 2000 but this had changed to Riverine Forest by 2013. The resultant effect is a net increase in coverage of Forest in the area. This indicates a higher stocking density of trees, higher crown cover and increased humidity levels in the vegetation community in this area.

Table 49: Area by vegetation type in 2000 and 2013

Vegetation	2000	2013
Riverine Forest	16.74	1186.38
Closed Woodland	2908.62	44564.58
Open Woodland	39822.03	22707.36
Natural Foest	178.38	
Shrubs	44154.36	
Grassland	12175.38	25259.4
Wetland	6927.66	5253.03
Open Water	2512.71	2511.99
Subsistence Farmland	5779.53	12720.33
Urban and Built-up Areas	9.63	78.21
Bare areas		195.21
Plantation trees		8.55

There was an apparent slight decline in wetland coverage during the same period. The area originally covered in wetland in 2011 seems to have been colonized by trees, turning to Woodland. On the whole, there has been an increase in wooded vegetation in the project area.

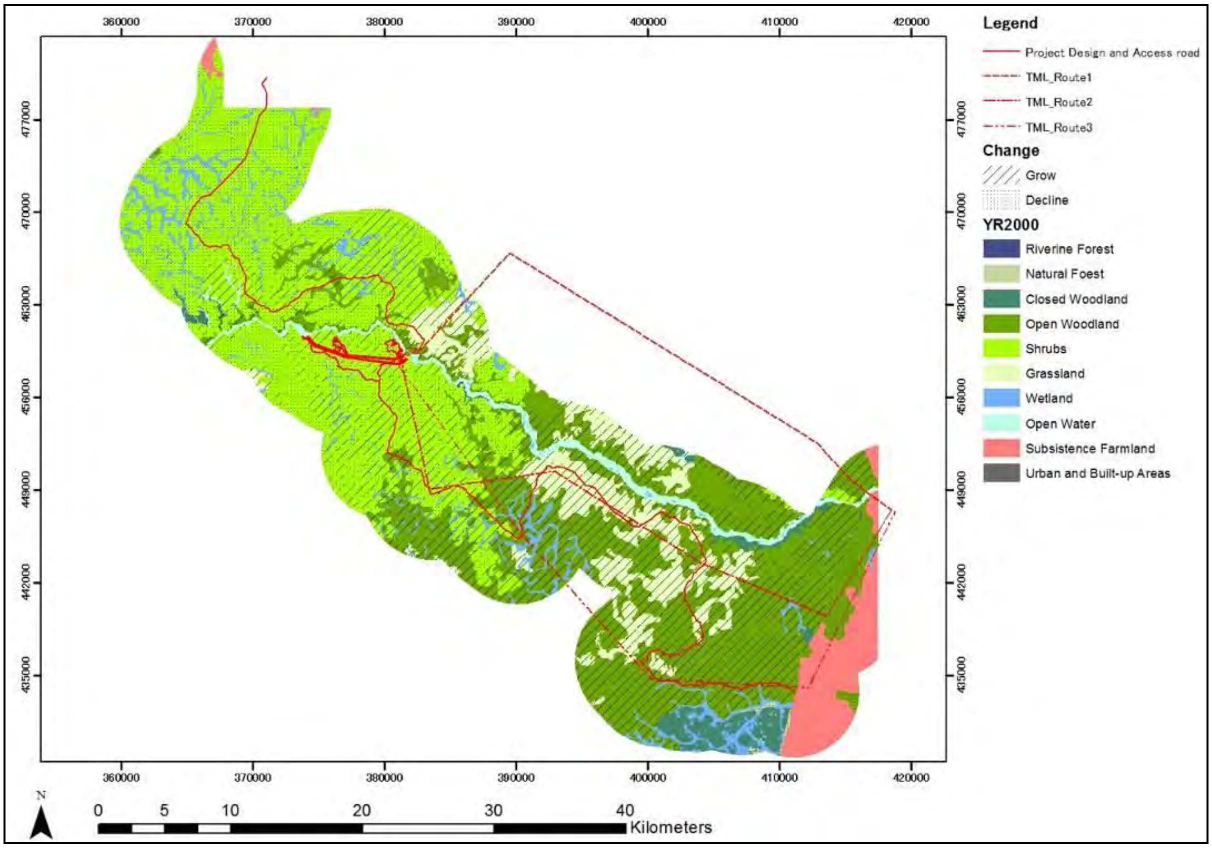


Figure 31: Vegetation Change from 2000-2011

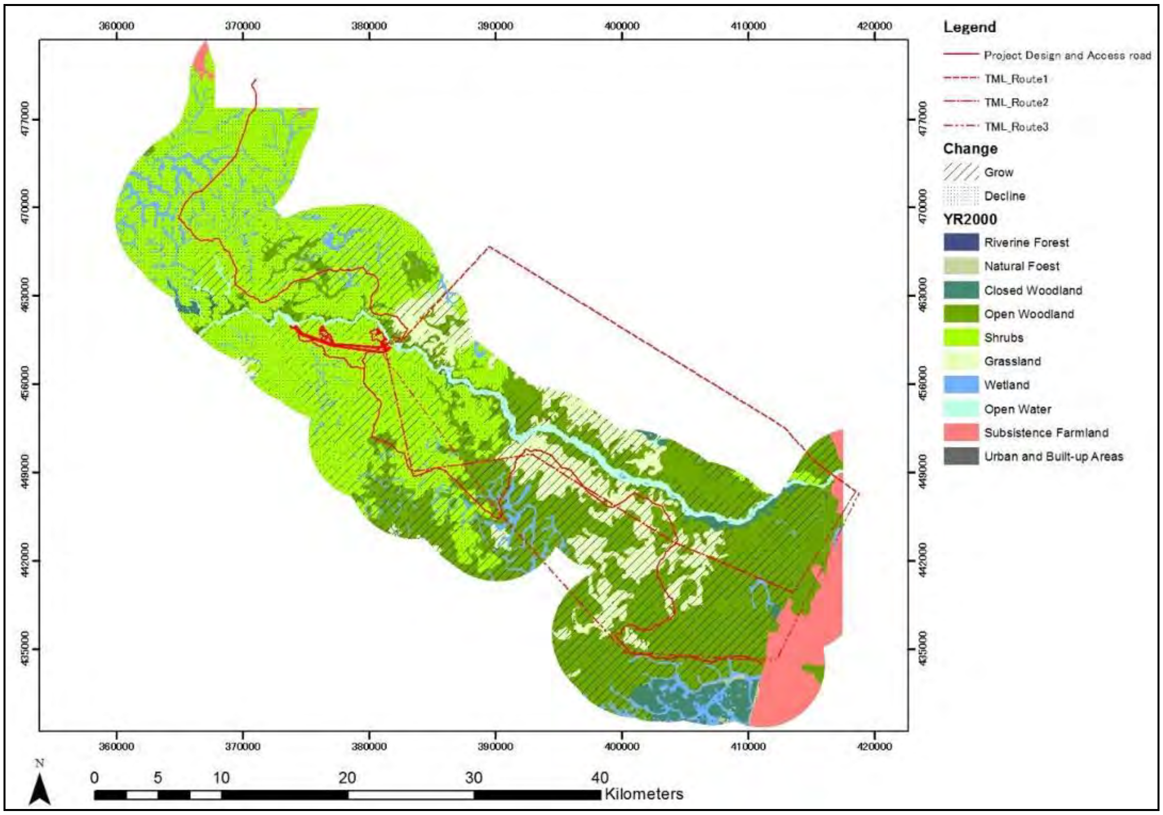


Figure 32: Vegetation Change from 2000 to 2013

5.3.3 Large Mammals

Wilson (1995) showed Murchison Falls National Park to have a total of at least 79 species of mammals), ranging from small mammals (bats, insectivores and rodents) to the large species of which the elephants are the largest species. Plumptre et al (2003) on the other hand showed the park to have a much richer mammalian fauna - 109 species, of which 54 species were categorized as large mammals. The same authors also indicated that the park has five threatened species. Such disparity in the known mammalian fauna diversity points to the fact that for this taxon as is noted for birds additional surveys/studies are bound to add species to the lists. Survey points for the game camera setting points for large mammals are shown in Figure 34.

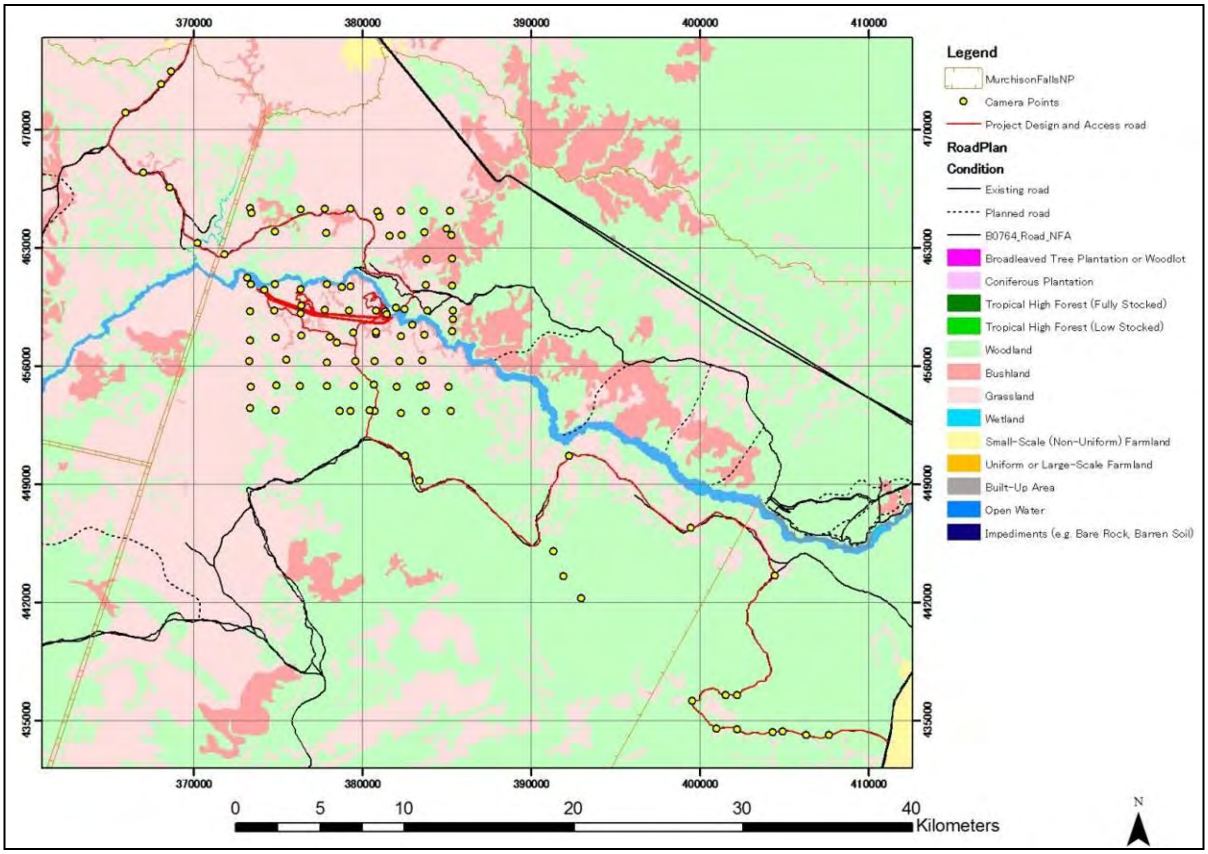


Figure 33: Game camera setting points for large mammals

Results

Altogether at least 47 species of mammals (Table 51 and Table 52) have been captured on Game camera, comprising of over 76% of the medium to large sized species of mammals known in the Park. These results would suggest that the Project Area is an important range for a large number of the species. Three of the large carnivore species (Lions, Leopard, and Spotted Hyenas) have been recorded in several locations in the south side of the core Project area with regular frequency. The areas within a radius of two kilometers from the proposed core project site have a continued presence of these three species throughout the study period. In addition to these, Serval Cat and Honey Badger have also been recorded although in much fewer locations than the larger carnivores. Table 46 lists the medium to large sized mammal species captured by the game cameras. Both south and north side of the core Project area seem important range areas for Hippopotami which have been captured on game camera up to five kilometers away from the Victoria Nile. This however is not surprising given that the area is crisscrossed by many small water courses that maybe dry during the dry season or carry very small volumes of water, but swell in volume in the wetter periods.

Elephant presence recorded on game camera seems to be more frequent on the north side of the Project area than on the south side. Transect walks however showed a fair amount of elephant activity in the south side.

Nocturnal species (Aardvarks, Crested Porcupine, Giant rats, Genets), small carnivores (Banded Mongoose, Marsh mongooses, Slender Mongooses, Genets) that are normally recorded only on the basis of presence of signs have been captured on game camera and will enable a reasonable assessment of species occurrence. The ungulates as would be expected are widely occurring although large concentrations are so far recorded only in a few locations. We list two species of the genus *Potamochoerus* (Bushpig and Red river Hog) simply because the two color phases typical of either of the species have been recorded on camera. It may however simply be a case of dichromatism, a fact that we are not able to verify at the present time and that might require a separate study. Table 46 presents the list of mammals recorded in the surveyed Project Area using game cameras. The last column in the table summarizes their conservation status based on IUCN (2013). The mammals recorded and presented in Table 51 belong to nine orders, six of which are of medium to large sized species, while three are of smaller mammals.

Table 50 Mammals Recorded in the Project Area

Order	Species	Common Name	IUCN Status
Artiodactyla	*Syncerus caffer*	Buffalo	Least Concern ver 3.1
	Sylvicapra grimmia	Common Duiker	Least Concern ver 3.1
	Tragelaphus scriptus	Bushbuck	Least Concern ver 3.1
	Alcelaphus buselaphus	Jackson's Hartebeest	Least Concern ver 3.1
	Kobus kob	Uganda Kob	Least Concern ver 3.1
	Kobus ellipsiprymnus	Waterbuck	Least Concern ver 3.1
	Ourebia ourebia	Oribi	Least Concern ver 3.1
	Giraffa camelopardalis ssp. *rothschildi*	Rothschild's Giraffe	Endangered C2a(i) ver 3.1
	Hippopotamus amphibius	Hippopotamus	Vulnerable A4cd ver 3.1
	Potamochoerus porcus	Red River Hog	Least Concern ver 3.1
	Potamochoerus larvatus	Bush pig	Least Concern ver 3.1
	Phacochoerus africanus	Common Warthog	Least Concern ver 3.1
Carnivores	*Panthera pardus*	Leopard	Near Threatened ver 3.1
	Panthera leo	Lion	Vulnerable A2abcd ver 3.1
	Leptailurus serval	Serval cat	Least Concern ver 3.1
	Crocuta crocuta	Spotted Hyena	Least Concern ver 3.1
	Genetta sp	Genet	
	Herpestes ichneumon	Egyptian Mongoose	Least Concern ver 3.1
	Atilax paludinosus	Marsh Mongoose	Least Concern ver 3.1
	Dologale dybowskii	Pousargues' Mongoose	Data Deficient ver 3.1
	Mellivora capensis	Ratel (Honey Badger)	Least Concern ver 3.1
	*Lutra maculicollis***	Spot-necked Otter	Least Concern ver3.1
	Ichneumia albicauda	White tailed Mongoose	Least Concern ver 3.1
	Mungos mungo	Banded Mongoose	Least Concern ver 3.1
Chiroptera*	*Epomophorus labiatus*.	Fruit Bat	Least Concern ver 3.1
Largomopha*	*Poelagus marjorita*	Uganda Grass-Hare (Bunyoro Rabbit)	Least Concern ver 3.1
	Lepus capensis	Cape (Brown) Hare	Least Concern ver 3.1
Manidae	*Manis (Smutsia) gigantea*	Giant Ground Pangolin	Near Threatened ver 3.1
	Manis (Smutsia) temmincki	Ground Pangolin	Least Concern ver3.1
Primate	*Pan troglodytes*	Chimpanzee	Endangered ver 3.1
	Colobus guereza	Guereza (Black & White)	Least Concern ver 3.1

Order	Species	Common Name	IUCN Status
		Colobus	
	Papio Anubis	Olive Baboon	Least Concern ver 3.1
	Chlorocebus (aethiops) pygerythrus	Vervet Monkey	Least Concern ver 3.1
	Erythrocebus pata	Patas Monkey	Least Concern ver3.1-
Proboscidae	*Loxodonta africana*	Elephant	Vulnerable A2a ver 3.1
Rodentia*	*Cricetomys gambianus*	Gambian Giant Pouched Rat	Least Concern ver 3.1
	Hystrix cristata	Crested Porcupine	Least Concern ver 3.1
	Anomalurus sp.	Flying Squirrel	
	Xerus erythropus	Striped Ground Squirrel	Least Concern ver 3.1
	Thryonomys swinderianus	Common Cane Rat	Least Concern ver 3.1
	Thryonomysgregorianus	Lesser Cane rat	Least Concern ver 3.1
Tubulidentata	*Orycteropus afer*	Aardvark	Least Concern ver 3.1
Notes: * The taxonomy used follows Wilson and Reeder, 2005 *Hydrictis maculicollis* is considered as Vulnerable in the old name *Lutra maculicollis* (Wilson and Reeder, 2005)			

Source: Ayago baseline study feasibility report

A total of 12 species of Carnivores and 12 of ungulates have been recorded in the Project area meaning that of all the mammals species recorded, these may be described as comprising the largest proportion of the mammalian diversity of the area.

Table 51: Mammal records from Camera traps within the project area

Order	Family	Species	Species total camera trap observations
Artiodactyla	Bovidae	Buffalo	4917
		Bush/Common Duiker	63
		Bushbuck	1090
		Jackson's Hartebeest	2042
		Oribi	9
		Uganda Kob	12582
		Waterbuck	5009
	Giraffidae	Giraffe	740
	Hippopotamidae	Hippopotamus	10476
	Suidae	Bush pig	30
		Red River Hog	539
		Warthog	5853
Carnivora	Felidae	African Wild Cat	1
		Leopard	71
		Lion	23
		Serval Cat	11
	Herpestidae	Banded Mongoose	46

Order	Family	Species	Species total camera trap observations
		Dwarf Mongoose	3
		Large Grey Mongoose	19
		Marsh Mongoose	29
		Slender Mongoose	1
		White tailed Mongoose	24
	Hyenidae	Spotted Hyena	143
	Mustelidae	Congo clawless Otter	1
		Honey Badger	5
		Spot-necked Otter	2
		Zorilla	1
	Viveridae	Genet	79
Chiroptera	Pteropodidae	Fruit Bat	2
Largomopha	Leporidae	Grass Hare	10
		Savanna Rabbit	145
Pholida	Manidae	Giant Pangolin	4
		Ground Pangolin	31
Primates	Cercopithecidae	Black and white Colobus	22
		Olive Baboon	7204
		Pata's Monkey	4
		Vervet Monkey	1348
	Pongidae	Chimpanzee	1
Proboscidae	Elephantidae	Elephant	1842
Rodentia	Cricetidae	Gambian Giant Pouched Rat	321
	Hystricidae	Crested Porcupine	266
		Porcupine	74
	Sciuridae	Flying Squirrel	1
		Gambian Sun Squirrel	2
		Side-striped Ground Squirrel	11
	Thryonomidae	Cane rat	4
Tubulidentata	Orycteropodidae	Aardvark	196

Source: Ayago baseline study feasibility report

Plate 2 presents the captured results of eight species of mammals by the trap/game camera. The captures included both full portraits of the species, partial photos but identifiable to species, diurnal as well as nocturnal activity photos. A few photos had very small part of the animals, a few of especially the night photos were blurry and in both these cases the species could not be identified. The foregoing notwithstanding however, we believe all species that could have been captured have been captured on Camera and that only some spatial-temporal details will miss in some minor details.

Elephants

Records of Elephant presence on camera in the south side are much fewer and in smaller groups than those recorded in the North side (Plate 2). In these figures, the graduated scales show the mean number of individuals captured by each camera per day for the duration the camera was powered.

The presentation of the elephant distribution is divided into four relative seasons - a long dry season from December to February, a short wet spell from March to May, a short dry spell from June to July and a long wet period from August to November. It is apparent from these results that Elephants were more concentrated in the project area between December to February, but with a higher presence in the area north of the Nile. Larger pockets of the populations were concentrated along or near the Nile and Ayago rivers. The project areas south of the Nile had fewer overall individuals but the elephants were fairly widely spread in the project area.

In the period March to May, the population of elephants was much lower in the project area and with only a single record of presence in the area south of the River Nile. To the north side, although the populations are low, they remain widely occurring in the area north of the Nile. Our results also suggest that the elephants seem to return and be more numerous in the project area between August to November. Given the relatively lower numbers in the north, minimizing operations of the Ayago HPP north of the Nile would result in reduced disruption of normal elephant activities. Overall, there seems to be a broader window in the year in which the elephant populations are not ranging into the project area in the area south of the Nile than is the case to the north side.

Red River Hog

Lion

Spotted Hyena

Elephant

Leopard

Rothschild's Giraffe

Ground Pangolin

Crested Porcupine

Plate 2: Species of Mammals Captured on Game camera

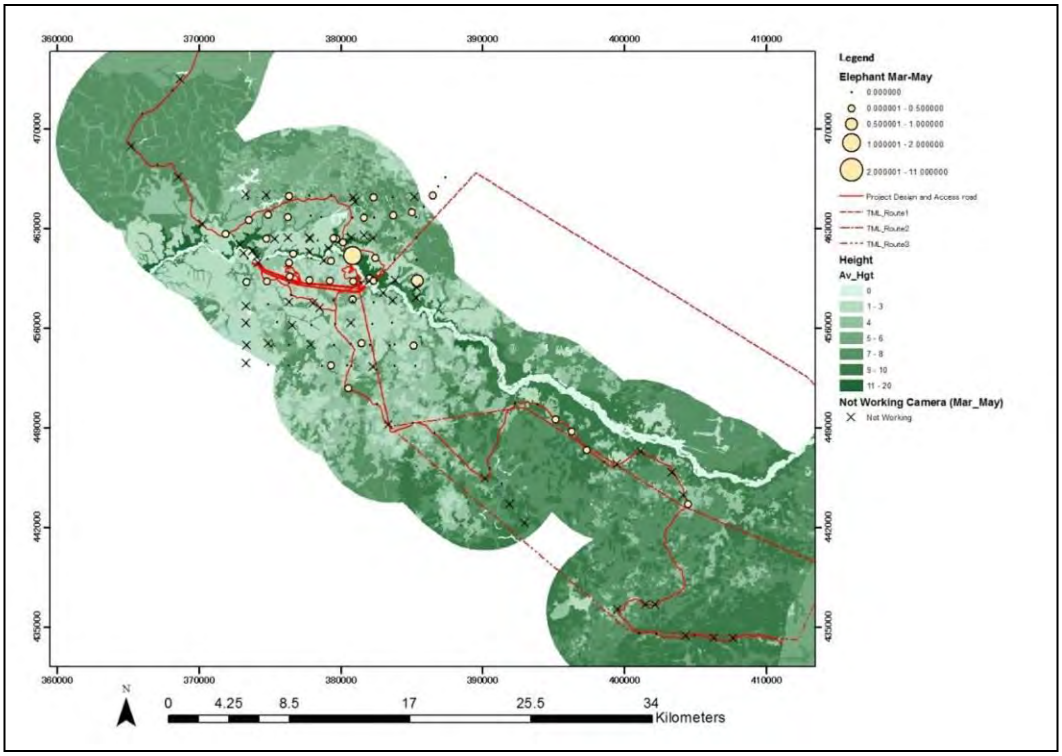


Figure 34: Elephant distributions within project area (March-May)

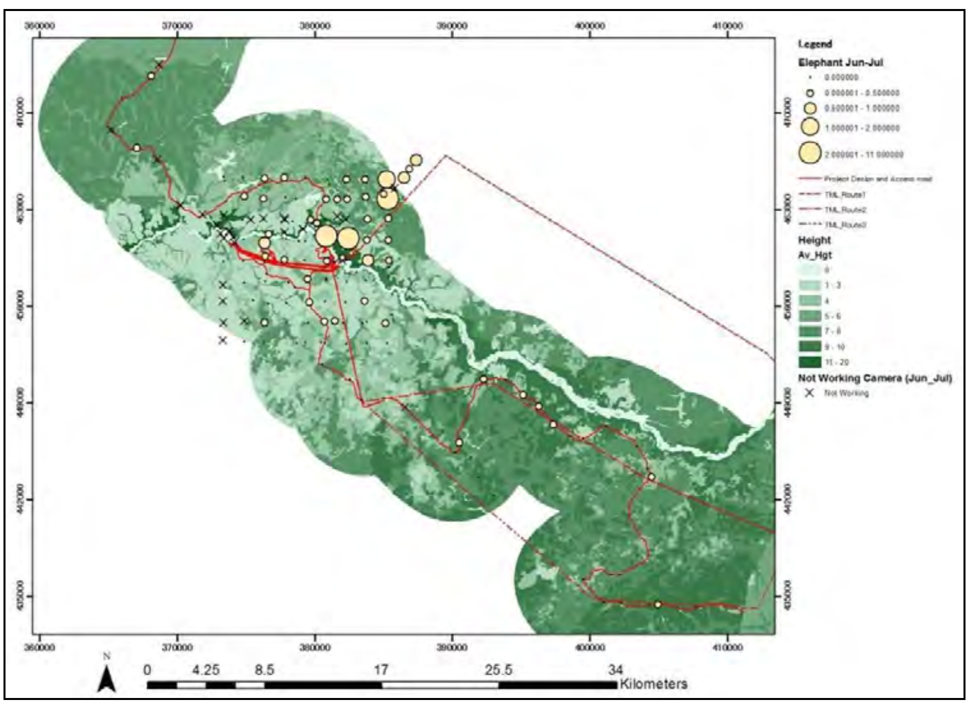


Figure 35: Elephant distribution in project area (June- July)

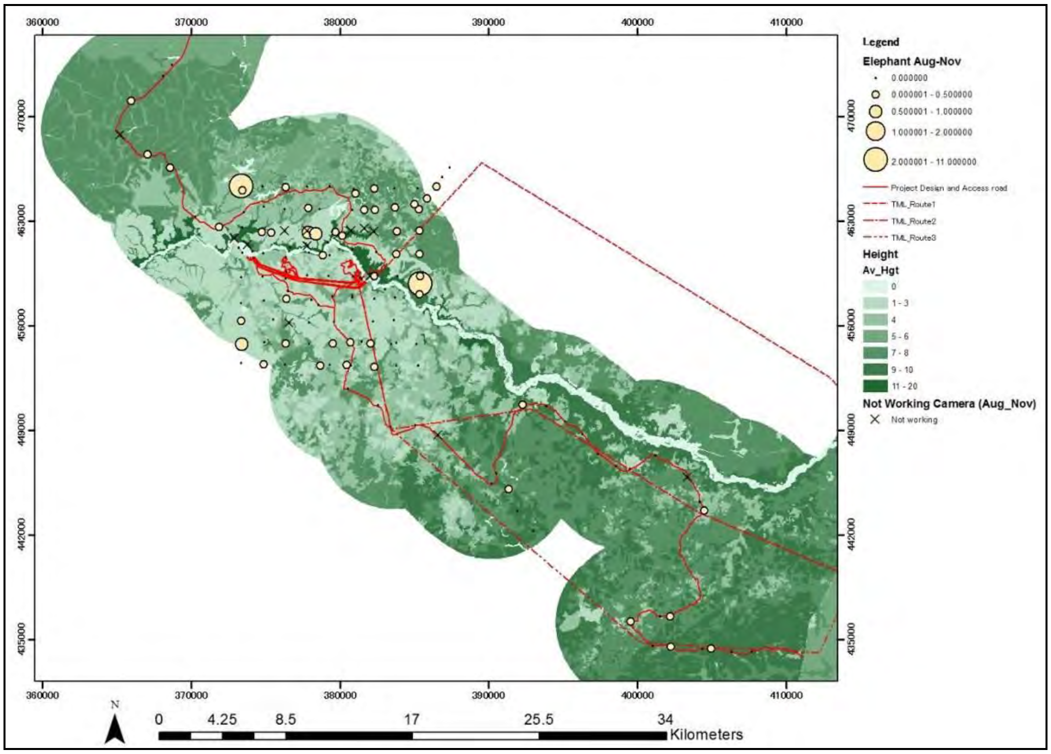


Figure 36: Elephant distributions within the project area (August-November)

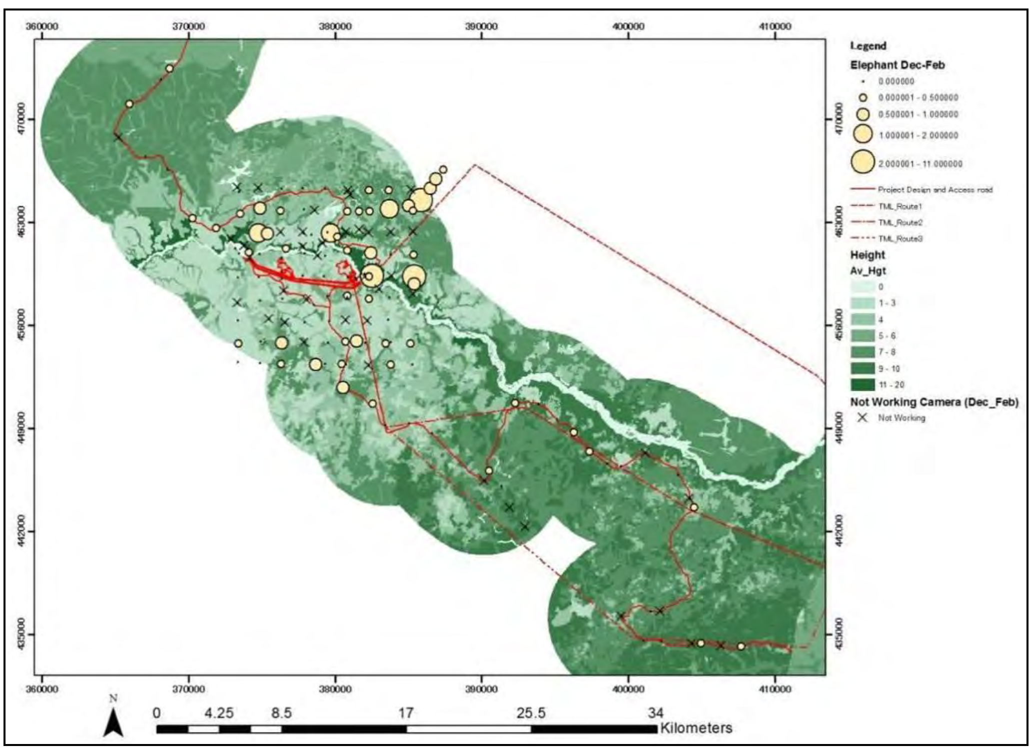


Figure 37: Elephant distributions within the project area (December-February)

Giraffe

Murchison Falls National Park is one of three protected Areas in Uganda that are important for Giraffe conservation, and it has the largest and viable population for this species in Uganda. In MFNP, the species was until recently restricted to the north side of the Nile which is the area from River Kibba towards Chobe and is crossed by a number of small and large rivers including Ayago. These rivers may in the wet season act as barriers to movement of Giraffe from the west to the east side of the Park, north of the Nile. The results of these surveys show varied patterns of occurrence for the Giraffe through the study period. Figure 39 shows the overall distribution of the species in the project area.

It is apparent that giraffe ranged into the central grid of the core project area most of months of the year. Unlike the other artiodactyls however, Giraffe don't occur in large numbers. The highest numbers were recorded in the project Area only in July and the rest of the year had low numbers. It is possibly the case, that the Giraffe populations west of Ayago and Kibba Rivers remain largely separated from the population east of these rivers. It will be interesting however to understand their ranging patterns in the long term in order to establish if these rivers are indeed imposing barriers. The results for the month of January show a larger presence of the Giraffe to the extreme west of the project area west of the 370000 Easting and very sparse to the east side of the same easting as shown in figure 39.

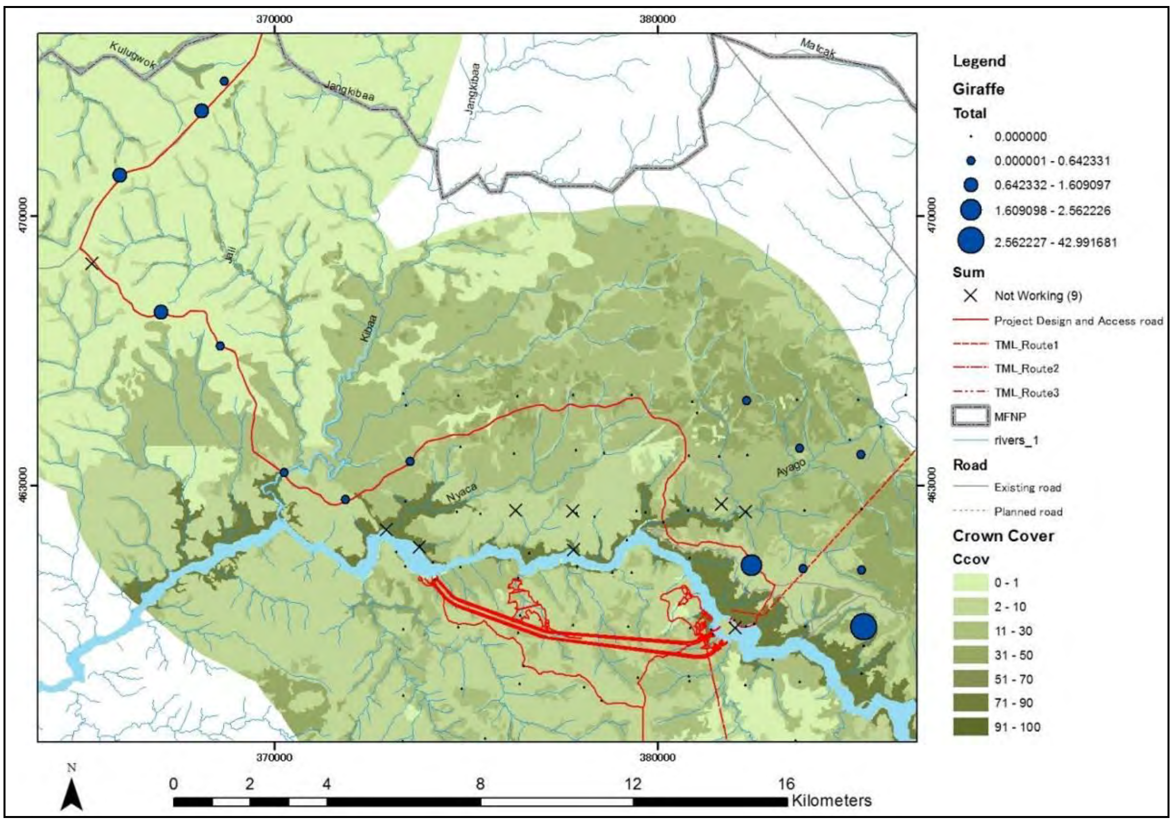


Figure 38: Overall Giraffe distributions in the project area during the study period

Other Species

In both the north and south portions of the survey grid, some species have been recorded to be fairly wide spread (for example Buffalo, Uganda Kob, Warthog, Waterbuck, Olive Baboon and Aardvark, while species such as the Spotted Hyena, Lion, Leopard, and several others are only recorded to occur in a few locations. The data in this table are only sums of “a presence” not the sum of how many of each species were recorded. The totals of individuals recorded would be much different and much higher.

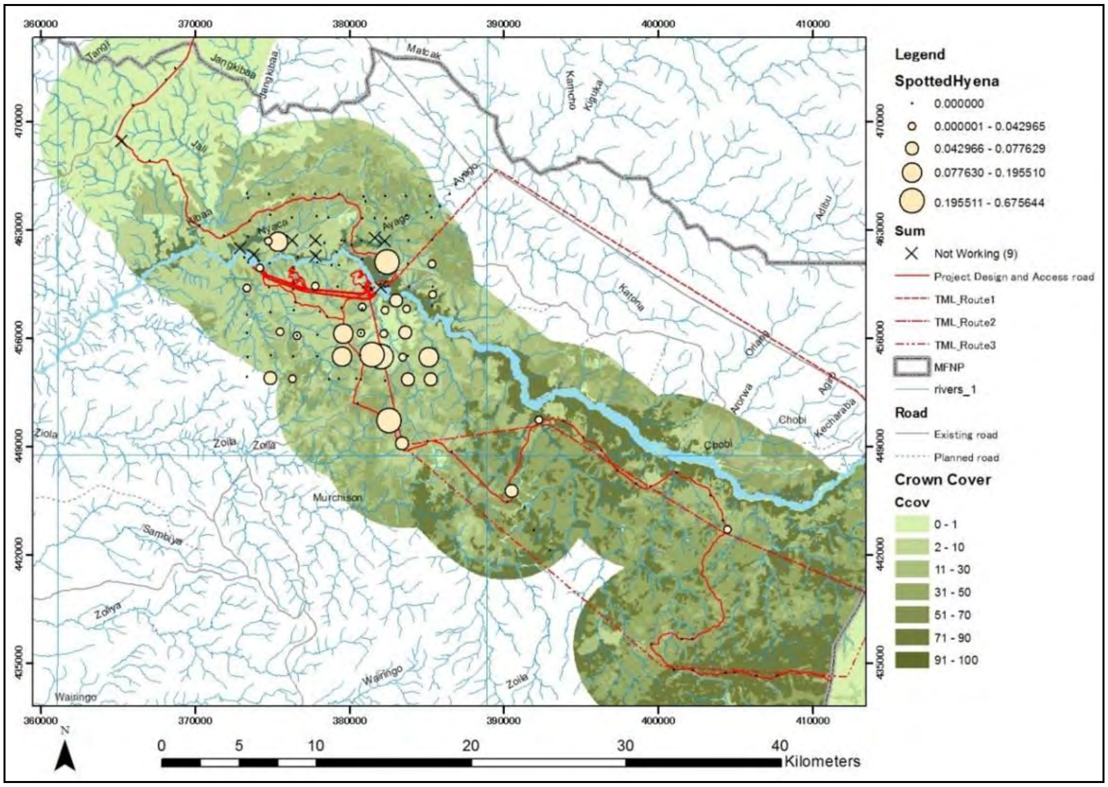


Figure 39: Spotted Hyena distributions within the project area

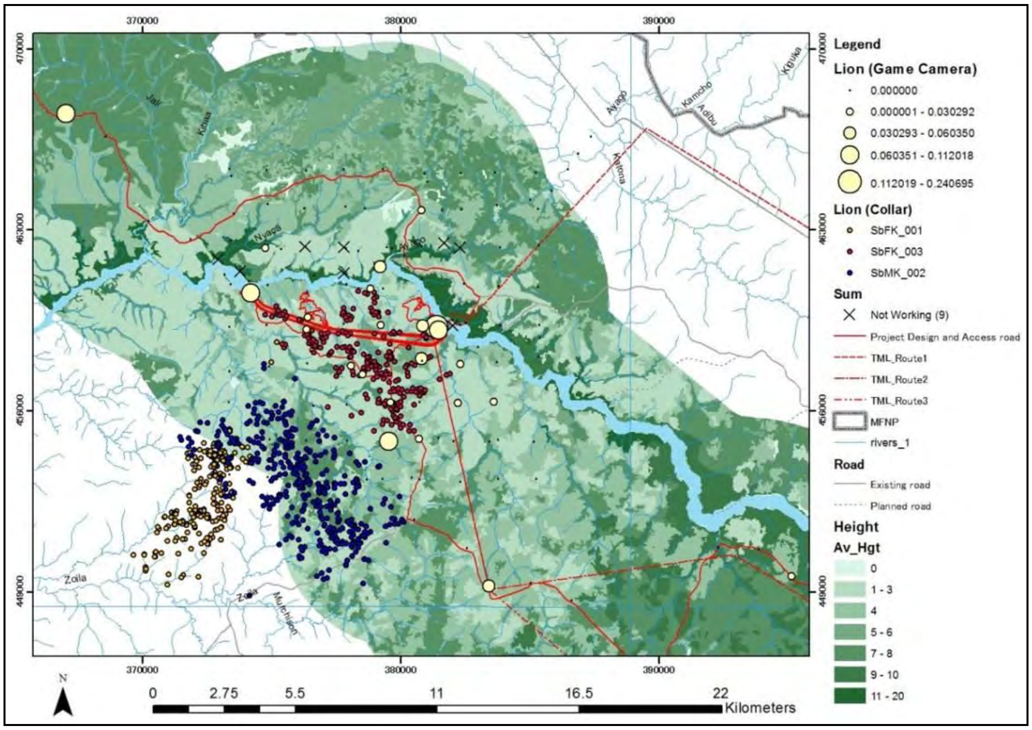


Figure 40: Lion distributions within the project area

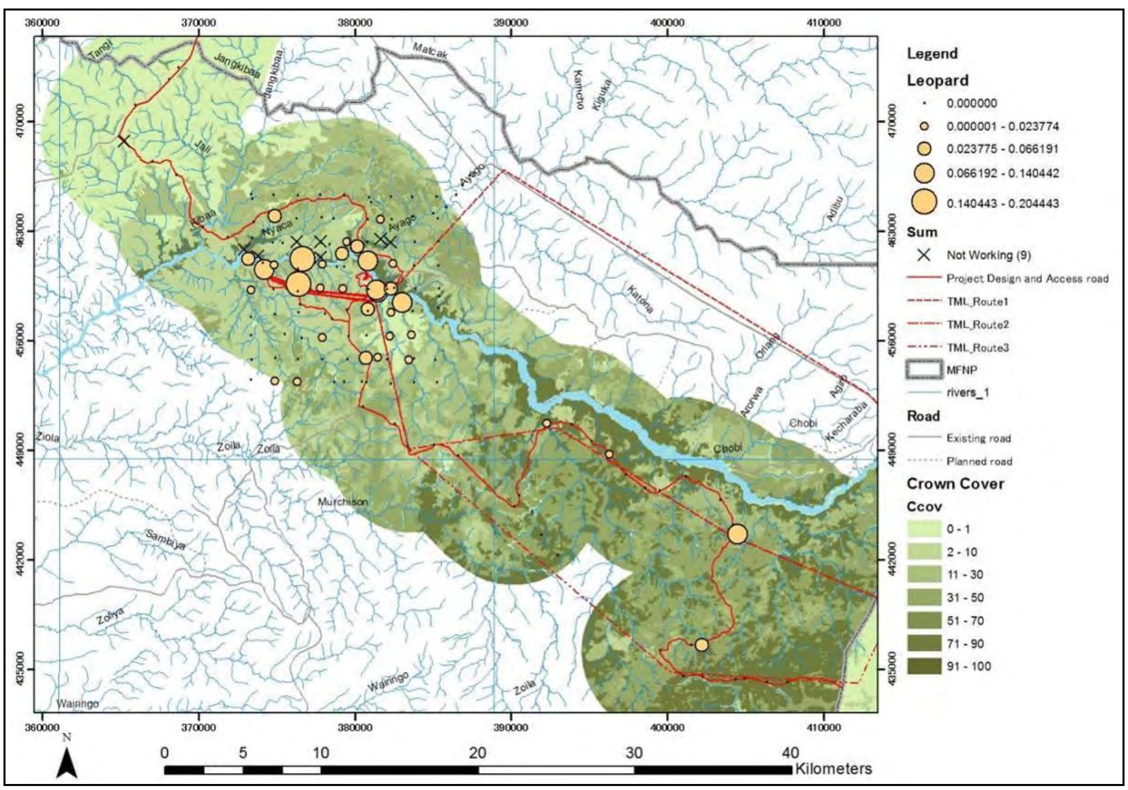


Figure 41: Leopard distribution in project area

On the basis of presence absence, Uganda Kob was the most frequent and six other species (Buffalo, Jackson's Hartebeest, Hippos, Warthog, Waterbuck and Olive Baboon) were also very frequently observed. These observations would imply that the project area is a key ranging area for these seven species of mammals.

Nineteen species were captured on camera 20 or fewer times, and for these we could conclude that the project area is not a major part of their range. Closer examination however, would suggest for example that even for species that were not recorded with high frequency, the south side of the core study area is an important range area as is the case for Lions than the north side.

The distribution of two species (Spotted Hyenas and Lions) that are usually associated with each other given that the former commonly scavenges on kills by the latter, may be compared in Figure 43 and Figure 44).The lion presence records largely overlap the Spotted Hyena distribution records; however it is evident that Spotted Hyena records are much more widely spread than those of lions. More records of Spotted Hyenas have been made to the north side of the river, than those of lions. However in both cases, the records of occurrence were more numerous in the south side. In addition, both species seem to be abundant in the area that would be directly impacted by the water way system. The other fairly large carnivore – the Leopard, has also mostly been recorded in more locations south side of the River Nile, with only a few records of occurrence in locations in the north side of the project area. Unlike the other two large carnivores, Leopards seem to be more tied to the forested areas along the river.

One really interesting record was that of the Chimpanze at N2.34394 E31.93371 in an area of riverine forest. This record represented only a single individual female, but there is a high possibility that this was part of a larger troop that passed further away from the camera.

The species richness recorded at different trap camera locations ranged from as low as one species at trap camera locations N 2.386499 E 31.908131 on the Northern Bank of River Nile and N2.223921 E32.130896 along Nanda Road. Such low species richness may be artefactual as a result of malfunctioned camera or stolen camera. The richest trap camera location (N2.348376 E31.888347) in an open grassland area had 29 species of mammals. Thirty one trap camera stations had 15 or more species while more than 50 stations had less than 10 species of mammals.

Table 53 summarizes the occurrence of five species of carnivores for which records are available for at least five locations in the survey area. The majority of the carnivore records have come from areas in the south side of the project area. Of the 144 survey locations for which we have captured mammal data, only 58 captured at least one of these five species. Leopard and Spotted Hyenas were the most frequently recorded occurring at 28 and 26 of the 58 locations respectively. The majority of these different survey locations only yielded one species of these carnivores. Two of the locations (N2.318979 E31.952974 and N2.334026 E31.927933) had four species of Carnivores recorded at them which represent the richest level for carnivores.

Table 52: Occurrence of Carnivore species recorded in five or more locations

Game camera	Leopard	Lion	Marsh Mongoose	Serval Cat	Spotted Hyena	Totals number of observations at a location
F04NP	0	1	0	0	0	**1**
G05NP	0	0	0	0	1	**1**
I09NP	0	0	0	0	1	**1**

Game camera	Leopard	Lion	Marsh Mongoose	Serval Cat	Spotted Hyena	Totals number of observations at a location
J39NP	1	0	0	0	0	**1**
G04NP	1	0	0	0	0	**1**
A10NP	0	1	0	0	1	**2**
I02NP	1	0	0	0	1	**2**
B02NP	1	0	0	0	0	**1**
B12NP	0	0	0	0	1	**1**
D09NP	0	0	0	0	1	**1**
D12NP	1	0	0	0	0	**1**
F05NP	0	0	0	1	0	**1**
G10NP	0	0	0	0	1	**1**
I03NP	0	0	0	0	1	**1**
I12NP	1	0	0	1	0	**2**
C05NP	1	0	0	0	0	**1**
D05NP	0	0	0	1	0	**1**
I08NP	0	0	0	0	1	**1**
J04NP	0	0	0	0	0	**1**
J08NP	1	0	0	0	0	**1**
J20NP	0	1	0	0	0	**1**
J24NP	0	1	0	0	0	**1**
C02NP	0	1	0	0	1	**2**
D01NP	0	0	0	0	1	**1**
D06NP	1	0	0	0	0	**1**
F11NP	0	0	0	1	0	**1**
H05NP	0	1	0	0	1	**2**
J13NP	0	0	1	0	0	**1**
G08NP	1	1	0	0	1	**3**
J23NP	0	0	0	0	0	**1**
D02NP	1	0	0	0	0	**1**
E04NP	1	0	0	0	0	**2**
E07NP	0	0	1	0	0	**1**
G12NP	0	0	0	0	1	**1**
H07NP	0	0	0	0	1	**1**
J02NP	0	0	0	0	1	**2**
D07NP	0	0	0	0	1	**1**
H06NP	1	0	0	0	0	**1**
J14NP	0	1	0	0	0	**1**
J42NP	1	0	1	0	0	**2**
F07NP	0	0	0	0	1	**1**
J09NP	0	0	0	0	1	**1**
J01NP	1	0	0	0	0	**1**
J38NP	1	1	1	0	0	**3**
K12NP	1	0	1	0	0	**2**

Game camera	Leopard	Lion	Marsh Mongoose	Serval Cat	Spotted Hyena	Totals number of observations at a location
D04NP	1	0	1	0	0	**3**
E06NP	0	1	0	0	0	**1**
H09NP	0	0	1	0	1	**2**
J21NP	1	0	0	0	1	**2**
J40NP	1	1	1	0	0	**3**
J43NP	1	0	1	0	1	**3**
B10NP	1	0	0	1	1	**3**
J27NP	1	1	0	0	0	**2**
J26NP	1	1	1	0	1	**4**
B11NP	1	0	0	0	1	**2**
J47NP	1	0	0	0	0	**1**
J33NP	1	0	1	0	1	**3**
J16NP	1	0	1	0	0	**2**
Total number of locations where carnival was observed	28	13	12	5	26	**90**

5.3.4 Hippopotamus and Crocodiles

Hippopotamus (*Hippopotamus amphibius*) are classified as Vulnerable (VU) by IUCN (2012). They are an amphibious species of mammal that requires sufficient amounts of water to allow for complete submergence, and preference is shown for permanent waters with sandy substrates. Access to adequate grazing is essential but hippos will move several kilometers away from water-bodies to reach suitable feeding areas.

The UWA Hippo census report 2014 estimates that upto 3,331 hippotamus occupy the Nile between Karuma and Murchison Falls. In the MFNP Hippo estimates have shown a reduction from a high of 12,000 individuals in the early 1970s to as low as 1,238 in 1999. Table 54 details the trends of available hippo population estimate figures for the MFNP from the 1970s to 2005. Again these figures may represent a gross under estimation of the Hippo population, but in the circumstances, they are the available data.

Table 53: IUCN Reported Hippo population trends in MFNP

Name		IUC N Red List status	Population in the MFNP								
English name	Scientific name		pre-1973a	1980 b	1991 c	April 1995d	Dec. 1995e	June 1999f	May 2002g	July 2005	March 2014
Hippopotamus	*Hippopotamus amphibius*	VU	12,000	7,565	-	1,498	1,238	1,792	-	2,104	3,331

Sources: [a]UNP (1971), Laws *et al* (1975); [b]Malpas (1978), Douglas-Hamilton *et al* (1980);[c]Olivier (1991);[d]Sommerlatte & Williamson (1995);[e]Lamprey and Michelmore (1996);[f]Lamprey (2000); [g]Rwetsiba et al (2002) , UWA (2014).

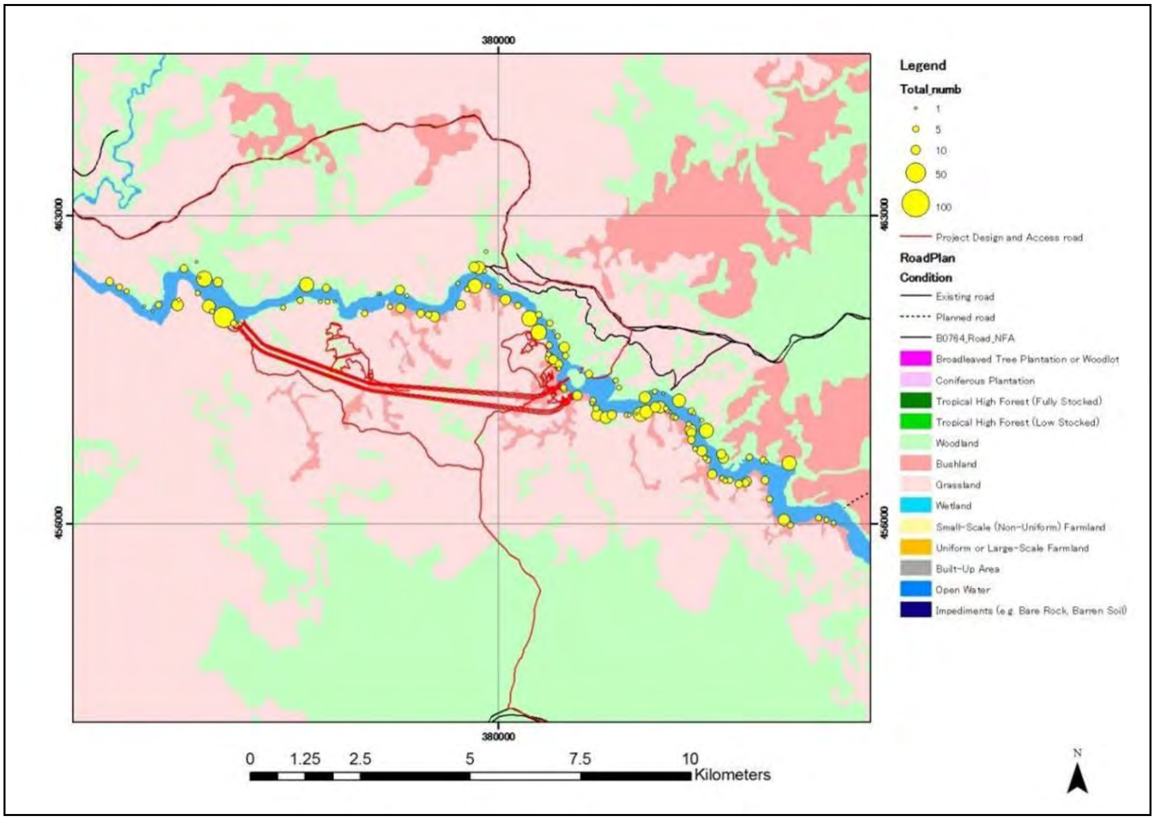


Figure 42: Hippopotamus Survey Results

<u>Results</u>
The counts resulted in a total of at least 1057 Hippopotamus in the area surveyed. Figure 43 maps the distribution of the Hippopotamus along the river section on the north and south banks of the river. The relative concentrations of numbers are variable along the river Section; however it is evident that the bigger concentration of the Hippopotamus is in the river section between easting 380000 to 385000.

Over all there is a mean of 39 Hippopotamus for every 1km^2 but with counts ranging from as low as less than 10 to over 100 in a 1 km^2 grid. Individual counts are indeed variable along the whole river section. The stretch of the river between easting 374000 to 382000 represents the part of the river that will have reduced flow due to the water diversion. This stretch of the river had 45 Hippopotamus congregations which could potentially represent individual schools. However they could also be fewer schools that were disassociated at the time of these counts. The survey result in the dry season will confirm the relative distribution of these congregations. The largest congregation of Hippopotamus in this river section was of 34 Hippopotamus while the total number of Hippopotamus in this section was 368 individuals.

At the proposed intake location, it could be envisaged that the pondage could result into holding back water for up to about 2.5 km. An assessment of Hippopotamus numbers in this river section shows a total of 234 individuals that were recorded in 23 subgroups with a mean of nine individuals in every group. At the point of the outlet and up to about 1.5 km after where it is expected the water level will be higher than the area between the inlet and outlets, a total of 137 Hippopotamus were recorded. These occurred in nine subgroups with a mean of 15 individuals in each subgroup. The largest subgroup of Hippopotamus (55 individuals) was recorded in this area.

Reptiles

Crocodiles:

Besides Hippos, there was evidence for Crocodiles and monitor lizards (Figures 44), and illegal fishing camps (below). Unlike crocodiles which were specifically searched for, Monitor Lizard records were only incidental, recorded whenever they were flushed. Evidence of crocodiles was scanty since the best time to study crocodile is at night using eye shiner. The UWA Census Report (2014) indicates upto 154 individual crocodiles occupying the area from Karuma Bridge to Top of Falls.Two crocodiles were recorded near the area of the proposed intake, each on the north and south bank of the Nile.

The riverine forest habitats provide the best habitats for this species of primate in the Ayago Project area and as well as in the Park a whole. Unlike Baboons and Vervet monkeys these are a largely an arboreal species that mainly forages in the canopy. The riverine forest vegetation is of much importance for the Black and white Colobus in the project area. More groups of Black and White Colobus encountered were recorded on the north bank than the south bank. Over 154 individuals were counted foraging in groups that ranged from two to 17.

The normal practice with primate censuses is to start the transect counts as soon as there is day light in the morning before they disperse far out of the transect route. Since in this case, the Colobus counts were combined in the main hippo census it may be possible that some of the individuals could have already been dispersed by the time the counts were conducted. In any case, these are going to be mainly restricted in the riverside forest. Other primates known to occur in the park (Baboons and Vervet monkeys), were not specifically surveyed. These are much wider ranging in the park than Colobus.

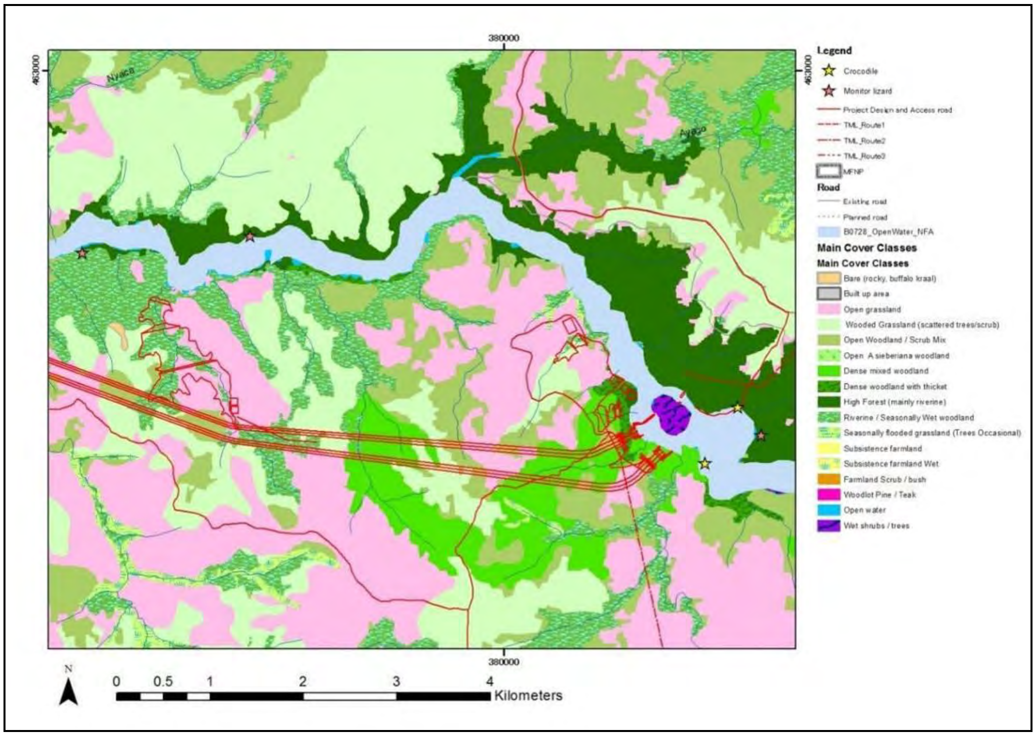


Figure 43: Crocodiles and Monitor lizard's survey

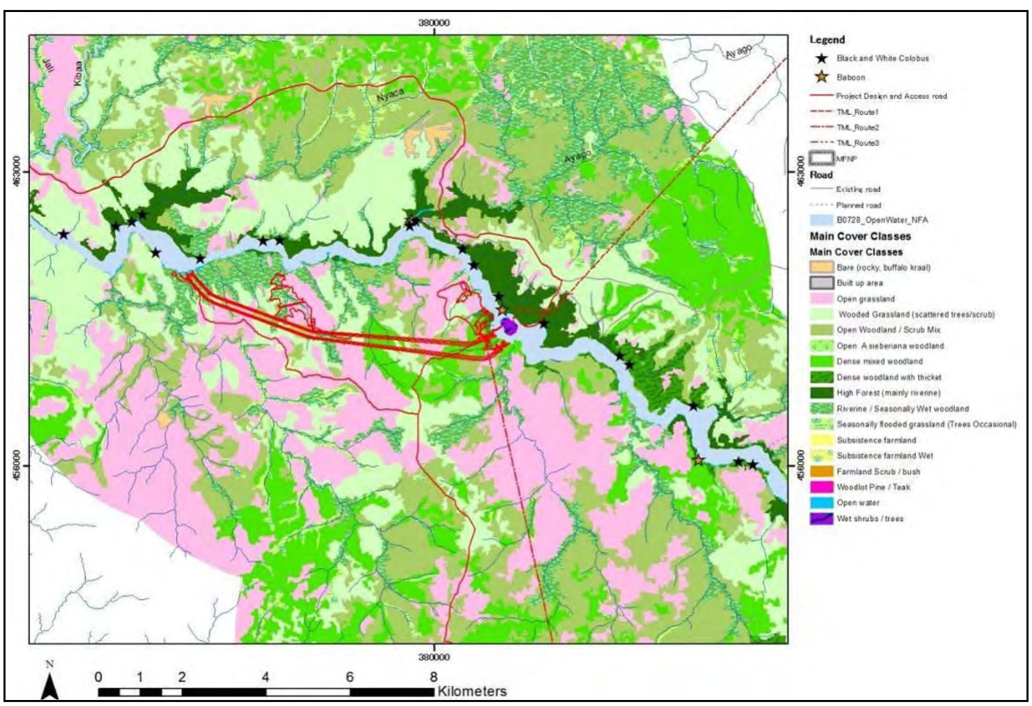


Figure 44: Black and White Colobus groups and Baboons

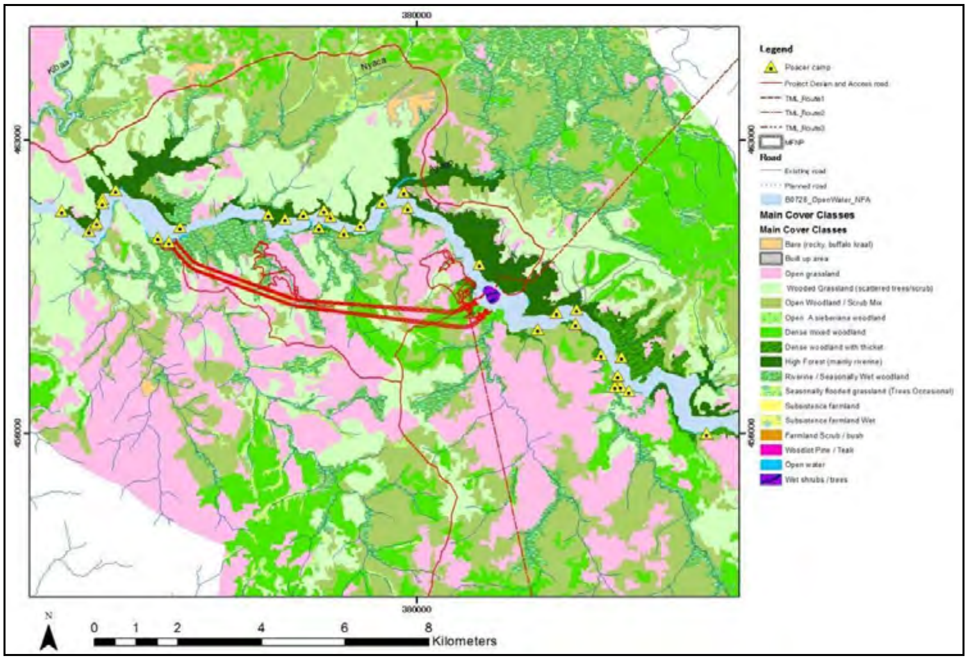


Figure 45: Poacher presence in the Project area

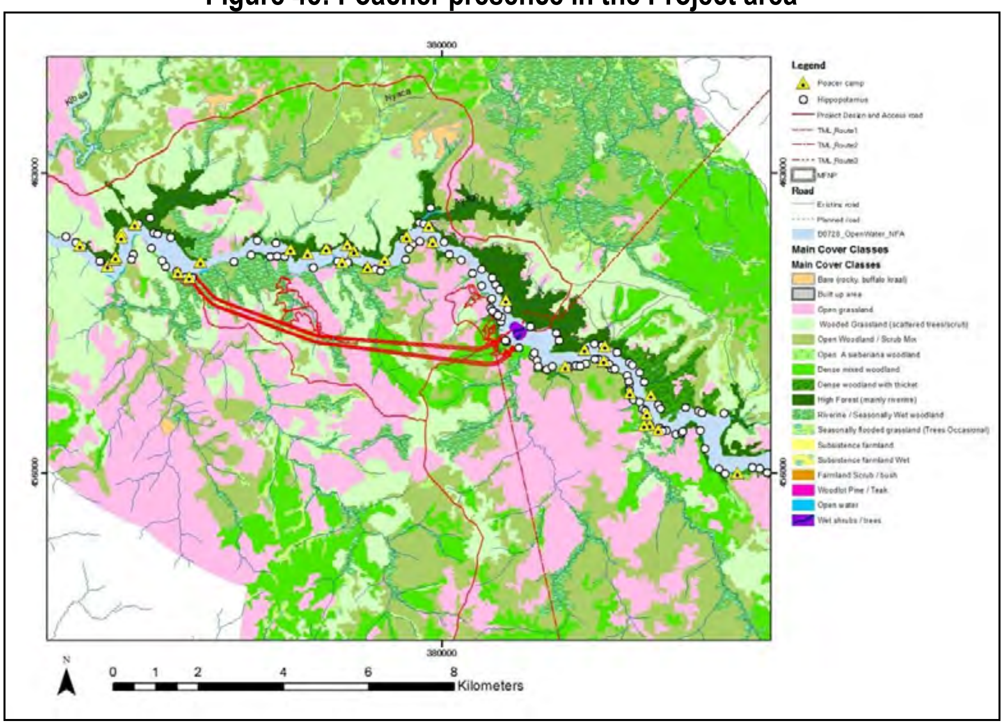


Figure 46: Hippo Distributions and poacher presence in the area

5.3.5 Small Mammals

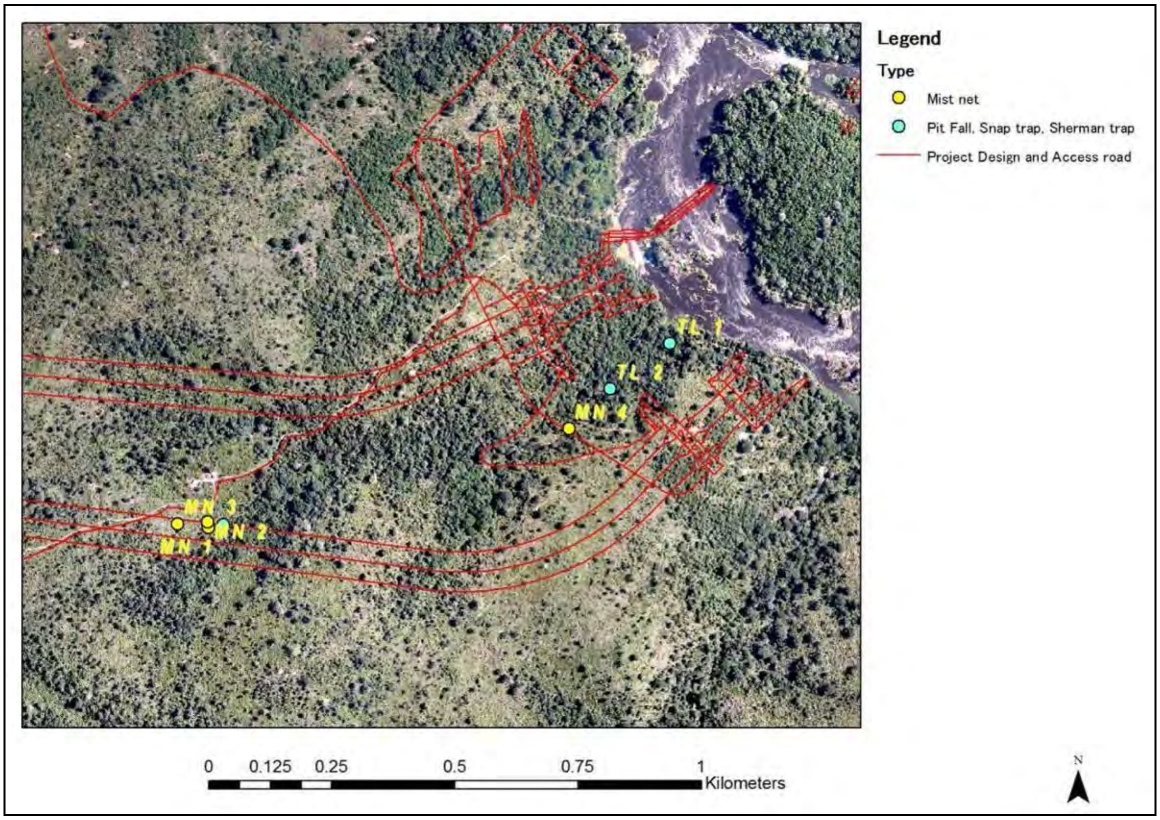


Figure 47: Small Mammal Survey Points in the project area

<u>Results</u>
All identifications are tentative as they are based on field observations. Skulls need to be extracted, cleaned, and measured, and then compared with properly curated collections in order to confirm identification. A total of 50 small mammal specimens were collected and preserved as voucher specimens. These included: 24 rodents, 24 bats, one shrew, and one rabbit (picked up dead on the road).

a) Rodents (Rodentia)``

A total of 24 rodents were collected within six genera, namely *Mus, Praomys, Lophuromys, Mastomys, Grammomys* and *Aethomys.* All rodent species recorded were of low IUCN conservation status and not threatened as shown in (Table 55).

Table 54: Conservation Status of Recorded Rodent Species

Species	Common Name	IUCN Status
Praomys jacksoni	Jackson's soft furred mouse	LC
Praomys sp		
Mus munitoides	African pygmy mouse	LC
Mus sp		
Aethomys hindei	Hinde's Rock rat	LC

Species	Common Name	IUCN Status
Lemniscomys striatus	Striped grass mouse	LC
Grammomys dolichurus	Woodland thicket rat	LC
Mastomys natalensis	Natal multimammate mouse	LC

b) Shrews (Soricidae)

One shrew individual from the genus *Crocidura* was collected.

c) Bats (Chiroptera)

A total of 24 bat specimens were collected within four genera of: *Mops*, *Epomophorus*, *Nycteris*, and *Micropteropus*. *Nycteris macrotis* is a particularly rare bat as there have only been three or five records documented previously (Thorn et al, 2009). All rodent species recorded were of low IUCN conservation status (Table 56).

Table 55: Conservation Status of Recorded bat Species

Species	Common Name	IUCN Status
Epomophorus labiatus	Ethiopian epauletted fruit bat	LC
Nycteris macrotis	Large eared slit faced bat	LC
Micropteropus pusillus	Peter's dwarf epauletted fruit bat	LC
Mops condylurus	Angolan free tailed bat	LC

d) Rabbits (Lagomorpha)

One rabbit from the genus Poelagus (Poelagus majorita) was found dead on the road with in the park (31°55'37.69"E, 31°55'37.69"E). It was also commonly encountered within the Project area adjacent to our campsite at night. This central African rabbit's conservation status is Least Concern (LC) but was, however, collected and prepared as a voucher specimen. This genus (*Poelagus*) contains a single species (*P. marjorita*). The taxon is endemic to the open grasslands of western Uganda, and adjacent southern Sudan, and northesat Democratic Republic of Congo (Garamba National Park). Virtually nothing is known on the ecology, demography, and behavior of this rabbit which is surprising as the entire genus is endemic to a very limited area of central Africa. We urge that its study be prioritized in the future.

e) Trap Success

Trap line three in the grassland had the highest trap success of 12.5% yet it had less trapping effort, followed by trap line one in the riverine forest which had 5.5% trap success. Trap line two along the seasonal stream had the least trap success of 2.4%. Two individuals of *Mus* were caught from the pit fall line previously set up by M. Behangana, however, no small mammal was trapped in the pit fall lines the Study Teams we set up. The mist net across the seasonal stream and adjacent to the fruiting fig tree was particularly successful with 5 captures per night for two nights. *Mops condylurus*, attracted by flying insects attracted to our camp lights, was only collected within camp with our tall 6 m mist net.

5.3.6 Birds

By 1995, 450 bird species had been reported from MFNP (Wilson, 1995), since then a further 22 have been added (NBDB, unpublished), bringing the current list to 472. This makes the park one of the favourite places in Uganda for bird-watchers, including many from overseas; their numbers have risen considerably in recent years and are continuing to do so (G Kaphu, pers comm.). Whilst the first target for many is the Shoebill *Balaeniceps rex*, most visitors have much wider interests. For these and other reasons – such as Uganda's international obligations under the CBD and other treaties – birds are an important feature of the Murchison Falls Conservation Area.

Existing data on birds: The first comprehensive EIA of the Ayago site was made in 1983 (Driver, 1986) although preliminary studies date back to 1970. In the later report (Pomeroy 1986), details of TSC counts of birds in three habitats are given (woodland, wooded bushland and bushland), with 88 species of land bird recoded. Counts at the river listed 37 waterbird species. These counts were made in December 1983 and again in March 1984.

Most research on birds in this park has been in the form of counts. Since 1990s waterbirds have been counted along the River Nile from the Falls to the start of the Albert delta, every January and July, as part of the Wetlands International scheme adopted by many countries; this is one of such sites in Uganda. A brief summary of the waterbird data is given in a report by NatureUganda (in prep). And in 1998, a Makerere University student made a study concentrating on Shoebills, but with additional data on some other waterbird species (Sempala 1999). In this study, counts were made at survey points covering parts of the project area (Figure 49).

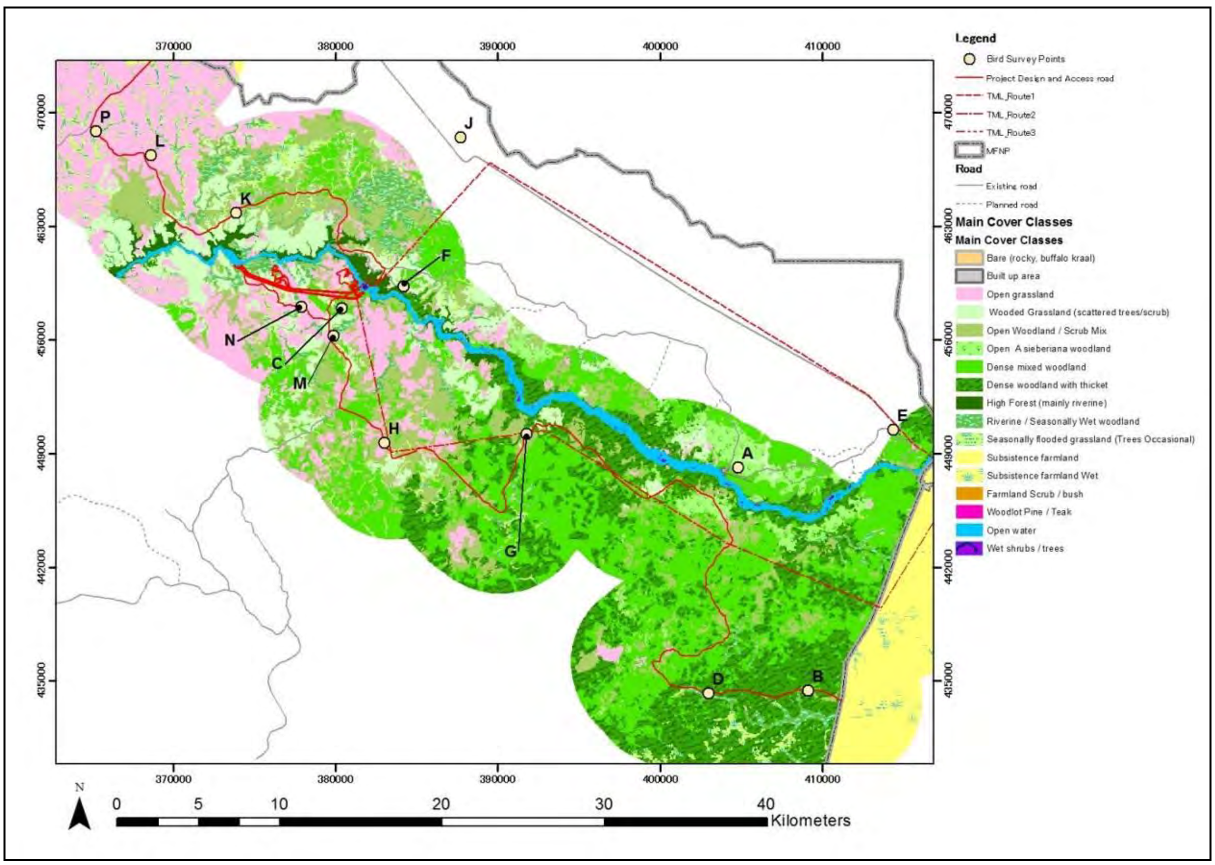


Figure 48: Bird Survey points

Results

a) Landbirds Assessed from Transects

We recorded 246 bird species from transect counts, well over half the current total number of species for the park, a good number of which are waterbirds. The only major group of landbirds that was missing was owls, and the avifauna of the area as a whole can be described as rich and varied. We divided the 14 transect sites into two categories, the first being woodlands (using the definition of Pratt & Gwynne for areas with a woody vegetation cover of trees that exceeds 20%; we counted the woody vegetation above 3 m for this purpose). Woodlands supported 190 of the species recorded, compared to 174 for the more open bush- and grasslands; altogether, 138 species were common to both categories.

The likely total richness of each site, as well as woodlands and open sites collectively, was estimated by the simple non-parametric statistic, Jack 1 (Magurran 2004). The calculated values were 233 species for woodlands, 223 for the more open areas, and 260 for the study area as a whole. This last figure represents more than three-quarters of all the landbirds ever recorded for the whole park, expected or already found within an area that is about 10-15% of the whole park.

b) Species richness of different habitats

The numbers of species supported by a particular habitat (its species richness) varies considerably, but data from the national bird monitoring programme suggest that bushed woodlands are generally high in this respect.

In this study, woodlands were the most species-rich category, averaging 45 species per count, compared to 31 for the more open sites. On average, the seven woodland sites also supported more individual birds (152 cf 98 per count). The diversity between sites - beta-diversity – is also considerable, with the woodland sites having twice as many 'tree species' (F and f), fewer grassland species, but more aerial feeders and Afrotropical migrants than the more open sites.

Estimates of vegetation cover are given in Table 57, from which the classification of sites was derived. All sites had a ground layer of grasses and other herbs, which was tall and dense at several of them. Note that, although taller trees (more than 8m) were found at all of the woodland sites, on average the canopy cover at this level were only just over 5%. The fourteen sites, A to P in the various tables, are ordered according to the amounts of woody vegetation, as summarised in Table 57. Note that there is no very satisfactory method of measuring grass height, so we have based our categories on the average amount of tall grass (which, by October, had markedly increased in the short and medium-height areas since the scoping visit in August).

Table 56: Summary of Transect and Landbird Data

				Habitat categories						Bird data				
											Mean numbers of[f]		Total no. of species[g]	
	Code	Site name	Transect type[a]	UTM co-ordinates	Physio-gnomic category[b]	LB[c]	Pink maps	Grass[d]	Associa-ted veg. transect	No of counts	Species	Individuals	Observed	Estimated
Woodland sites	A	Chobe Terminalia	I	0404805 0248147	W	H2/H1	W	2		5	40	154	90	124

	B	Nanda East	I	0409085 0234394	W	H2/H1	W	3		4	37	140	68	95
	C	Camp site	C	0380393 0257977	W	K	D	2		4	48	176	107	141
	D	Nanda West	I	0402979 0234244	W	H2/H1	W	2		4	39	150	79	105
	E	Chobe Acacia	C	0414348 0250460	W	H2/H1	W	1		5	46	150	94	116
	F	Ayago	I		W	K	G	2		3	50	145	98	136
	G	Bulaya River	I	0391766 0250201	W	K	G	3		4	52	108	107	147
Bush - and grassland sites	H	Nanda Far West	I	0249654		K	W	2		4	40	173	95	133
	J	N-trans-N	I		B	K	D	3		3	29	67	63	95
	K	Kibar East	C	0373888 0263821	WG	K	G	1		3	32	111	62	88
	L	Kibar Plateau	C	0368633 0267395	BG	K	G	2		3	26	88	50	69
	M	Camp South	C	0379888 0256253	BG	K	G	1		4	30	108	66	93
	N	Camp West	I	0377901 0258066	BG	K	G	3[e]		4	30	154	72	104
	P	Wankwar	I		G	Q_1	G	2		3	27	81	47	61

Site order reflects decreasing amounts of woody vegetation UTM co-ordinates are for the approximate mid-point each site.

Notes: a – I = linear C = roughly circular

b – Pratt & Gwynne (1977): W = Woodland; B = Bushland; WG = Woodland grassland; BG = Bushed grassland

c – Langdale-Brown *et al* (1964)

d – 3 = thick and tall (>8% is > 1m) 2 = thick, medium (5 – 8% is > 1m) 1 = less than (2)

e – some areas in category (1), but (3) overall

Estimates of vegetation cover are given from which the classification of sites was derived. All sites had a ground layer of grasses and other herbs, which was tall and dense at several of them. Although taller trees (more than 8m) were found at all of the woodland sites, on average the canopy at this level was only just over 5%. The eleven sites, A to L in the various tables, are ordered according to the amounts of woody vegetation, as summarized in Table 58. Note that there is no very satisfactory method of measuring grass height, so we have based our categories on the average amount of tall grass (which had markedly increased in the short and medium-height areas since the scoping visit in August).

Table 57: Vegetation at Bird Transect Sites

Site code and name	Woody vegetation				Non-woody vegetation		Classification		Common woody species[c]
	0-1	1-3	3-8	>8 m	0-1	1-3 m	PG[a]	Grass[b]	
Woodlands									
A Chobe Terminalia	35	40	41	8	100	5	W	M-T	Term, Ack, Alb, Comb.
B Nanda East	12	15	30	14	100	10	W	T	Term, Alb, Ack, Fic.
C Camp site	11	24	36	5.5	78	5	W	M	Fic, Ach, Lan, Til, Comb.
D Nanda West	37	29	35	5	100	3.5	W	M-T	Term, Fic, Ack, Spa
E Chobe Acacia	14	16	27	6	96	1.5	W	S	Ack
F Ayago	22	20	21	9	96	5.4	W	S-M	Ack, Fic, Comb
G Bulaya River	26	31	18	2	100	9	W	T	Term, Alb, Fic, Comb.
Bush-and grass-lands									
H Nanda Far West	10	21	13	0	100	7	B	M	Comb, Term, Ach, Fic
J N Trans N	13	22	8.7	0	100	7	B	M-T	Comb, Term, Fic, Spa
K Kibba East	5.5	8.5	6	1.5	93	4.2	WG	S	Comb, Term, Ack
L Kibba Plateau	5.1	1.9	0.1	0	99	6.5	BG	M	Fic
M Camp South	2.3	3	1.1	0	89	3.1	BG	S	Ach, Comb, Lan
N Camp West	1.1	2.6	1	0	97	12	BG	T	Lan, Fic
P Wankwar	1.4	0.6	0.3	0	95	1.8	G	S-M	Fic, Kig

Notes: The six columns of numerical data are average values of % cover in the indicated vertical layers. Woodlands have more that 20% cover above 3 metres. Sites ordered by decreasing cover of woody vegetation above 3 m for woodlands and below 3 m for other sites. (W = Woodland, B = Bushland, WG = Woodland grassland, BG = Bushed grassland, G = Grassland).

a – Pratt & Gwynne (1977) categories

b – S(hort), M(edium), or T(all) in Aug/Oct, reflected in % cover above 1m: >8% = tall, 5-8% = medium, >5% = short.

c – Ach = Acacia hockii, Ack = Acacia kirkii and/or Ac. senegalensis, Alb = Albizia sp, Comb = Combretum sp, Fic = Ficus sp, mainly F. sycomorus, Kig = Kigelia africana, Lan = Lannea welwitschii, Spa = Spathodea campanulata, Term = Terminalia sp, Til = Tiliostipina sp.

There are many ways of categorising birds; Table 59 includes several of these, namely – important habitat and behavioural types, migrants and species of conservation concern. In fact all of the categories are of some conservation concern; for example, deforestation in Uganda is rampant, so all birds needing trees will be affected; grasslands are almost always overgrazed, which suits a few bird species, such as pipits and wagtails, but many ‘grassland specialists’ prefer longer grass. The global categories of threat are those of IUCN, whilst the regional ones use similar criteria applied just to East Africa (Bennun and Njoroge, 1996). The latter includes the category of ‘regional responsibility’ (R-RR) for species which are largely confined to East Africa.

The distribution of species related to forests and trees is as expected – sites with more woody vegetation have more of them. Woodlands always have grasses as the main understorey plants, and some grassland birds are found in all the woodlands; but only about ten such species on average, compared to eighteen in the more open sites. Numbers of migratory species were generally low, but the open areas were important for Whinchats, and to a lesser extent Northern Wheatears, whilst Eurasian Bee-eaters, Sand Martins and Barn Swallows were common in all habitats during October, when they were on passage. By January, Grasshopper Buzzards and Grey-headed Kingfishers, both Afrotropical migrants, were widespread, the former mainly in the woodlands.

Table 58: Numbers of bird species in various categories – important habitats, migration and Red Data

			Habitats						Migration		Red Data Listings				
			F	f	W	w	G	Ae	P	A	G-EN	G-VU	R-VU	R-NT	R-RR
Woodlands	A	Chobe *Terminalia*	6	61	0	10	15	7	3	6	0	0	0	1	0
	B	Nanda East	11	49	0	4	8	4	3	4	0	0	2	1	0
	C	Camp site	11	61	1	12	15	4	5	6	0	1	1	1	0
	D	Nanda West	10	47	1	5	11	6	4	4	0	0	0	1	0
	E	Chobe *Acacia*	7	57	2	16	9	6	5	5	0	0	0	0	1
	F	Ayago	9	52	1	14	13	4	5	3	0	2	3	1	2
	G	Bulaya	10	57	3	12	16	9	7	4	0	0	2	2	1
	Average		9.1	54.9	1.1	10.4	12.7	5.7	4.6	4.6	0.0	0.4	1.1	1.0	0.6
Bush- and grasslands	H	Nanda Far West	3	42	1	10	20	5	6	3	0	1	3	3	0
	J	N trans N	3	37	1	7	11	1	4	1	0	0	0	1	0
	K	Kibar East	1	32	2	7	15	3	6	2	0	0	1	1	0
	L	Kibar West	1	22	0	7	20	4	5	0	0	0	0	0	0
	M	Camp South	2	26	2	7	20	4	5	2	0	1	4	1	1
	N	Camp West	4	25	3	7	19	6	6	6	0	1	1	1	1
	P	Wankwar	1	11	1	3	18	1	1	1	0	2	3	1	0
	Average		2.1	27.9	1.4	6.9	17.6	3.4	4.7	2.1	0.0	0.7	1.7	1.1	0.3

Note that some species belong to more than one category.

Key to symbols:

F - Forest generalist	P - Palearctic migrant	G-EN - globally endangered
f - Forest visitor	A - Afrotropical migrant	G-VU - globally vulnerable
W - Waterbird, specialist	Ae – Aerial species	R-VU - regionally vulnerable
w - Waterbird, non-specialist		R-NT - regionally near-threatened

G – Grassland species	R-RR - species of regional responsibility

Species of either global or regional conservation concern were comparatively few, but several that were not recorded, such as White-headed and Lappet-faced Vultures, and Pallid Harrier, are known from the raptor road counts (Pomeroy et al, in prep) to occur widely within the MFNP.

Interestingly, the numbers of raptors – both species and individuals – were higher in woodlands than the less wooded habitats: an average of 5.7 and 4.6 species, and 3.2 and 2.0 individuals, respectively; but the samples are relatively small. Overall, we recorded 26 species of raptor (including two along the River Nile, African Fish Eagle and Osprey), a remarkably high figure. However, the annual road counts of raptors show a different picture, with largest numbers in the open grasslands, where vulture parties are most likely to be observed. During these January counts, there can be good numbers of Honey Buzzards in the woodlands and some Grasshopper Buzzards too, but few other raptor species (Pomeroy et al, in prep).

Tushabe et al (2006) showed that, overall, there is a fairly high degree of congruence between different taxa in Uganda's Important Bird Areas (IBAs). In our studies, the numbers of species of birds and mammals showed no correlation at local levels (Figure 52). If further analyses show this to be also so for other taxa, then the case can easily be made for surveying as many taxa as is practicably possible, since no single group, such as birds, can adequately represent biodiversity as a whole. Long-term monitoring of birds by TSCs, in MFNP and other areas has shown a considerable turn-over of species at particular sites over a period of years (Pomeroy and Sheil, in prep). This effect is more pronounced in less common species – bulbuls occur almost everywhere, always. The implication of this is that relatively large areas are needed for the conservation of the less common species –which are the majority - not only because of their lower densities, but also because particular sites are only occupied from time to time.

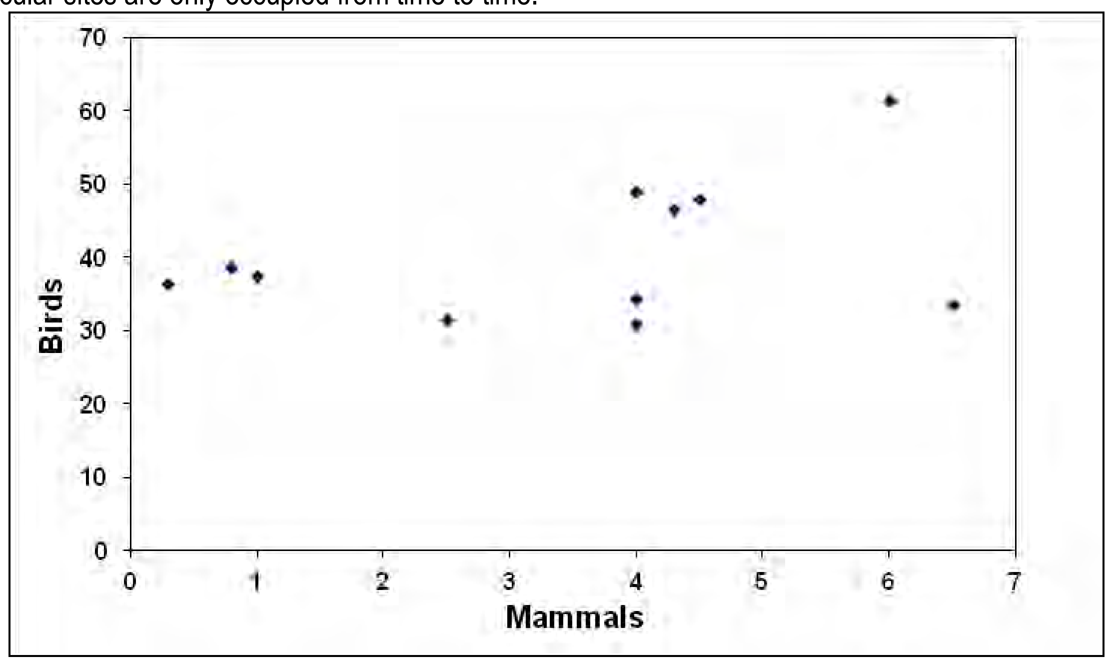


Figure 49: Correlation between the numbers of mammal species recorded at the various sites & the numbers of bird species (by sight or sound)

Nightjars and Owls

In both October 2012 and January 2013, we drove between the main Nanda cross-roads and the camp, a distance of about 7 km, from about 19:10 to 20:00, intended to span the best time for counting nightjars on roads (Pomeroy et al 2013). The October count produced only a single Gabon Nightjar, whereas in January two male Long-tailed Nightjars were recorded. However, several opportunistic observations add to this. Notably, in August 2012, a c30 Pennant-winged Nightjars along the Nanda road near to the camp junction was seen; and a single male of this species in the same area was recorded on 08 January. On 04 January, soon after dark, four male and four presumed female Long-tailed Nightjars were recorded in the same area – but no Pennant-winged or other species. One Long-tailed was also found dead near the camp. Most interesting of all was a middle-of-the-night count (22:30 to 00:40) with the results as shown in Table 60.

Table 59: Nightjars

	Nightjar	Number
341	Swamp nightjar	2
342	Long-tailed Nightjar	2
343	Slender-tailed Nightjar	7
348	Plain Nightjar	5
351	Eurasian Nightjar	4
352	Standard-winged Nightjar	13
353	Pennant-winged Nightjar	1
	Unidentified nightjars``	12
Total		**46**

The distance travelled, from the Wangkwar turn-off to Chobe was 62 km, so there was almost one bird for every kilometre of road. No owl of any species was recoded, despite a total of about ten nights spent in camp, when they would have been likely to be heard, if active. Pel's Fishing-owl has been recorded at Chobe and may well occur along the river within the project area.

Impact of Fire on Savanna birds

One of the primary objectives for the January visit was to see how birds and butterflies were affected by fire. To do so, transect counts were made at two sites, a small one south of the river and a larger area to the north (there had been few fires by the time of our visit, and most covered only a few hectares). In both cases, the fires were part of UWA's management activities. The southern (Nanda road) site impinged on only 200 metres of road, whilst that in the north (on the road to Ayago) extended along the road, on one side only, for about 1.5 km, and for a minimum of several hundred metres away from the road. Both sites were in *Combretum* bush/woodland, with a canopy cover above 1 m of about 21 % in the south and 15% in the north, both figures referring to unburnt areas. After burning, since most of the canopy is leaf, these figures fell to less than 5% in both areas.

At both sites, there were more species, and more individuals, in the burnt than in the unburnt areas (details in Table 61). But of these four comparisons, although they all pointed the same way, only the numbers of species at the Ayago site showed a significant difference at a P = 0.05 level; larger samples may well lead to all such comparisons being significant. There were no obvious differences in the effects of fire on particular groups of birds, such as granivores (which might have found seeds easier to spot), insectivores (soon after fire there would have been lots of dead insects on which to forage) or gleaners (nothing much to glean).

Table 60: Analysis of counts on transects comparing burnt and unburnt areas

Site	Area	Species			Individuals		
		Average No.	t	P	Average No.	t	P
Nanda road	Unburnt	8.1	1.8368	0.2722	12.3	1.6671	0.2813
	Burnt	14			20.5		
Ayago road	Unburnt	8.4	2.7895	0.0493	12.6	1.9366	0.1249
	Burnt	14.6			22.8		

Note: For the Ayago road, the numbers of species were significantly higher in the burnt area, while the difference in numbers of individuals was also suggestive. The initial assumption was that there would be fewer birds in the burnt areas – because of less cover, cooked fruits, burnt insects so it was big surprised to find the opposite. On the face of it, burning is good for birds! (We might add that there were far fewer butterflies in the burnt than unburnt areas – and only a few mammals; the new grass had yet to appear in quantity). Burning in the southern area had been about a week before the counts; along the Ayago road, the interval was about two weeks. For a full assessment of the impact of fire on birds, a much longer series of data would be needed, beginning before burning and continuing for some months afterwards.

A note on interpreting transect counts

Bird counts are affected by various factors, such as time of day and temperature. We recorded times of all counts and noted how warm it was as one of five categories – cool (c15 degrees), mild (c20), warm (c25), fairly hot (c30) and hot (c35). This information is shown at the head of each count in Table 55 and Table 56. Figure 47 shows the variation in numbers of species recorded in the two sites with five counts, and two of those with four counts, as a percentage of the average for the site. Clearly, more birds are seen when it is cooler, but the differences are not great – about 10% either side of the average. There was one count recorded as 'hot', and that did produce a low count – 58% of the average for that site (L). Generally the numbers of bird species recorded appeared to be little affected, except at woodland site A.

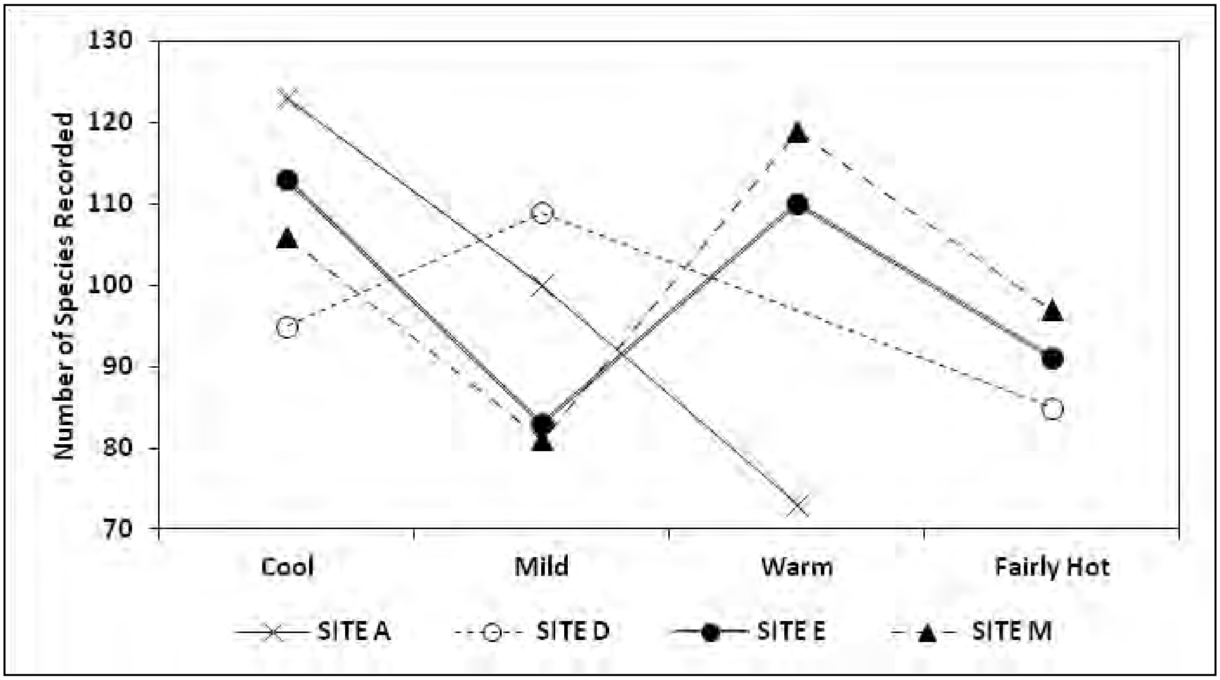


Figure 50: Effect of temperature onthe number of bird species recorded at different sites

The numbers recorded also depend upon the species themselves. Some, such as the Tropical Boubou, are recorded almost entirely by sound, so if they do not call, they go unrecorded. Overall, birds heard but not seen accounted for more than 30% of the total, the proportion being higher in woodlands than in open areas – as would be expected. In addition, an average of between 5 and 10% of birds in any one count were unidentified. We believe that our count data give a good impression of the distribution and abundance of each species, but the numbers are not absolute; in fact they will usually be under-estimates, but we do not know by how much, although we believe it to be fairly small.

Table 61: Proportions of birds seen and heard along one count (the first) for each transect

Sites	No. of spp. in count	No of individuals		
		Seen	Heard	% seen
WOODLAND SITES				
A Chobe *Terminalia*	43	78	68	53
B Nanda East	40	58	42	58
C Camp site	49	95	73	57
D Nanda West	38	88	55	62
E Chobe *Acacia*	38	45	64	41
F N trans Sa [Ayago]	62	117	59	66
G Bulaya River	59	118	77	61
Average	47	-	-	57
BUSH and GRASSLAND				
H N Trans Na	26	18	37	33
J Nanda Far West	50	155	61	72
K Kibar East	35	85	39	69
L Kibar West [Plateau]	37	67	31	68

Sites	No. of spp. in count	No of individuals		
		Seen	Heard	% seen
M Camp South	39	106	26	80
N Camp West	36	126	47	73
P Wankwar	26	76	-	90
Average	36	-	-	69
UNIDENTIFIED BIRDS (all sites combined)				
Woodland sites (n = 7)	-	39	7	85
Bush and grassland (n = 7)	-	36	8	82
INDIVIDUAL SPECIES b				
Palm Swift – woodland	3	34	0	100
– bush and grassland	4	13	0	100
Common Bulbul – woodland	7	52	56	48
– bush and grassland	7	56	26	68
Yellow-fronted Tinkerbird - woodland	7	4	25	14
– bush and grassland	2	1	1	-
Tropical Boubou – woodland	4	0	22	0
– bush and grassland	2	0	7	0

For the same counts, an average of about six birds per count (about 5% of the total) were unidentified, most of these being seen (but usually too briefly). Four individual species show the range of possibilities.

Notes a-North and South ends of the proposed northern route for transmission line
b-Here n is the number of sites where the species occurred

It is also notable that in sites with counts of 30 or more species, more than half of them are recorded from only one of the ten sections of the transect. Thus habitats which are more species-rich have more uncommon species, which are often those most likely to be missed. Ideally, such sites would receive more attention in order to pick up more of the less common species, that is, they had more rare species and would therefore require more counts to approach a total for the site.

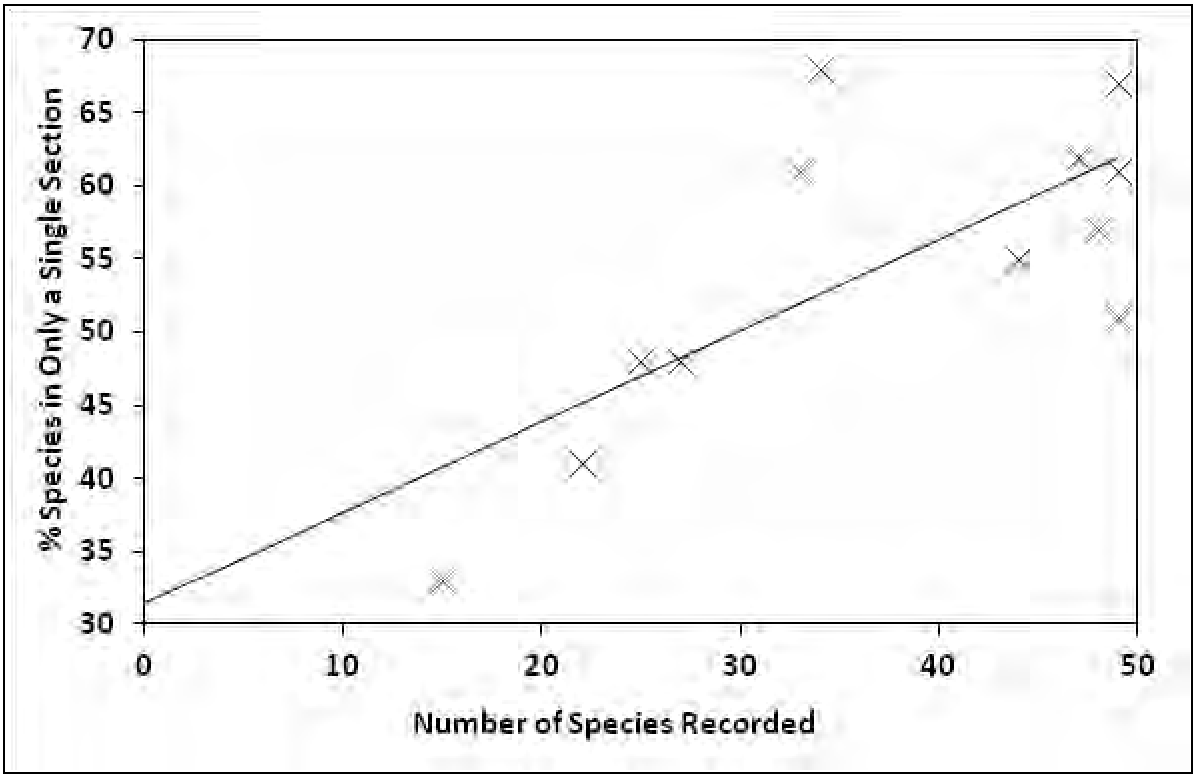


Figure 51: Proportion of species recorded in only one of the ten sections of the transect

Changes since 1973-4

During the earlier surveys (Pomeroy 1976), 15 TSC counts in woodland, wooded bush and bushland produced a list of 88 species, of which no less than 25 – mostly Palearctic migrants - were not recorded in 2012-13. Notable amongst the migrants in the earlier counts were Lesser Kestrel (formerly G-VU, now G-LC; R-VU) and Redstart, whilst amongst the resident species were Lappet-faced (G-VU, R-NT) and White-headed (G-VU and R-VU) Vultures. However, the overall picture is one of similarity, with all the commoner species being similar in both periods.

Forest birds

Table 63 summarises the records of the 35 species of birds in two strips of riverine forest along the Rivers Nile and Ayago. The total time spent in the two areas was about twelve hours, and the numbers of species recorded in that time are surprisingly few. There were no forest interior species, unlike Rabongo (Dranzoa et al 2011), although the total area of riverine forest along the Nile and Ayago is probably greater than the area of Rabongo; and both are relatively isolated. Although six species were recorded in these forests that were not found elsewhere, to a large extent the avifauna is a subset of that from the richer woodlands.

Table 62: Birds recorded from the riverine forests

No.	Name		Scarcity	Habitat	Mid-time	1300	1300	1030	1030	1200

					Date	11-Oct-12	12-Oct-12	19-Oct-12	19-Oct-12	3-Jan-13
						Net	Other	Net		Other
28	HAMERKOP Scopus umbretta		RB	w					P	
39	HADADA Bostrychia hagedash		RB	w					P	
76	AFRICAN FISH EAGLE Haliaeetus vocifer		RB	W			P		P	
77	PALM-NUT VULTURE Gypohierax angolensis		RB							P
142	HELMETED GUINEAFOWL Numida meleagris		RB	G			P			
271	BLUE-SPOTTED WOOD DOVE Turtur afer		RB	f			P		P	P
319	KLAAS' CUCKOO Chrysococcyx klaas		RB	f			P			
321	YELLOWBILL Ceuthmochares aereus		RB	F						P
374	BLUE-BREASTED KINGFISHER Halcyon malimbica	*	RB	F,w			P		P	
378	AFRICAN PYGMY KINGFISHER Ceyx picta		RB, AfM/NB	f,w		1				
382	GIANT KINGFISHER Megaceryle maxima		RB	R-NT,W					P	
389	RED-THROATED BEE-EATER Merops bullocki		RB	w			P			P
420	AFRICAN GREY HORNBILL Tockus nasutus		RB							P
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus		RB	f			P		P	P
455	GREATER HONEYGUIDE Indicator indicator		RB	f					P	
473	CARDINAL WOODPECKER Dendropicos fuscescens		RB							P
530	RED-SHOULDERED CUCKOO SHRIKE Campephaga phoenicea		RB, AfM/NB?							P
538	LITTLE GREENBUL Andropadus virens		RB	F			P		P	
547	YELLOW-THROATED GREENBUL Chlorocichla flavicollis	*	RB	f						P
562	COMMON BULBUL Pycnonotus barbatus		RB	f			P		P	P
578	SNOWY-HEADED ROBIN-CHAT Cossypha niveicapilla	*	RB	F,w				1		
638	RED-FACED CISTICOLA Cisticola erythrops		RB	w					P	
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura		RB			2	P	4	P	P
691	RED-FACED CROMBEC Sylvietta whytii		RB				P		P	
692	GREEN CROMBEC Sylvietta virens	*	RB	F						P
695	WILLOW WARBLER Phylloscopus trochilus		WV, PM	P,f						P
714	PALE FLYCATCHER Melaenornis pallidus		RB							P
739	AFRICAN PARADISE FLYCATCHER Terpsiphone viridis		RB	f				1		

No.	Name		Scarcity	Habitat	Mid-time	1300	1300	1030	1030	1200
					Date	11-Oct-12	12-Oct-12	19-Oct-12	19-Oct-12	3-Jan-13
						Net	Other	Net		Other
746	BROWN-THROATED WATTLE-EYE Platysteira cyanea		RB	f			P		P	P
794	COLLARED SUNBIRD Hedydipna collaris		RB	F						P
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	*	RB	R-RR,W						P
828	SULPHUR-BREASTED BUSH-SHRIKE Malaconotus sulfureopectus		RB? AfM/B?	f				1	P	
836	NORTHERN PUFFBACK Dryoscopus gambensis		RB	F					P	
908	BLACK-HEADED WEAVER Ploceus cucullatus		RB	f				2		
915	COMPACT WEAVER Ploceus superciliosus	*	R(B)?	FF				1		
	Totals (birds caught, total species)					3	14	10	19	

Six species (*) are additional to the transect lists, P = present.

Water birds

Compared to the surveys of 1983-4 (Pomeroy 1986), fewer waterbird species were found despite a longer period of observation. The difference may partly be due to the time of year, with four more Palearctic species, and one Afrotropical, in the earlier period, but at most this is a partial explanation. Thus the numbers of herons, storks and plover species recorded in 1983-4 were 5, 3 and 3 respectively, compared to three, one and one in 2012. However, big numbers of Rock Pratincoles (R-VU) and Wire-tailed Swallows were recorded, both species – and particularly the Pratincole – with limited distributions in Uganda. The Rock Pratincole is also one of three waterbird species that are high on the 'wants' lists for visiting birders, as are African Finfoot (twice seen with good views from the Ayago bridge, so that should continue to be there) and Giant Kingfisher. The Pratincole is also easily seen above and below the fall, and the Giant Kingfisher is usually seen on launch trips from Paraa to the Falls. A count on the Nile from the proposed weir site to the outfall recorded the following numbers in February 2013.

Table 63: Water bird species recorded from the weir site to the outfall

7	African Darter	2	223	Spur-winged Plover	6
39	Hadada Ibis	14	30	African Open-billed Stork	1
17	Cattle Egret	28	383	Pied Kingfisher	1
197	Black-winged Stilt	1	382	Giant Gingfisher	1
21	Little Egret	1	32	Abdim's Stork	27
209	Rock Pratincole	27	28	Hamerkop	1

These numbers are easily comparable to those from the fixed points summarised in Table 65; most would probably find the reduced flow unsuitable, and much lower numbers are likely once the scheme is in operation.

Table 64: Waterbirds counted at the Ayago- Nile confluence and at the weir site

No.	Name	Birders' score	Habitat and statusa	Ayago – Nile confluence	Weir site	1984 recordsb
7	African Darter Anhinga rufa		R-VU,W	2 (12)	2 (9)	F. common
14	Common Squacco Heron Ardeola ralloides		W		1 (1)	Present
18	Striated Heron Butorides striatus		R-NT,W		1 (1)	Present
27	Goliath Heron Ardea goliath		R-NT,W	2 (7)	1 (1)	Present
28	Hamerkop Scopus umbretta		W	1 (1)	4 (3)	Present
30	African Open-billed Stork Anastomus lamelligerus		A,w,G	1 (1)		Common
39	Hadada Ibis Bostrychia hagedash		W	2 (3)	7 (6)	Present
50	Egyptian Goose Alopochen aegyptiacus		W,G	1 (8)		Present
69	Osprey Pandion haliaetus		P,W		1 (1)	Present
76	African Fish Eagle Haliaeetus vocifer		W	2 (5)	1 (2)	Rather sparse
186	African FinfootaPodica senegalensis	****	R-VU,W	1 (2)c		No record
193	African Jacana Actophilornis africana		W	1 (2)		No record
200	Senegal Thicknee Burhinus senegalensis		W	2 (1)		No record
209	Rock Pratincole Glareola nuchalis	***	R-VU,W	8 (16)	15 (24)	Very common
223	Spur-winged Lapwing Vanellus spinosus		w,G	2 (4)		Present
246	Common Greenshank Tringa nebularia		P,W	1 (1)	1 (1)	Present
248	Wood Sandpiper Tringa glareola		P,W		1 (1)	No record
250	Common Sandpiper Actitis hypoleucos		P,W	2 (8)	1 (5)	Common
259	Gull-billed Tern Gelochelidon nilotica		P,W	1 (1)	1 (1)	No record
382	Giant Kingfisher Megaceryle maxima	***	R-NT,W	1 (2)	2 (5)	Present
383	Pied Kingfisher Ceryle rudis		W	3 (9)	2 (4)	Breeding
500	Sand Martin Riparia riparia		P,W,Ae		5 (1)	No record
509	Wire-tailed Swallow Hirundo smithii		w,Ae	C50 (16)	6 (14)	Breeding
520	African Pied Wagtail Motacilla aguimp		w	2 (8)	2 (24)	Common
910	Yellow-backed Weaver Ploceus melanocephalus		W		4 (3)	No record

Counted at the Ayago - Nile confluence during 19 half-hourly periods on one day each in October and December 2012, and January, 2013 – all counted between 1000 and 1500; and at the weir site during 25 half-hourly periods on two days in October 2012, one day in December 2012 and one day in January 2013 – all counts between 0700 and 1800. Figures show the highest count in any half-hourly period, and the number of such periods with records of the species. The 1984 counts were at the weir site, where there is an island.
Total 25 species (cf 37 in 1984, and 44 for the combined lists; see Note (b))
Notes: a – see Table 5.36 for explanation
b - the following additional species were recorded in 1984 – Long-tailed and Greater Cormorants, Grey

No.	Name	Birders' score	Habitat and statusa	Ayago – Nile confluence	Weir site	1984 recordsb
Heron, Great White Egret, Abdim's (many thousands in March), Woolly-necked and Marabou Storks, Sacred Ibis, Teal, Palm-nut Vulture, Ringed and Wattled Plovers, Black-winged Stilt, White-winged Black Tern, Grey-headed Kingfisher, Yellow Wagtail. c – by the road bridge over River Ayago on two occasions						

Birders' birds

Birdwatchers make up a significant proportion of the visitors to the MFCA, and many have particular species on their lists of 'must-see' birds; The 45 bird species that are most commonly requested to ranger-guides are listed in Table 66. Almost all of the 34 land-bird species were recorded during the surveys (Denham's Bustard and Northern Carmine Bee-eater were the main exceptions, but both are possible). The original lists were provided by senior ranger-guides (George Kaphu and Taban Bruhan, and Malcom Wilson), who leads bird tours of Uganda. Their lists have been combined, with species that they say are most wanted having more stars. Most species are specialties of northern Uganda, especially land-birds. Species' names are preceded by check-list numbers.

Table 65: Bird species considered priorities by visiting serious birdwatchers

A.	WATERBIRDS	
37	SHOEBILL Balaeniceps rex	****
186	AFRICAN FINFOOT Podica senegalensis	***
194	LESSER JACANA Microparra capensis	**
200	SENEGAL THICKNEE Burhinus senegalensis	**
203	EGYPTIAN PLOVER Pluvianus aegyptius	****
209	ROCK PRATINCOLE Glareola nuchalis	**
221a	WHITE-CROWNED LAPWING	***
222	BLACK-HEADED LAPWING Vanellus tectus	**
334	PEL'S FISHING-OWL Scotopelia peli	***
382	GIANT KINGFISHER Megaceryle maxima	**
842	PAPYRUS GONOLEK Laniarius mufumbiri	***
B.	LAND-BIRDS – 34 species	
87	WESTERN BANDED SNAKE-EAGLE Circaetus cinerascens	*
91	PALLID HARRIER Circus macrourus	*
108	GRASSHOPPER BUZZARD	*
133	RED-NECKED FALCON Falco chicquera	**
149	RING-NECKED FRANCOLIN Francolinus streptophorus	**
157	HEUGLIN'S FRANCOLIN Francolinus icterorhynchus	*
187	DENHAM'S BUSTARD Neotis denhami	***
269	BRUCE'S GREEN-PIGEON Treron waalia	**
285	VINACEOUS DOVE Streptopelia vinacea	*
298	WHITE-CRESTED TURACO Tauraco leucolophus	**

352	STANDARD-WINGED NIGHTJAR Macrodipteryx longipennis	***
388	SWALLOW-TAILED BEE-EATER Merops hirundineus	*
389	RED-THROATED BEE-EATER Merops bullocki	**
395a	NORTHERN CARMINE BEE-EATER	**
397	ABYSSINIAN ROLLER Coracias abyssinica	***
409	ABYSSINIAN GROUND-HORNBILL Bucorvus abyssinicus	*
441	BLACK-BILLED BARBET Lybius guifsobalito	**
479	BROWN-BACKED WOODPECKER Picoides obsoletus	***
602	WHITE-FRONTED BLACK CHAT Myrmecocichla albifrons	***
653	FOXY CISTICOLA Cisticola troglodytes	*
663	RED-WINGED GREY WARBLER Drymocichla incana	**
686	GREEN-BACKED EREMOMELA Eremomela pusilla	**
763	DUSKY BABBLER Turdoides tenebrosus	**
795	PYGMY SUNBIRD Hedydipna platura	***
801	BEAUTIFUL SUNBIRD Cinnyris pulchella	*
821	YELLOW-BILLED SHRIKE Corvinella corvina	***
891	CHESTNUT-CROWNED SPARROW WEAVER	*
930	NORTHERN RED BISHOP Euplectes franciscanus	*
947	RED-WINGED PYTILIA Pytilia phoenicoptera	**
956	BROWN TWINSPOT Clytospiza monteiri	*
960	BAR BREASTED FIREFINCH	**
962	BLACK-BELLIED FIREFINCH Lagonosticta rara	*
1006	BROWN-RUMPED BUNTING Emberiza affinis	***
1007	CABANIS' BUNTING Emberiza cabanisi	**

As Table 67 shows, both woodlands and the more open areas were good for these species, with sightings of such birds in almost every count. This is another measure of the conservation values of all parts of the study area.

Table 66: Frequency of recording birds of special interest to visiting bird watchers

	3-star species	2-star species	1-star species
Woodlands	8	22	39
Bush - and grasslands	6	20	31

Herpetofauna

Locations for the different surveys of amphibians and reptiles (herpetiles) are mapped in Figure 53.

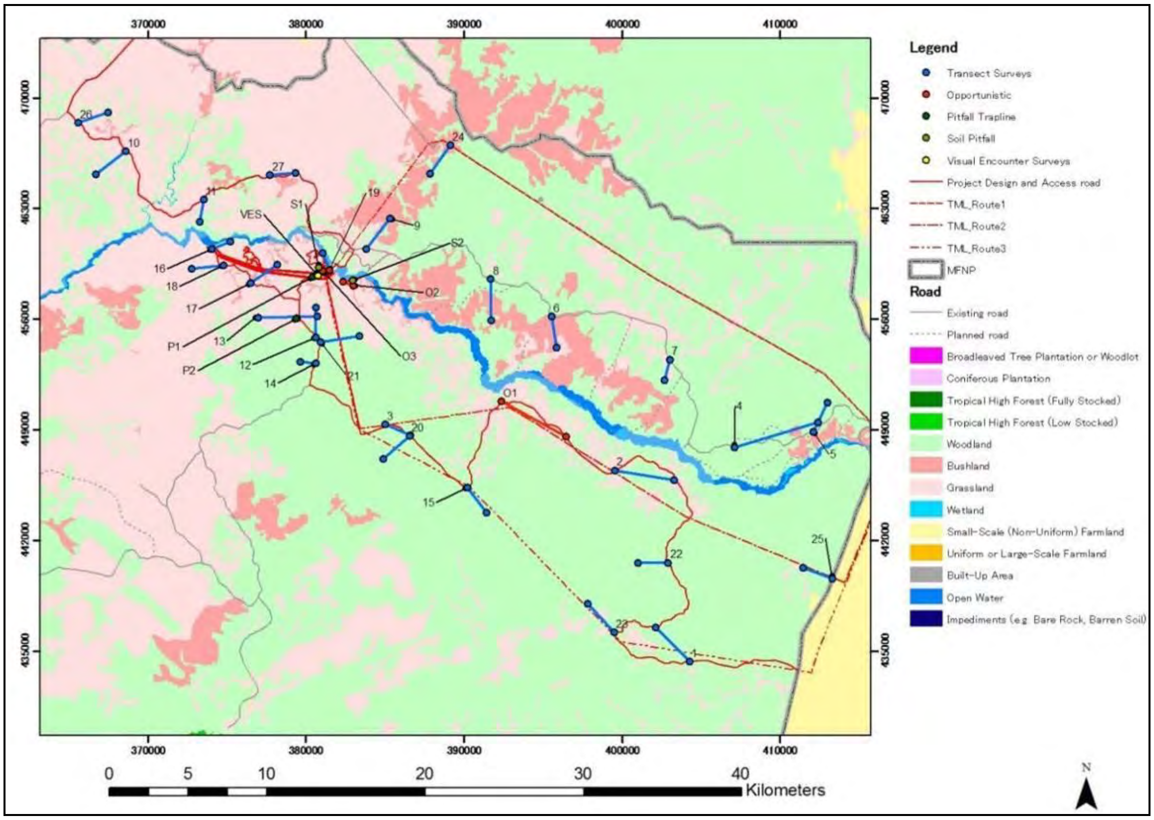


Figure 52: Survey Points for herpetofauna

<u>Results</u>

A total of 24 amphibian species belonging to six families and 11 genera were recorded during the study (Table 63). A total of 26 reptilian species belonging to 14 families and 24 genera were recorded during the study (Table 62). The important species of the Project area were a toad – Amietophrynus vittatus (IUCN Category – DD) and the Nile Crocodile – Crocodylus niloticus (Cites Appendix II species). All other amphibian species belong to the Least Concern (LC) category while the reptile species belong to the Not Evaluated (NE) category. One cricket frog, a ridged frog, a skink and a blind snake are the four specimens whose identity is yet to be determined. Table 63 and Table 64 show the checklist of amphibian and reptilian, respectively.

Table 67: Checklist of Amphibians in project area

Family	Scientific name	Common name	IUCN Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		O1	O2	O3	P1	P2	S1	S2	VES	Tot
Bufonidae	*Amietophrynus gutturalis*	Guttural Toad	LC	1									1											1																3
Bufonidae	*Amietophrynus regularis*	Leopard Toad	LC		1												1	1	1													1	1			1			1	8
Bufonidae	*Amietophrynus vittatus*	Lake Victoria Toad	DD																			1																		1
Hyperoliidae	*Afrixalus osorioi*	Osorioi's Spiny Reed Frog	LC																															1						1
Hyperoliidae	*Afrixalus fulvovittatus*	Banded Banana Frog	LC		1	1		1				1																												4
Hyperoliidae	*Hyperolius acuticeps*	Slender Reed Frog	LC																															1						1
Hyperoliidae	*Hyperolius cinnamomeoventris*	Cinnamon-bellied Reed Frog	LC			1																																		1
Hyperoliidae	*Hyperolius kivuensis*	Kivu Reed Frog	LC		1	1																																		2
Hyperoliidae	*Hyperolius viridiflavus*	Common Reed Frog	LC		1	1																										1	1							4
Hyperolii	*Kassina senegalensi*	Senegal	LC			1						1		1	1	1	1	1														1	1						1	10

dae	*s*	Kassin a																																						
Rani dae	*Amietia angolensis*	Angola River Frog	LC		1								1																											2
Rani dae	*Hoplobatrac hus occipitalis*	Crowne d Bullfrog	LC		1	1		1											1			1										1	1				1		1	9
Rani dae	*Phrynobatra chus acridoides*	Eastern Puddle Frog	LC		1					1		1	1				1			1			1	1			1	1	1					1	1					1 3
Rani dae	*Phrynobatra chus mababiensi s*	Commo n Cricket Frog	LC			1						1			1			1																						4
Rani dae	*Phrynobatra chus sp1(minutus ?)*					1	1	1						1	1																		1						1	7
Rani dae	*Phrynobatra chus natalensis*	Natal Puddle Frog	LC		1	1							1																			1	1							5
Rani dae	*Ptychadena anchieatae*	Anchiet 's Ridged Frog																																1						1
Rani dae	*Ptychadena christyi*	Christy' s Grassla nd Frog	LC																														1							1
Rani dae	*Ptychadena mascarenie nsis*	Mascar ene Ridged Frog	LC		1	1			1			1	1	1	1	1				1	1	1	1				1	1		1			1							1 6
Rani dae	*Ptychadena sp (honk)*																																1						1	2

Hemisidae	*Hemisus marmoratus*	Snout Burrowing Frog																																1						1
Microhylidae	*Phrynomantis microps*	West African Rubber Frog	LC																												1									1
Pipidae	*Xenopus laevis*	African Clawed Frog	LC		1																																			1
Pipidae	*Xenopus mulleri*	Muller's Clawed Frog	LC			1									1				1											1										4
				1	10	11	1	3	1	1		5	5	3	5	2	3	3	3	2	1	3	2	2			2	2	1	2		6	9	4	2	1	1		5	102

Where: LC = Least Concern, DD = Data Deficient, NE = Not Evaluated

Table 68: Checklist of Reptilian Fauna of the Project Area

Family name	Scientific name	Common Name	IUCN Status	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	O1	O2	O3	P1	P2	A1	S2	VES	Total
Gekkoniidae	*Hemidactylus brookii*	Brook's House Gecko	NE																																1				1
Gekkoniidae	*Lygodactylus gutturalis*	Chevron-throated Dwarf Gec	NE				1		1																														2

		ko																																					
Scincidae	*Lygosoma sundevalli*	Writhing Skink	-														1															1							2
Scincidae	*Trachylepis maculilabris*	Speckle-lipped Skink	NE						1					1		1						1	1								1	1			1				8
Scincidae	*Mabuya quinquetaeniata*	Rainbow Skink																		1		1												1			1				4
Scincidae	*Lepidothyris fernandi*	Fire Skink	NE												1	1											1														3
Chamaelionidae	*Chamaeleo gracilis*	Gracile Chamaeleon																																	1						1
Agamidae	*Agama agama*	Red-headed Agama	NE						1			1		1	1				1			1									1	1	1						9
Varanidae	*Varanus niloticus*	Nile Monitor	NE						1			1			1			1												1	1	1							7
Crocodilydae	*Crocodylus niloticus*	Nile Crocodile	NE													1															1		1						3
Leptotyphlopidae	*Leptotyphlops scutifrons*	Peter's Thre	NE					1																															1

		ad Snake																																					
Typhlopidae	*Typhlops lineolatus*	Blind Snake	NE				1																																1
Colubridae	*Philothamnus bequaerti*	Bequaert's Green Snake																		1																			1
Colubridae	*Philothamnus semivariegatus*	Variegated Green Snake	NE		1																																	1	2
Colubridae	*Psammophylax tritaeniatus*	Striped Skaapsteker	NE									1					1																						2
Colubridae	*Psammophis mossambicus*	Olive Grass Snake																				1																	1
Colubridae	*Dasypeltis scabra*	Rhombic Egg Eater	NE																								1												1
Colubridae	*Rhamphiophis sp.*																																1						1

Pythonidae	*Python sebae*	African Rock Python	NE								1																												1
Elapidae	*Dendroaspis polylepis*	Black Mamba	NE																										1				1						2
Elapidae	*Naja melanoleuca*	Forest/Water Cobra	NE					1	1	1																					1	1							5
Viperidae	*Causus rhombeatus*	Rhombic Night Adder	NE						1																														1
Viperidae	*Bitis arietans*	Puff Adder	NE			1			1																														2
Viperidae	*Bitis gabonica*	Gaboon Viper	NE		1																																		1
Pelomedusidae	*Pelomedusa subrufa williamsi*	Williams' African Mud Turtle	NE									1				1															1								3
Testudinidae	*Kinixys belliana*	Bell's Hing	NE		1	1														1										1									4

		ed Tortoise																																					
					3	2	2	2	7	1	1	4		2	3	4	2	1	1	3		4	1				2		1	2	6	6	5		3			1	69

Where: LC = Least Concern, DD = Data Defficient, NE = Not Evaluated

1) Amphibian Species Accumulation

The species accumulation curve for amphibian species in Figure 54 shows leveling off at about the 16th sample using the transect method. However, with use of new methods – i.e. by pitfall traps and opportunistic surveys, the cumulative species curves rises again and starts leveling off at about the 24th sample. This implies that the species composition of the Project area is likely to be higher than the 24 recorded with the use of new methods and in time and space.

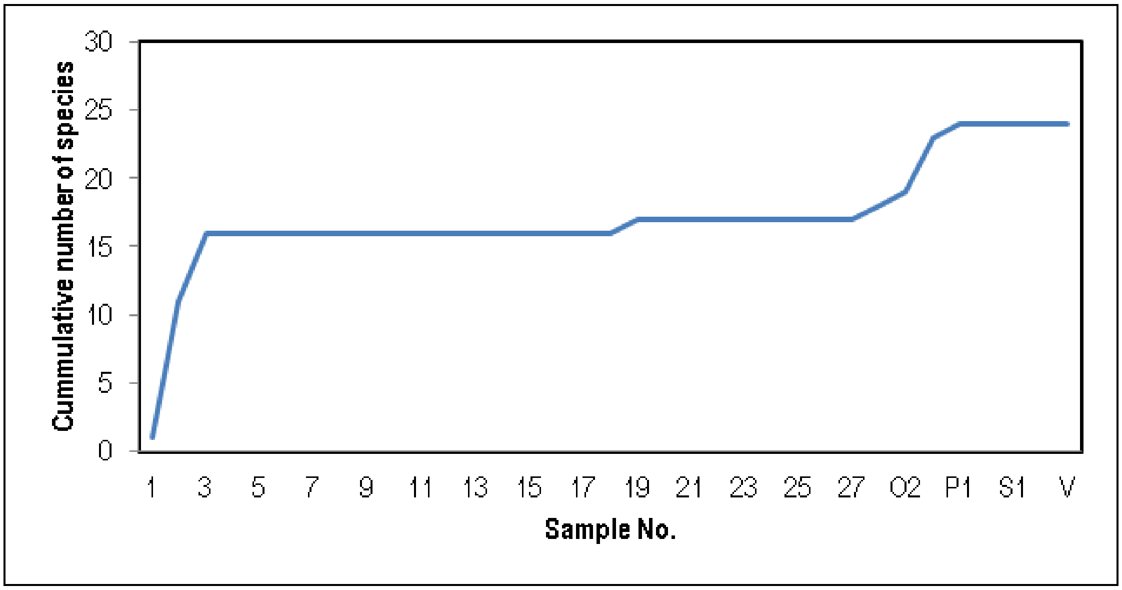


Figure 53: Species Accumulation Curve for Amphibians of the Project Area

2) Amphibian species Distribution and Diversity

The commonest amphibians were *Ptychadena mascareniensis* – the Mascarene Ridged Frog (recorded in 16 transects), *Phrynobatrachus acridoides* – the Eastern Puddle Frog (13), *Kassina senegalensis* - Senegal Kassina (10), *Hoplobatrachus occipitalis* – the Crowned Bullfrog (9) *Amietophrynus regularis* - the Leopart Toad (8) and un-identified *Phrynobatrachus* sp1 (*minutus*?) (7). The rest of the species were rare, nine of them recorded along only one transect each. Transects 3 and 2 had the highest diversity with 11 and 10 species respectively, followed by opportunistic surveys 2 and 1 with 9 and 6 species respectively. Transects 9, 10, 12 and VES had five species each recorded. Transects 8, 22, 23 and Soil Pit 2 had no species recorded for them. The remaining transects had poor diversity ranging from 4 to 1.

3) Reptile Species Accumulation

The species accumulation curve for reptile species shown in Figure 55, however, was still rising without leveling off. This implies that the reptilian species composition of the Project area is definitely higher than the 26. More sampling will therefore yield more species in time and space.

4) Reptilian Species Distribution and Diversity

The commonest reptilian species were Agama agama – the Orange-headed Agama (recorded in 9 transects), followed by *Trachylepis maculilabris* – the Speckle-lipped Skink (8), *Varanus niloticus* – the Nile Monitor (7), *Naja melanoleuca* – the Forest/Water Cobra (5) and *Mabuya quinquetaeniata* – the Rainbow Skink and *Kinixys belliana* - Bell's Hinged Tortoise (each recorded along 4 transects). The rest of the species were rare recorded once or twice in 18 of the samplings.

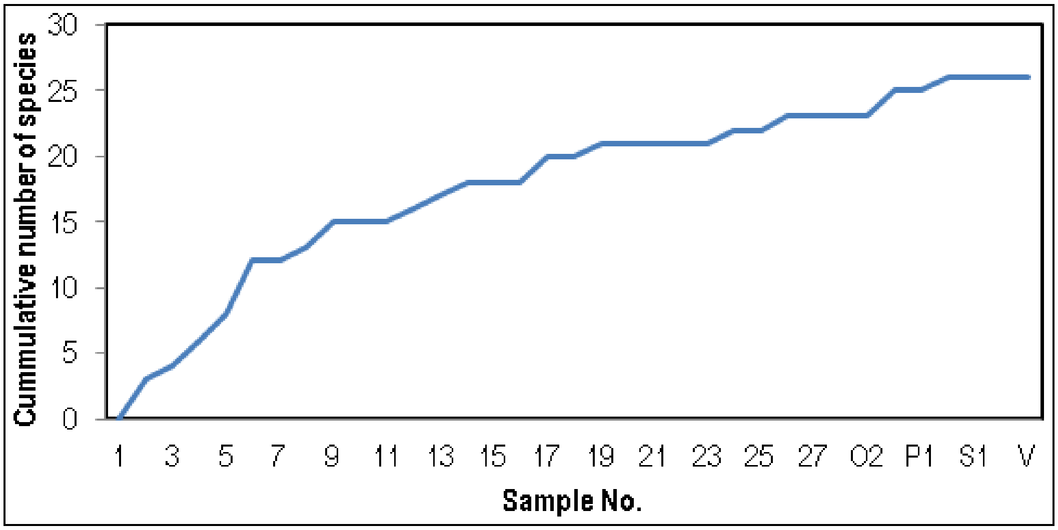


Figure 54: Species accumulation curve for Reptiles in project area

Transect 6 had the highest species diversity with 7 species, followed by opportunistic studies 1 and 2 (O1 and O2) each with 6 species, then O3 with 5 species and transects 9, 13, and 19 each with 4 species. No species were recorded for transects 1, 10, 18, 21, 22, 23, 25, Pitfall trap 1, soil pitfalls 1 and 2 (S1 & S2). The rest of the samplings had very poor diversity of 1, 2 or 3 species.

5) Important Sampling Stations

Plates 3 and 4 presents some of the herpetile species observed during the surveys. Important locations for amphibian fauna were along Transects 2, 3, 9, 10, 11, 12, 14, 15, 16, 17, 27, and O1 and O2, while for reptilian fauna were along: Transects 6, 9, 13, 19, O1, O2, and O3.

 *Ptychadena christyi?/anchietae*?	 *Ptychadena mascareniensis*	 *Ptychadena* sp.
382957 258465 04.11.2012	412972 239751 10.01.2013	385632 247689 07.01.2013

 *Amietophrynus regularis*	 *Hemisus marmoratus*	 *Phrynobatrachus mababiensis/acridoides*
380513 258645 18.10.2012	38041 258682 05.11.2012	381250 259108 05.11.2012
 *Xenopus mulleri*		
380725 256205 17.10.2012		

Plate 3: Specimens for Amphibians observed

 *Typhlops lineolatus*	 *Dasypeltis scabra*	 *Lygosoma sundevalli*
413158 249690 11.10.2012	389196 266872 10.01.2013	380505 258648 17.10.2012
 *Mabuya quinquetaeniata*	 Rhamphiophis sp.	 *Dendroaspis polylepis*
380508 258641 05.11.2012	2°20'32.41"N 31°55'44.13"E	
 *Philothannus semivariegatus*	 *Varanus niloticus*	 *Geochelone pardalis*
382015 254851 07.01.2013	404174 251313 12.10.2012	374133 246320 15.10.2012

 *Pelomedusa subrufa*	 *Lepidothrys fernandi*	 *Chameleo gracilis*
2 21 25.0 E31 52 00.3 19.10.2012	382595 258431 06.11.2012	381084 259053 04.11.2012
 *Agama agama*		
381352 259243 06.01.2013		

Plate 4: Reptiles observed

5.3.7 Invertebrates

This section presents the findings of the invertebrate survey in the project area. Figure 56 presents the geographical locations of the study.

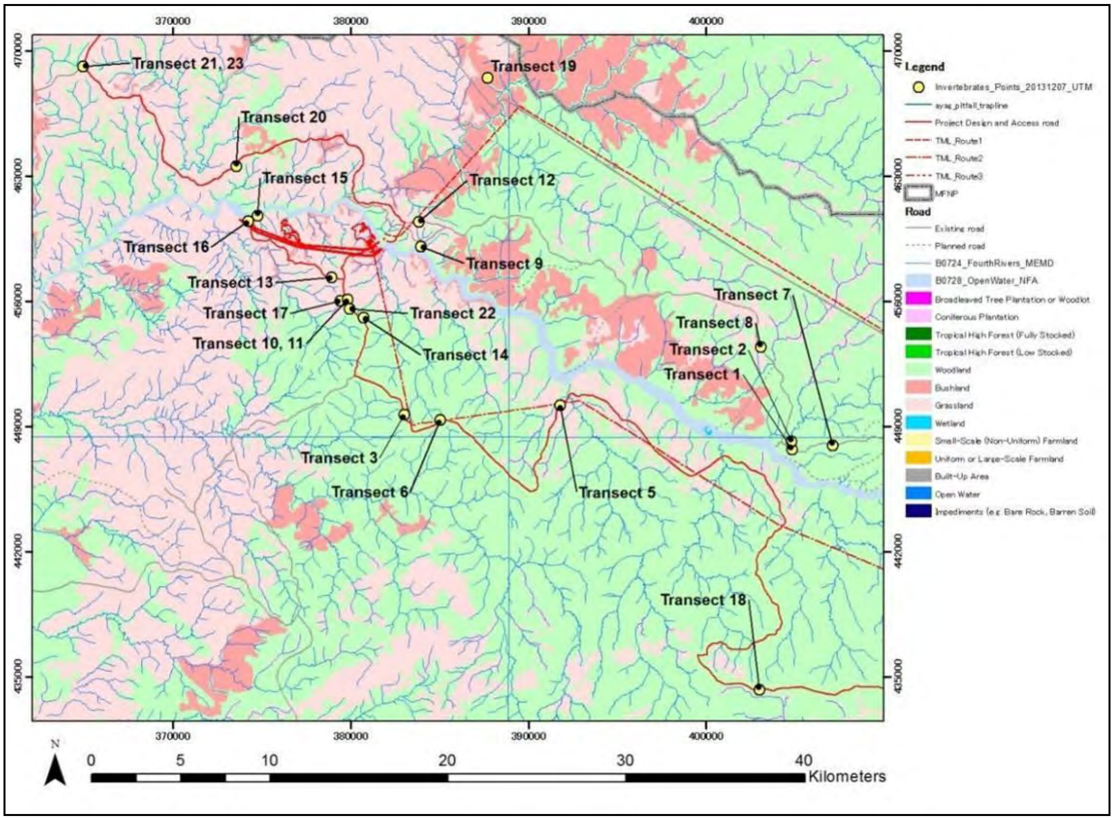


Figure 55: Invertebrate Survey Points

Results

A total of 139 species of butterflies, 47 species of dragonflies, 31 species of dung beetles were recorded both on the north and south sides of the Project area. Plate 5 shows some of the butterfly species observed during the insect surveys. For butterflies, 25 forest dependent butterfly species, 24 forests edge/woodland species, 22 migrant species, 22 open habitat species, 43 widespread species and only one wetland species were recorded in the Project areas.

Seven species have been evaluated for the IUCN Red List, while the other species have not yet been evaluated. The seven species are all categorized as being of least concern. Table below presents butterfly species recorded in the different transects surveyed in the Project area.

All the dragonflies recorded have been assessed for the IUCN Red List and are all categorized as being of Least Concern (LC). But given the potential threats that have been noted for some of the species, the dam project will sure impact on these species. Plate 6 shows some of the dragonfly species observed during the insect surveys. Table 64 presents dragonfly species recorded in the different transects surveyed in the Project area.

None of the beetle species recorded has been assessed by IUCN. High numbers and species of beetles were found during the wet season. While some dung beetles have been recorded to travel long distances in a short time, many species seem to have restricted movement within the different habitat types. Thus it seems likely that as long as the communities of mammals providing dung remain stable, the community structure of the beetle would remain stable.

The large copper dung beetle, *Scarabaeus nigroaeneus* and Addo flightless dung beetles, *Cercellium bacchus* were the most dominant in majority of mammals' dung: the Forked-horned Rhino beetle, *Cyphonistes vallatus* and *Coptorhina* sp were dominant in elephant dung; *Garreta crenulatus* and *Gymnopleurus humanus* were only found in the baboon dung, monkey and human dung. Plate 7 shows some of the bettle species observed during the insect surveys. Table 70 presents beetle species recorded in the different transects surveyed in the Project area.

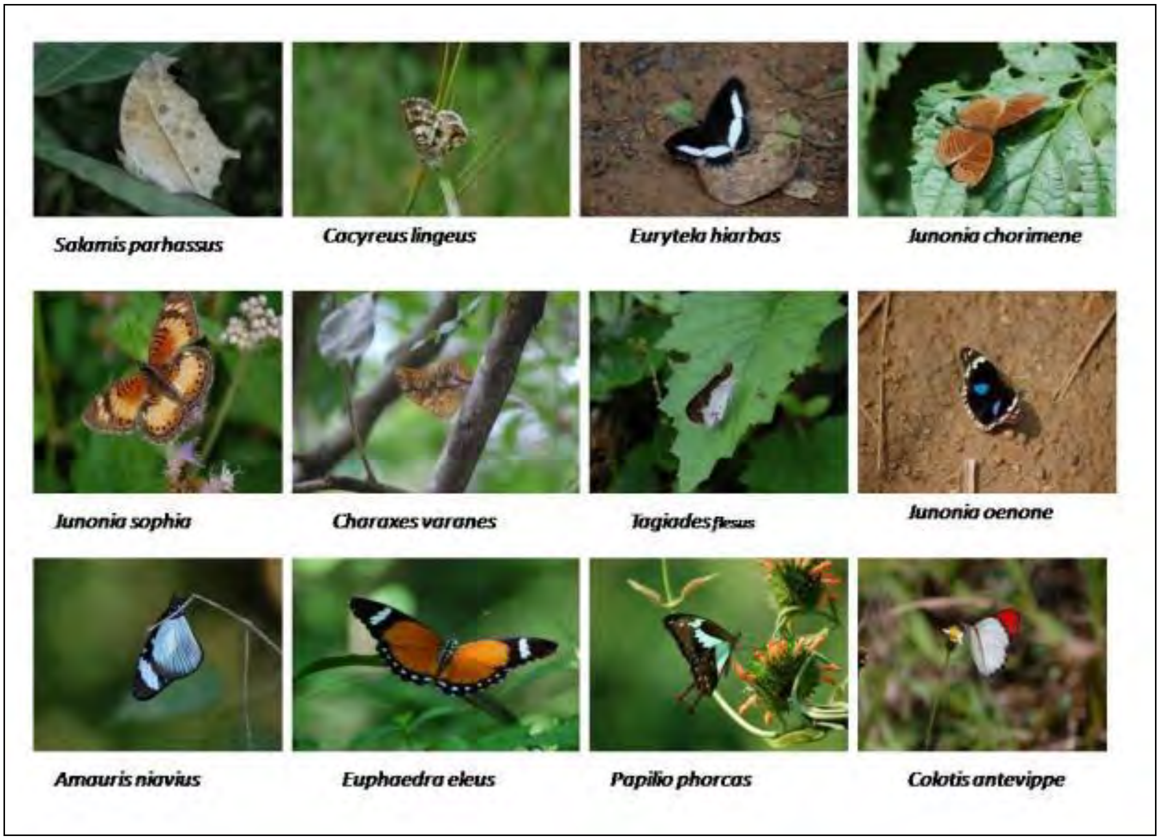


Plate 5: Specimens for butterflies observed

Plate 6: Specimens for dragonflies observed

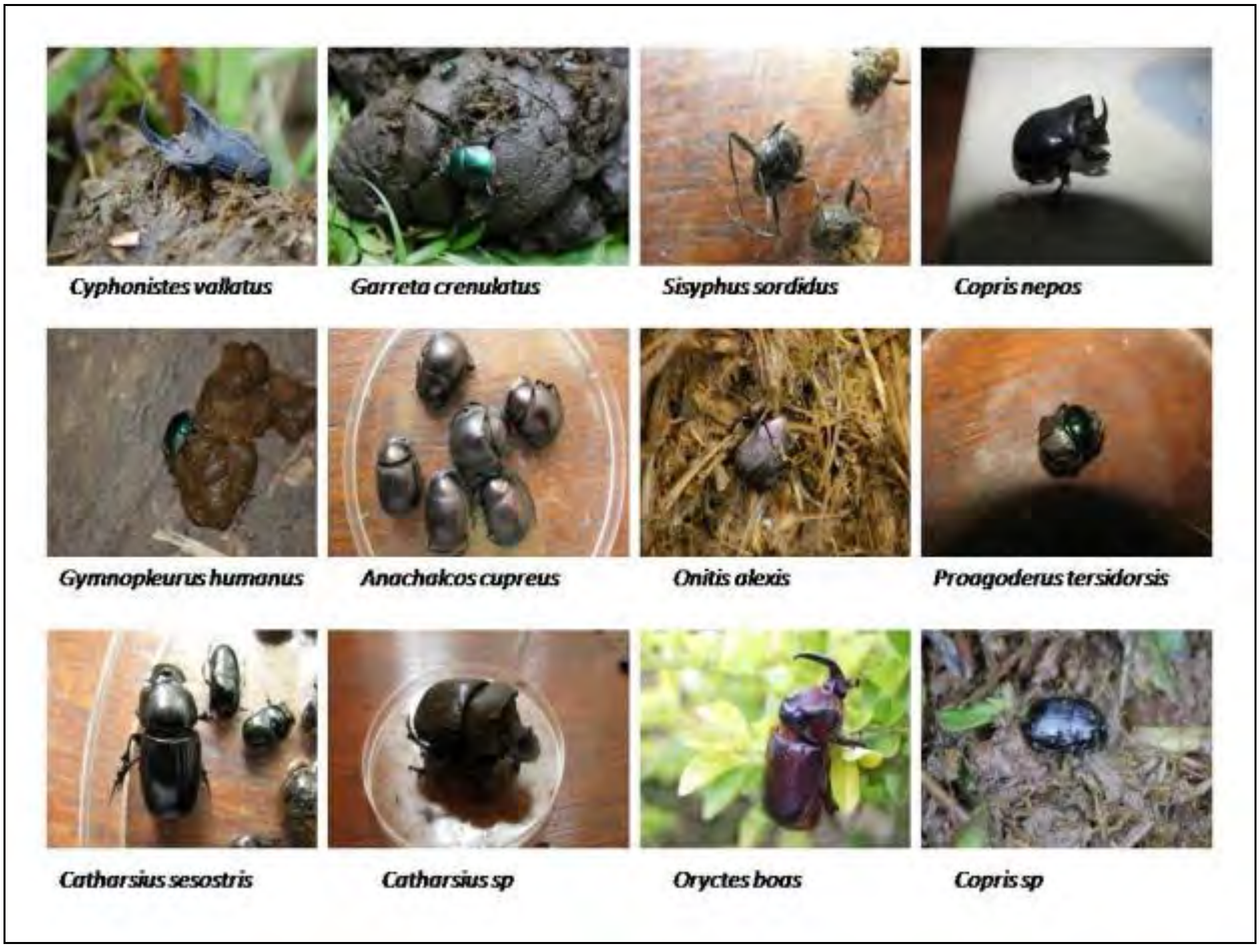


Plate 7: Specimens for beetles observed

Table 69: Butterfly Species Recorded in the Different Transects Surveyed in the Project

Species	Ecotype	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Nymphalidae																				
Acraea acerata	W	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	5	√	
Acraea alicia	W											1						1	√	
Acraea encedon	W	0	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	6	√	
Acraea eponina	W	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	√	
Acraea macarista	F											1						1	√	
Acraea neobule	W	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	5	√	
Acraea pharsalus	f.	0	1	0	1	1	1	1	1	0	1	0	0	0	1	0	1	9	√	
Acraea psedegina	W												1	1			1	3	√	
Acraea zetes	W	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	5	√	
Amauris albimaculata	f.	1	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	9	√	
Amauris niavius	W	0	1	0	0	1	1	0	0	0	1	1	0	0	1	0	0	6	√	
Amauris tartarea	f.											1			1			2	√	
Ariadne enotrea	F					1					1	1			1			4	√	√
Aterica galene	F	1	1	0	0	1	1	0	0	1	0	1	0	0	1	1	0	8	√	√
Bicyclus auricrudus	F										1	1			1			3		√
Bicyclus campus	f.														1			1		√
Bicyclus funebris	F	1	1												1			3		√
Bicyclus mandanes	F											1			1			2		√
Bicyclus milyas	O														1			1		√
Bicyclus safitza	W	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	0	12	√	√
Bicyclus vulgaris	W	1	1	1	0	1	0	0	0	1	1	1	0	1	1	0	1	10	√	√
Byblia anvatara	M	1	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	11	√	
Catacroptera cloanthe	O				1												1	2	√	
Charaxes etesipe	f.	1	0	1	0	0	0	0	0	1	0	1	0	0	1	1	1	7		√
Charaxes jasius	O														1			1		√
Charaxes numenes	f.	0	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	5		√

Species	Ecotype	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Charaxes tiridates	F	0	1	0	0	1	1	0	0	0	1	0	0	0	1	0	0	5		√
Charaxes varanes	W	1	1	1	0	1	1	1	0	1	1	1	0	0	1	1	1	12	√	√
Cymothoe herminia	F											1			1			2		√
Danaus chrysippus	M	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0	11	√	
Euphaedra medon	F														1			1		√
Euphaedra eleus	F											1			1			2	√	√
Eurytela hiarbas	f.	1													1			2	√	
Gnophodes betsimena	F	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	4		√
Hamanumida daedalus	W	1	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	13	√	
Henotesia perspicua	O	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	1	5	√	
Hypolimnas anthedon	F	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	4	√	√
Hypolimnas misippus	M	1															1	2	√	
Junonia chorimene	O	1	1	0	1	1	1	1	1	0	1	1	1	0	1	0	1	12	√	
Junonia hierta	M																1	1	√	
Junonia oenone	W	0	1	0	1	1	1	0	1	0	1	1	1	0	1	0	0	9	√	
Junonia orithya	M	1				1											1	3	√	
Junonia sophia	W	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	6	√	
Junonia stygia	f.	1	0	1	0	1	0	1	1	1	0	1	0	0	0	1	1	9	√	
Junonia terea	W	1	1	0	0	1	0	1	1	0	0	1	1	0	0	0	1	8	√	
Junonia westermanni	F	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	√	√
Melanitis leda	W	0	0	0	0	1	0	1	1	0	0	1	1	0	1	0	1	7	√	√
Neptis melicerta	F											1			1			2	√	√
Neptis metella	f.	1	0	1	0	0	0	0	0	1	0	1	0	0	1	1	0	6	√	√
Neptis saclava	W	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	13	√	
Neptis serena	W	0	1	0	1	1	1	1	1	0	1	1	1	0	1	0	1	11		
Neptisdopsis ophione	f.	0	1	0	1	1	1	1	1	0	1	0	0	0	1	0	1	9		√
Pardopsis punctatissima	W											1						1	√	

Species	Ecotype	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Phalanta eurytis	M											1						1	√	
Phalanta phalanta	M														1			1	√	√
Precis octavia	W					1			1								1	3	√	
Precise pelarga	f.	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	0	11	√	
Salamis parhassus	f.	0	1	0	1	1	1	1	1	0	1	0	0	0	1	0	1	9	√	
Sallya occidentalium	M	1	0	1	0	0	0	1	0	1	0	1	0	1	1	1	0	8		√
Sp xx															1			1	√	
Tirumala petiverana	M	1	1	0	1	1	0	1	1	1	0	1	1	1	1	0	1	12	√	
Ypthima albida	f.	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	5	√	
Ypthima asterope	O	1	0	0	0	1	0	1	1	0	0	1	1	0	0	0	1	7	√	
Ypthima doleta	W			1	1	1												3	√	
Ypthima granulosus	O			1	1													2	√	
Ypthimomorpha itonia	f.	0	1	0	1	1	0	0	0	0	0	0	0	0	1	1	0	5	√	
																		0		
Pieridae																		0	√	
Appias epaphia	M				1	1												2	√	
Appias lasti	O	1	1									1		1				4	√	
Appias sabina	F	0	0	0	0	0	0	0	1	1	0	1	0	0	1	1	0	5	√	
Belenois aurota	M	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	6	√	
Belenois creona	M	1	1	1	1	0	1	0	0	1	1	1	0	1	1	1	0	11	√	
Belenois solilucis	f.	1				1					1	1			1			5	√	
Belenois thysa	f.	1	1	0	1	1	1	1	1	0		1	0	0	1	0	1	10	√	
Catopsilia florella	M	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	√	
Colotis antevippe	O	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	4	√	
Colotis danae	W	0	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	10	√	
Colotis eucharis	W	1	0	1	0	1	0	1	1	1	0	1	1	1	0	1	1	11	√	
Colotis evagore	M				1												1	2	√	
Dixeia orbona	W	0	1	0	1	1	1	0	0	0	1	0	0	0	1	0	0	6	√	

Species	Ecotype	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Dixeia pigea	W	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	6	√	
Eronia cleodora	O	1	1		1			1				1						5	√	
Eronia leda	W	1	1									1			1			4	√	
Eurema brigitta	M	1	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	13	√	
Eurema hecabe	M	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	14	√	
Eurema regularis	W				1												1	2	√	
Eurema senegalesis	F					1						1			1			3	√	
Leptosia alcesta	W	1																1	√	
Leptosia nupta	F	1	0	1	1	1	0	0	1	1	0	1	0	0	1	1	0	9	√	
Leptosia wigginsi	F	1				1					1	1			1			5	√	
Nepheronia argia	F	1	0	0	0	1	0	0	1	1	0	1	0	0	1	0	0	6	√	
Nepheronia bouqueti	O	1	1															2	√	
Nepheronia thalassina	f.										1	1			1			3	√	
																		0		
Lycaenidae																		0		
Anthene amarah	O	1																1	√	
Anthene definita	W	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	0	5	√	
Anthene larydas	F											1						1	√	
Azanus jesous	M	1	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	6	√	
Azanus natalensis	W							1									1	2	√	
Azanus ubaldus	M		1															1	√	
Cacyreus ligures	f.	1										1			1			3	√	
Cupidopsis jobates	W				1												1	2	√	
Eicochrysops hippocrates	O	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	4	√	
Eresina fontainei	F														1			1	√	
Euchrysops malathana	O				1	1											1	3	√	
Freyeria trochylus	W	0	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	10	√	

Species	Ecotype	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Lachnocnema bibulus	W													1			1	2	√	
Lepidochrysops neonegus	O				1	1						1						3	√	
Leptotes pirithous	M	0	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	10	√	
Pentila pauli	f.	1	0	1	0	1	0	1	1	1	0	1	0	0	1	1	1	10	√	
Ptelina carnuta	O											1			1			2	√	
Tuxentius cretosus	O	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	3	√	
Zizeeria knysna	W	1	1	0	1	1	1	1	1	0	1	0	1	0	1	0	1	11	√	
Zizina antanossa	W				1	1												2	√	
Zizula hylax	W	0	1	1	1	1	1	1	1	0	1	1	1	0	1	0	1	12	√	
																		0		
Hesperiidae																		0		
Acleros ploetzi	f.		1									1			1			3	√	
Borbo fatuellus	W					1												1	√	
Borbo gamella	W	1			1						1		1					4	√	
Borbo holtzii	O		1		1													2	√	
Borbo perobscura	O	1	1								1	1	1		1			6	√	
Coeliades forestans	W	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	5	√	
Eretis lugens	W	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	0	12	√	
Gegenes hottentota	O	1	1				1							1			1	5	√	
Gorgyra bibulus	W											1						1	√	
Metisella midas	S											1						1	√	
Monza cretacea	W	1	1															2	√	
Osmodes thora	F		1									1			1			3	√	
Pardaleodes incerta	F	1	1			1					1	1			1	1		7	√	
Pelopidas mathias	M	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	1	5	√	
Sarangesa maculata	O	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	4	√	
Spialia spio	O	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	3	√	

Species	Ecotyp e	Transect																Total number of sites	Sweep net records	Baited trap records
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Tagiades flesus	F	1	1								1	1			1			5	√	
Zenonia zeno	f.	1	1					1			1				1			5	√	
																		0		
Papilionidae																		0		
Graphium angolanus	M												1				1	2	√	
Graphium policenes	f.	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	4	√	
Papilio bromius	f.	1	1	1	0	0	1	1	0	1	1	1	0	0	1	1	1	11	√	
Papilio dardanus	W	1	1	0	1	1	0	1	1	0	1	1	0	1	1	1	0	11	√	
Papilio demodocus	M	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	14	√	
Papilio nireus	f.	0	1	0	1	0	0	1	1	0	0	1	0	0	1	1	1	8	√	
Papilio phorcas	F	1	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	7	√	

Table 70: Dragonfly Species Recorded in the Different Transects Surveyed in the Project Area

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Acisoma panorpoides (Rambur, 1842)	Swampy and well-vegetated open habitats	Widespread in Africa (except dense rain forest), southern Europe, Middle East, southern Asia, and Indian Ocean Islands	LC	Terrestrial; Freshwater	Drainage and destruction of swampy habitats may be a potential threat in some parts of its range	No information available
Aethriamanta rezia (Kirby, 1889)	Pools, slow streams and rivers, lake shores with dense aquatic vegetation	Widespread in tropical sub-Saharan Africa except rain forest areas, and Madagascar	LC	Terrestrial; Freshwater	Unknown	No information available
Atoconeura sp	NA	NA	NA	NA	NA	NA

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Brachythemis lacustris (Kirby, 1889)	Rivers and streams in savanna, bush and woodland	The species is widespread in tropical sub-Saharan Africa, except from rainforest areas	LC	Terrestrial; Freshwater	Habitat loss due to agriculture and dam construction and water pollution	No conservation measures known
Brachythemis leucosticta (Burmeister, 1839)	Lakes, pools, and rivers. The species usually occurs in swarms above thinly vegetated shorelines	Widespread in Africa (except in forest areas), southern Europe, and the Middle East.	LC	Terrestrial; Freshwater	There are no serious threats affecting this species across its global range	Not needed
Brachythemis wilsoni (Pinhey, 1952)	Swampy streams and rivers in bush	The species has been recorded from Sudan to Botswana and Nigeria. It is much scarcer than other Brachythemis. Principally, it is found in the savannah belt	LC	Terrestrial; Freshwater	Potentially drainage and destruction of swampy habitats due to agriculture and water pollution are major threats	More research is needed to gather data on taxonomy, range, population status, and threats
Ceriagrion bakeri (Fraser, 1941)	The species is found in pools in forest areas	The species has been recorded from Uganda to Nigeria and Angola, south western Africa to Congo Basin	LC	Terrestrial; Freshwater	Habitat destruction caused by drainage for agriculture and wood extraction	No conservation measures known
Ceriagrion glabrum (Burmeister, 1839)	Any kind of standing water, permanent and intermittent wadis; absent from the driest areas such as the Kalahari and the inland Arabian desert	Widespread from South Africa to the Sahel and formerly occurred along the Nile River valley. It reaches the southern half of the Arabian Peninsula, including Socotra Island	LC	Terrestrial; Freshwater	Species not under any serious threats across its global range	No conservation measures are known
Chalcostephia	Swampy habitats in	Widespread in tropical sub-	LC	Terrestrial;	Drainage and	No conservation

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
flavifrons (Kirby, 1889)	savannah and bush	Saharan Africa		Freshwater	destruction of swampy habitats due to agriculture	measures known
Chlorocnemis marshalli (Ris, 1921)	Streams in forest or thick bush	Widespread species with no known major threats	LC	Streams in forest or thick bush	Drainage and destruction of swampy habitats due to agriculture and wood extraction. Invasive species are also a threat	No conservation measures known
Chlorocypha rubida (Hagen in Selys, 1853)	Swampy rainforest streams	The species has been recorded from Guinea and Sierra Leone to Cameroon and Gabon, but may include more than one species	LC	Terrestrial; Freshwater	Forest destruction due to agriculture	No conservation measures known
Crocothemis divisa (Baumann, 1898)	Pools, streams in bush or woodland	The species is widespread in tropical sub-Saharan Africa	LC	Terrestrial; Freshwater	Habitat loss due to agriculture	No conservation measures known
Crocothemis erythraea (Brulle, 1832)	The species occurs at a wide range of running and standing, unshaded waters including rice paddies and brackish lagoons. In the northern part of its range it is mostly found at not too	The species is widespread in Africa, southern Europe, the Middle East, and west Asia, extending as far east as Yunnan in China	LC	Terrestrial; Freshwater	The species is not under any specific threat	No conservation measures are needed

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
	shallow, well vegetated waters. Various terrestrial habitats except dense forest, and prefer stagnant water					
Diplacodes lefebvrii (Rambur, 1842)	Recorded from almost all kinds of well-vegetated freshwater habitats, including seasonal	Very widespread and common species in Africa, across the Indian Ocean and into Eurasia and Europe	LC	Terrestrial; Freshwater	Not threatened at the global scale, although local decline may occur due to habitat destruction and water pollution	None required for this widespread species
Elattoneura glauca (Selys, 1860)	Shady rivers and streams, occasionally shorelines of lakes	The species is widespread in eastern and southern Africa	LC	Terrestrial; Freshwater	Destruction of gallery forest due to agriculture and wood extraction, and water pollution.	No conservation measures known
Gomphidia quarrei (Schouteden, 1934)	In central, eastern and northeastern Africa, the species is present in streams and rivers in forest and woodlands	This is a widespread species	LC	Terrestrial; Freshwater	Destruction of gallery forest and water pollution due to agriculture	No conservation measures are known to be in place or are planned at present
Hemistigma albipunctum (Rambur, 1842)	Swampy habitats in bush, woodland or forest	The species is widespread in tropical sub-Saharan Africa to northern southern Africa	LC	Terrestrial; Freshwater	Drainage and destruction of swampy habitats due to agriculture and wood extraction, and water	No conservation measures known

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
					pollution	
Ictinogomphus ferox (Rambur, 1842)	Various habitats, lakes, rivers, stream in savannah, bush, forest	The species is widespread in tropical Africa, yet many country records are suspect and require confirmation	LC	Terrestrial; Freshwater	Habitat loss due to agriculture and water pollution in the vicinity of cities	No conservation measures known
Lestes uncifer (Karsch, 1899)	Swamps, slow streams; found in forested areas in Botswana	This is a widespread species	LC	Terrestrial; Freshwater	Drainage and destruction of swampy habitats due to agriculture and water pollution are the inferred threats	No information available
Nesciothemis farinosa (Förster, 1898)	Mostly common at rivers and permanent streams with high reeds margins. It is also recorded at pools and ponds	Widespread from northern South Africa to Egypt. Records from Mali and Benin are to be confirmed. Also found in western and southern Arabia	LC	Terrestrial; Freshwater	Not threatened at the global scale. Local decreases and extinction can occur through water pollution, drought, stream management, over-irrigation and agriculture	No conservation actions are needed for this species
Orthetrum africanum (Selys, 1887)	Forest streams and rivers	The species is a very widespread	LC	Terrestrial; Freshwater	Forest destruction caused by agriculture and wood extraction	No conservation measures known
Orthetrum austeni (Kirby, 1900)	This is a forest species	The species is widespread	LC	Terrestrial; Freshwater	Forest destruction caused by agriculture	No conservation measures known

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Orthetrum chrysostigma (Burmeister, 1839)	The species is known from any kind of standing and slow-flowing fresh and brackish waters, except in dense rainforest areas (such as the Congo Basin)	This is one of the most common species in Africa and is widespread throughout the African continent, except in dense forests. It reaches southern Europe, the Middle East and the whole Arabian Peninsula	LC	Terrestrial; Freshwater	Not threatened at the global scale, although local declines may occur due to habitat destruction and water pollution	This species does not need conservation plans or further research
Orthetrum guineense (Ris, 1910)	Open streams	The species is widespread in sub-Saharan Africa. Records from eastern coastal South Africa and Mozambique are unlikely, as are two records from southern Angola/northern Namibia	LC	Terrestrial; Freshwater	Destruction of its habitat due to agriculture, as well as water pollution	Research into trends and monitoring of this species would be valuable
Orthetrum julia (Kirby, 1900)	Streams in forest and dense woodland. In the arid southwest of southern Africa the species is limited to perennial springs	The species is widespread in tropical Africa, extending west to Guinea, but presence further north-west (Burkina Faso, Senegal) is unconfirmed. It has also been recorded in North Yemen and Socotra	LC	Terrestrial; Freshwater	In parts of the southern Africa region the destruction of springs is a local threat. It is known to be affected by wood extraction, agriculture and water pollution. However it is unlikely to be seriously threatened across its whole range	No information available
Orthetrum	Strongly associated	This is a widespread species	LC	Terrestrial;	Drainage and	No information available.

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
microstigma (Ris, 1911)	with forest, including swamp forest			Freshwater	destruction of swampy habitats caused by agriculture	
Orthetrum trinacria (Selys, 1841)	Species well adapted to littoral dune lakes and desert and semi-desert environments with temporary waters showing increasing salt concentrations from the rainy season to the dry season	Widespread throughout the whole of Africa, except in the tropical rainforest, and the Middle East, and reaches the south of Europe	LC	Terrestrial; Freshwater	Habitat modification caused by agriculture and water pollution although not affecting the species at global level	No specific actions are required at the global scale. However, local declines may occur due to pollution, agriculture and water abstraction
Oxythemis phoenicosceles (Ris, 1910)	Rainforest pools, floodplains and swamps	The species has been recorded from Uganda to Ivory Coast	LC	Terrestrial; Freshwater	Forest destruction caused by agriculture and wood extraction	Research into population numbers and range, biology and ecology, habitat status, threats, conservation measures, and trends/monitoring of this species would also be valuable. Habitat and site-based actions are also required

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Palpopleura deceptor (Calvert, 1899)	The species favours shallow reedy and grassy swamps, ponds and pools, even temporary ones	It is an Afrotropical species which is widespread from the north of South-Africa to the Sahel. The northern limit of its range runs from the Senegal River to central Sudan and Ethiopia. Further east the species was recorded once from the south west of the Arabian Peninsula	LC	Terrestrial; Freshwater	This is a widespread species which is well adapted to temporary waters in semi-desert and savannah environments and is not threatened at the global scale. Drainage and destruction of swampy habitats caused by agriculture, and water pollution, are local threats to the species, however these are not expected to affect the population at the global scale at present	No conservation action is presently needed for this widespread species but research into population size and trends would be valuable as the species is often found at temporary ponds and pools, which are unstable habitats at various time scales and are easily destroyed by agriculture and water over-consumption. Monitoring actions may be locally useful
Palpopleura lucia (Drury, 1773)	Swampy habitats in bush, woodland and forest.	The species is widespread in sub-Saharan Africa except dense rainforest, Madagascar	LC	Terrestrial; Freshwater	Water pollution and drainage and destruction of swampy habitats caused by agriculture	No information available but research into trends and monitoring of the species would be valuable
Pantala flavescens (Fabricius, 1798)	The species is an obligate migrant that is linked to the monsoon front of the Intertropical	It is a circumtropical species known from all continents crossed by the equator. It is an obligate migrant of which the migrations are linked to	LC	Terrestrial; Freshwater	No present threats are known	No conservation action is needed for this very widespread species

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
	Convergence Zone (ITCZ). It used commonly temporary pools and ponds watered by monsoon rainfalls but may occasionally breed in permanent water	the monsoon front and which is commonly recorded from all African countries pertaining to the Afrotropics (including Madagascar and the nearby islands)				
Parazyxomma flavicans (Martin, 1908)	The species is know from standing waters in or near forest	This is a widespread species	LC	Terrestrial; Freshwater	The main threats to the population in South Africa are forest destruction in central and eastern Africa, and tree removal through urbanisation and agriculture. No information is available about threats outside this region	No information available but research into population numbers and range, and trends/monitoring of the species would be valuable
Phaon iridipennis (Burmeister, 1839)	Streams and rivers with gallery forest in savannah, bush and woodland	The species is widespread in sub-Saharan Africa except rainforest regions	LC	Terrestrial; Freshwater	Water pollution and destruction of gallery forest caused by agriculture and wood extraction	No information available but research into habitat status and trends/monitoring of the species would be valuable

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Platycnemis sikassoensis (Martin, 1912)	Open rivers, often with some forest	This is a widespread species	LC	Terrestrial; Freshwater	Water pollution and forest destruction caused by agriculture and wood extraction	Research into population numbers and range, biology and ecology, habitat status, threats, conservation measures, and trends/monitoring of this species would also be valuable. Habitat and site-based actions are also required
Platycnemis sp	NA	NA	NA	NA	NA	NA
Platycypha caligata (Selys, 1853)	Shady streams and rivers in forest, woodland, bush and savannah, shorelines of large lakes	This species is widespread in eastern and southern Africa except in dense rainforest, from Ethiopia to Angola and South Africa.	LC	Terrestrial; Freshwater	Water pollution in the vicinity of cities and habitat loss due to agriculture	No information available
Pseudagrion acaciae (Förster, 1906)	Shady streams and rivers in forest, woodland, bush and savannah, shorelines of large lakes	This species is widespread in eastern and southern Africa except in dense rainforest, from Ethiopia to Angola and South Africa	LC	Terrestrial; Freshwater	Water pollution, habitat loss through drainage and destruction/deforestation of swampy habitats caused by agriculture	No precise information available but research into trends and monitoring of the species would be valuable
Pseudagrion hageni (Karsch, 1893)	Shady streams in forest, thicket and bush	The species is widespread from South Africa to Kenya and west Uganda	LC	Terrestrial; Freshwater	Habitat loss through drainage and destruction/deforestation of swampy habitats caused by agriculture	No precise information available but research into trends and monitoring of the species would be valuable

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
					and wood extraction, as well as water pollution	
Pseudagrion kersteni (Gerstäcker, 1869)	The species occurs in shady, open or half-open streams and rivers in various environments, below 1,800 m asl in Africa, 2,300 m asl in Yemen	Widespread species ranging from south to western and eastern Africa, but lacking in dense rain-forests. It reaches Arabian in the extreme southwest of the Peninsula	LC	Terrestrial; Freshwater	Unlikely to decline fast enough to be considered as threatened, and no major threats are known	No precise information is available but research into trends and monitoring of the species would be valuable
Pseudagrion melanicterum (Selys, 1876)	Forest streams. Often the dominant Pseudagrion species in forests.	This is a widespread species with no known major widespread threats	LC	Terrestrial; Freshwater	Forest destruction caused by agriculture and wood extraction are threats to the species	Research into population numbers and range, biology and ecology, habitat status, threats, conservation measures, and trends/monitoring of this species would be valuable. Habitat and site-based actions are also required
Pseudagrion torridum (Selys, 1876)	Reedy lake shores.	Global distribution: Kenya west to Senegal, south to Zambia. In East Africa the species has been recorded from lakes in Uganda and Tanzania	LC	Terrestrial; Freshwater	Unknown	No information available

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
Sympetrum fonscolombii (Selys, 1840)	Species is found in, and reproduces in, a wide range of habitats (permanent and ephemeral shallow and sunny standing waters, man-made barrage lakes, tanks and ponds, permanent and seasonal rivers and wadis)	widespread and common species found from the south to the north of Africa, including Madagascar, southern Europe and eastwards to the Middle East, Central Asia, the Indian Subcontinent and the Indian Ocean Islands	LC	Terrestrial; Freshwater	This is a widespread and colonizing species which is very common, sometimes in huge numbers, in warm countries. It is not threatened	No conservation action is needed for this species
Tetrathemis polleni (Selys, 1869)	Shady pools, streams or swamps in various habitats except dense rainforest	This is a widespread species with no known major widespread threats	LC	Terrestrial; Freshwater	Drainage and destruction of swampy habitats caused by agriculture are threats to the species	No information available but research into population numbers and range, and trends/monitoring of the species would be valuable. Habitat maintenance/conservation is also needed
Trithemis arteriosa (Burmeister, 1839)	The species occurs in freshwater ponds and lakes and at permanent pools in temporary flowing wadis. It is also found along irrigation	One of the most widespread and common dragonflies in Africa, southern Europe and the Arabian Peninsula	LC	Terrestrial; Freshwater	Not threatened at the global scale, although excessive use of water by humans and pollution may cause the species to decline at local level	No conservation action is needed at present

Species	Habitat and ecology	Range description	IUCN category	Systems	Main threats	Conservation action
	channels and ditches in oases and near large rivers					
Trithemis dorsalis (Rambur, 1842)	Streams, rivers and pools in bush or savannah	This is a widespread species	LC	Terrestrial; Freshwater	Water pollution, drainage and destruction of swampy habitats caused by agriculture	No precise information available but research into trends and monitoring of the species would be valuable
Urothemis assignata (Selys, 1872)	Pools, lakes or slow streams and rivers in savannah, bush and woodland	The species is widespread in Africa except in forested areas	LC	Terrestrial; Freshwater	Drainage and destruction of swampy habitats caused by agriculture	No precise information available but research into threats and trends and monitoring of the species would be valuable
Urothemis edwardsii (Selys, 1849)	The species is found at pools, lakes, backwaters in rivers, floodplains and at slow-flowing streams and rivers in savannah, bush, woodland and semi-desert environments	The species is widespread in open landscapes throughout the whole of sub Saharan Africa, including Madagascar	LC	Terrestrial; Freshwater	Not threatened at the global scale although local declines are known due to eutrophication, destruction of riparian vegetation, aquaculture, water extraction, drainage and fire	Does not need any protection actions at the global scale, but surviving relict disjunct isolates in Algeria (Lac Bleu) and Oman need urgent and effective protection

Table 71: Beetle Species Recorded along the Different Transects Surveyed in the Project Area

Species	Pitfall traps	Direct searching	Opportunistic samples
Anachalcos cupreus	√	√	√
Aphodius fimetarius		√	
Aphodius lividus		√	
Aphodius sp	√	√	√
Augosoma centaurus		√	
Catharsius sesostris	√	√	
Catharsius sp		√	
Catharsius tricornutus	√	√	
Cercellium bacchus		√	
Copris nepos		√	
Copris orphanus		√	
Copris sp		√	
Coptorhina sp		√	
Cyphonistes vallatus		√	
Garreta crenulatus	√	√	√
Gymnopleurus crenulatus	√	√	√
Gymnopleurus humanus	√	√	√
Heliocopris punctiventris		√	
Heteronitis sp	√	√	
Heteronychus arator		√	
Onitis alexis		√	√
Onthophagus fuscidorsis	√	√	
Onthophagus liberianus		√	
Onthophagus possoi		√	
Onthophagus sp 1			√
Oryctes boas		√	√
Proagoderus tersidorsis		√	
Scarabaeus nigroaeneus	√	√	
Scarabus rugosus		√	
Sisyphus sordidus		√	√
Thanatophilus sp		√	

5.3.8 Fish

Fish richness: There are high concentrations of fish species are within the African Great lakes, Malawi, Tanganyika and Victoria. The bulk of species in these lakes is from the family Cichlidae and most are endemic to single lakes. Beyond the Great Lakes, the Rufiji/Ruaha, Pangani, Malagarasi, Shire and Tana River basins also have high species richness. Lakes Albert, Edward, Turkana and Kivu support a large diversity of fish species, again predominantly cichlids many of which are lake endemics. Given that river catchment is now widely accepted as the appropriate management unit for freshwater ecosystems, it is worth mentioning that the Malagarasi and Rusizi River catchments adjacent to Lake Tanganyika are highlighted as holding the greatest numbers of fish species and that the East African coastal rivers and Lower Shire catchments are also rich in species.

Threatened Species: Two-hundred-and-fifty-two of the 901 fish taxa assessed at the global level (mostly endemic to the region) are threatened (28% of the total number of fish taxa assessed), with two species (Aplocheilichthys sp. "Naivasha" and Barbus microbarbis) thought to be extinct. The main centres of threatened fish species are within Lake Victoria, particularly in the most intensively surveyed south-eastern part of the lake, and Lake Malawi. Many of the Lake Victoria cichlids were previously thought to be extinct but following additional and more extensive surveys, it appears that a number of these species still exist in small pockets in the lesser-known parts of the main lake and in the smaller satellite lakes (e.g., Bisini, Kanyaboli and Nabugabo). The majority of these species are now assessed as either Critically Endangered (where small subpopulations have now been found), or as Critically Endangered – Possibly Extinct where survey intensity is still considered insufficient to confirm that they are truly extinct. In some cases these species may be restricted to a section of rocky shore of less than a few hundred metres length. Such species are assessed as Vulnerable due to the risk from stochastic events that may possibly eliminate entire populations given their highly restricted ranges.

Most of the restricted range species are within the group of mouth breeding rocky shore cichlids. Three cyprinid species are threatened by heavy fishing pressure during the annual spawning migrations when nets are set across river mouths as they ascend the rivers to spawn in the headwaters. An additional threat to river-spawning species is sedimentation of the spawning gravels in the river headwaters, a product of the large-scale deforestation. With the exclusion of Vulnerable D2 species the Malagarasi River catchment and the southern and western drainages, Lake Victoria hold the greatest numbers of threatened species. The Pangani and Lake Kyoga/Victoria Nile catchments also hold high numbers of threatened species most of which are threatened by overfishing and sedimentation[7]. Figure 57 shows the location of fish survey points within the project area.

[7]http://www.iucnredlist.org/initiatives/freshwater/eastafrica/geographicpatternsea.

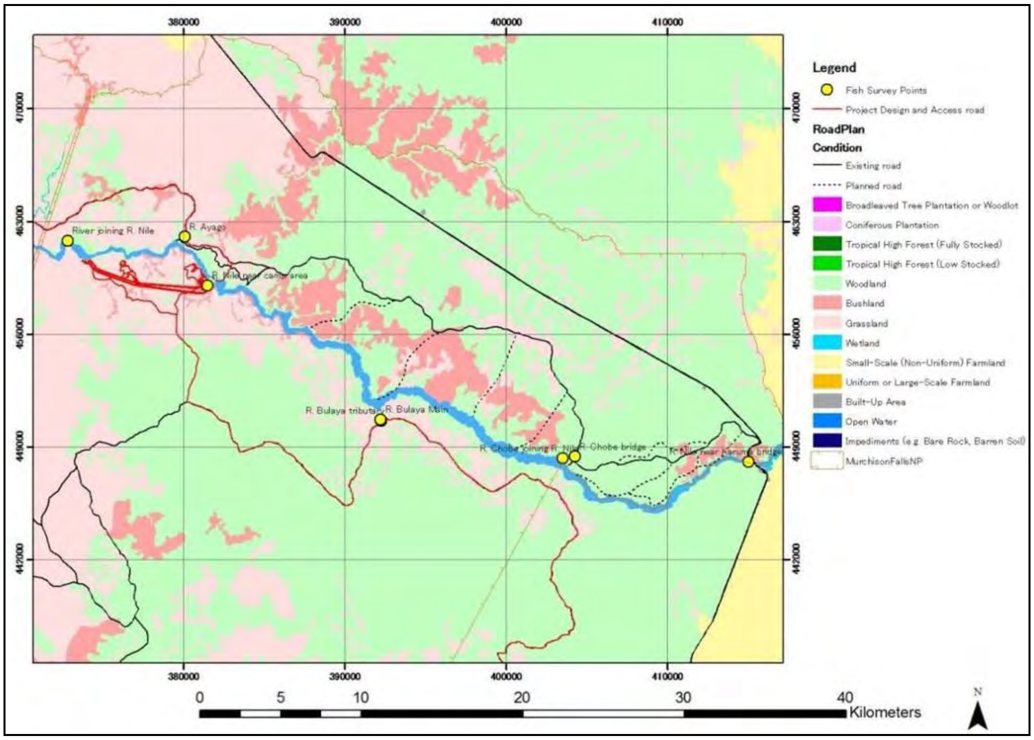


Figure 56: Survey points for fish

Results

A total of 15 fish species were caught within the Project area belonging to 8 families. All the species caught were what was expected in the water bodies within the Project area. Plate 8 shows some of the specimens species observed during the fish surveys.

Table 72: Fish Species and Families Caught within the Project Area

Family	Fish species	Percentage (%)
Lepidosirenidae	*Protopterus aethiopicus*	0.4
Momyridae (Elephant-snoutfishes)	*Mormyrus kannume*	5.6
Cyprinidae (Carps)	*Labeo forskalii*	3.9
	Brycinus nurse	3.3
	Barbus altinianulis	24.5
	Barbus apleurogramma	3.0
Bagridae	*Bagrus docmac*	5.6
Clariidae	*Clarias gariepinus*	0.4
Morchokidae	*Synodontis afrofisheri*	0.4
Centropomidae	*Lates niloticus*	8.9
Cichlidae	*Oreochromis niloticus*	27.1
	Oreochromis variabilis	3.3
	Sarotherodon galilaea	7.4
	Tilapia zillii	0.4
	Haplochromine species	6.3
Total = 8 families	15 species	269 fish

Species Abunance

A total of 269 fish individuals were caught and examined. Table 74 indicates that *Oreochromis niloticus* (Nile tilapia) was the most abundant species (27.1 %), followed by *Barbus altinianulis* (24.5 %) and the least abundant were *Tilapia zilli*, *Synodontis afrofisheri* and *C. liocephalus* and Protopterus aethiopicus each contributing only 0.4 % each (only one individual of each was recorded).The fish were divided up in order to highlight the species caught from the main River Nile and those caught in the surrounding streams.

Table 73: Fish Species Distribution in the Various Water Bodies within the Project Area

Species / Location	P. aethiopicus	M.kannume	Labeo forskali	B.nurse	B. altianulis	B. apleurogramma	C. gariepinus	B. docmac	S. afrofisheri	L. niloticus	O. niloticus	O. variabilis	S. gallile	T. zilli	Haplochromines	Total
R. Ayago	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
R. Ayago at Nile	-	-	-	-	-	-	-	2	-	1	-	-	1	-	-	4
R. Bulaya main	2	-	2	-	1	-	-	1	-	1	3	-	-	1	-	11
R. Bulaya tributary	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	4
R. Kyobe at bridge	-	-	-	2	-	4	-	-	-	-	-	-	-	-	-	6
R. Nile near camp	-	-	-	-	8	-	-	3	-	3	2	-	4	-	-	20
R. Nile near River Kibar	-	-	-	-	-	-	-	-	-	1	3	-	3	-	3	10
R. Nile near Kyobe	-	-	-	-	1	-	-	-	-	2	5	2	-	-	-	10
Nile near Karuma bridge	-	8	1	-	-	-	-	2	1	8	-	-	2	-	-	22
Total	2	8	6	2	10	4	1	9	1	16	13	2	10	1	3	88

Labeo forskalii

Barbus altinianulis

	
Clarias gariepinus	*Bagrus docmac*
	
Lates niloticus	*Tilapia zillii*
	
Oreochromis niloticus	*Sarotherodon galilaea*
	
Oreochromis variabilis	

Plate 8: Fish Specimens observed

Table 74: Percent contribution of the fish species caught along the main R. Nile Before and after the project area

Fish species	After project area (%)	Before project area (%)	Overall (%)
Mormyrus kannume	8	9	8
Labeo forskalii	1	3	2
Brycinus nurse	1	1	1
Barbus altinianulis	39	30	34
Bagrus docmack	6	8	7

Synodontis afrofisheri	-	1	1
Lates niloticus	9	16	13
Oreochromis niloticus	18	21	20
Oreochromis variabilis	1	2	1
Sarotherodon galilaea	4	4	4
Tilapia zillii	3	4	3
Haplochromine species	10	1	6
Fish counts	**87**	**91**	**178**

From Table 75, *Barbus altinianulis* were most abundant (34 %) followed by *Oreochromis niloticus* (20 %) and *Lates niloticus* (13 %). The fish species composition and abundance along the main R. Nile, before and after the project area did not show any significant difference.A total of 92 fish were caught from the five streams which were sampled within the project area, that is Ayago, Bulaya, Kiba, Kyobe and X (name could not be identified). Bulaya recorded highest number of fish and fish species (12 species) as showed in Table 76.

Table 75: Percent contribution of the fish species caught in the stream within the project area

Fish species	Stream				
	Ayago	Bulaya	Kiba	Kyobe	R. X
Protopterus aethiopicus	-	1	-	-	-
Mormyrus kannume	-	-	-	-	-
Labeo forskalii	1	5	-	-	-
Brycinus nurse	-	4	-	1	1
Barbus altinianulis	2	2	-	-	1
Barbus apleurogramma	-	-	3	5	-
Bagrus docmack	2	1	-	-	-
Clarias gariepinus	-	1	-	-	-
Synodontis afrofisheri	-	-	-	-	-
Lates niloticus	-	1	-	-	-
Oreochromis niloticus	9	10	4	-	19
Oreochromis variabilis	-	5	-	-	2
Sarotherodon galilaea	-	8	-	-	-
Tilapia zillii	-	1	-	-	-
Haplochromine species	-	1	-	-	4
Number of species	4	12	2	2	5

Exotic Fish Survey

<u>Aquatic habitats</u>

Three habitat types (River, Stream and Pond) were surveyed. The following are descriptions of identified aquatic habitats during the survey and more details are presented in Table below.

Victoria Nile: The Victoria Nile section within the proposed Ayago HPP area was the only river surveyed. The Victoria Nile is the central watercourse for the proposed Ayago HPP with weir, reservoir and in-flow stream sites along its course.

Six survey points (F_3, F_5, F_10, F_13, F_14 and F_17) were select along the Nile section within the project area. The studies confirmed that the Nile possessed prime fish habitats that included; feeding grounds such as submerged and exposed rock surface for epilithic algae grazer species; spawning and refuge grounds such as riparian marshes, river mouths and sheltered bays; and migration routes such as meanders and inflow streams. The habitats along the Nile, within the project area will be directly and indirectly impacted upon by project components and activities.
Streams: There were four (F_1, F_2, F_7 and F_9) surveyed sites along streams that flow towards and feed the Nile (Table 72). Besides the permanent streams having continuous flow, each survey point had its unique environmental status in relation to turbidity (clearness) of the water and presence/absence in stream of aquatic plants.

In-flow streams form a lacustrine-like reach at the river-stream junction (river mouths) that favours fish species that require such conditions for spawning and breeding purposes. The upstream reach of these streams is also important spawning ground for some fish species and refuge for endemic fish species, besides being watering points for other animals. The streams will be directly or indirectly impacted upon by the project component and activities.

Ponds: Ponds were of two categories; scattered water pool in seasonal stream valleys and terrestrial depressions normally filled by storm flood water, and therefore would provide spawning ground for fish species that prefer flood water for breeding purposes. Six pond environments (F_6, F_8, F_11, F_12, F_15 and F_16) were surveyed. Ponds will be directly and indirectly impacted upon by the project access roads.

Table 76: Location and Habitat Characteristics of the Fish Survey Points

F_1 (Bulaya01)
Location: N 36 250725.6; E 392290.4; pH 7.3; Temp. 20.5; Depth 1.0m

This site is located on River Bulaya upstream of Bulaya Bridge on Nanda route. At the investigation site, the river is running through a closed canopy riverine forest, banks were covered with hanging vegetation and shoreline fringed with rooted aquatic plants in opened areas and with 0.13m transparency. Water flow was slow current (pool) over sand and mud riverbed. The downstream end of the survey point, towards the bridge culvert, became flat shallow with fast current over pebble riverbed and some exposed rock.
9 Fish species; *Poecilia reticulata*, *Barbus* spp1, *Barbus* spp2, *Barbus* spp4, *Barbus* spp5, *Barbus* spp6,

Labeo horie, *Clarias gariepinus*, *Haplochromine* spp1

F_2 (Bulaya02)

Location: N 36 250781; E 392176.1; pH; 7.6; Temp. 24.9; Depth 0.8m

This site is located on River Bulaya downstream of Bulaya Bridge on Nanda route. At the investigation site, the river is running through an open canopy forest, banks were covered with hanging vegetation and with 0.13m transparency. The core riverbed was sand and pebble receding into sand and mud towards shoreline. The shore was covered with floating and rooted aquatic plant. Water flow was slow current (pool).

11 Fish species; *Poecilia reticulata, Barbus* spp1, *Barbus kerstenii, Thoracochromis wangatii, Aplocheilichthys centralis, Oreochromis niloticus, Barbus* spp4, *Labeo horie, Clarias gariepinus, Lates macrophthalmus, Astatoreochromis* spp1

F_3 (Bulaya–Nile Junction)

Location: 36 N 251342.9; E 392272.3; Temp. 26.0; Depth 0.6m

This site is at the Bulaya-Nile junction on the left bank of the Victoria Nile which is lined with a riverine forest. The Bulaya section, before joining the Nile, formed a river mouth - like body covered by floating and rooted plants with sand and mud riverbed. The Victoria Nile at the survey site had sand and pebble riverbed with 0.25m transparency, and was mainly flat with some rapids (riffle).

4 Fish species; *Oreochromis niloticus, Sarotherodon galileus, Lates niloticus, Lates macrophthalmus*

F_4 (Lion Camp)
Location: 36 N 254301.3; E 373805; pH 7.6; Temp. 23.5; Depth 0.4m

Small stream valley pond near the lion survey camp flowing through Savanna grassland, over a sand and pebble riverbed with little current forming, transparency was 1.0m with some exposed rock.
Fish species; No fish recorded

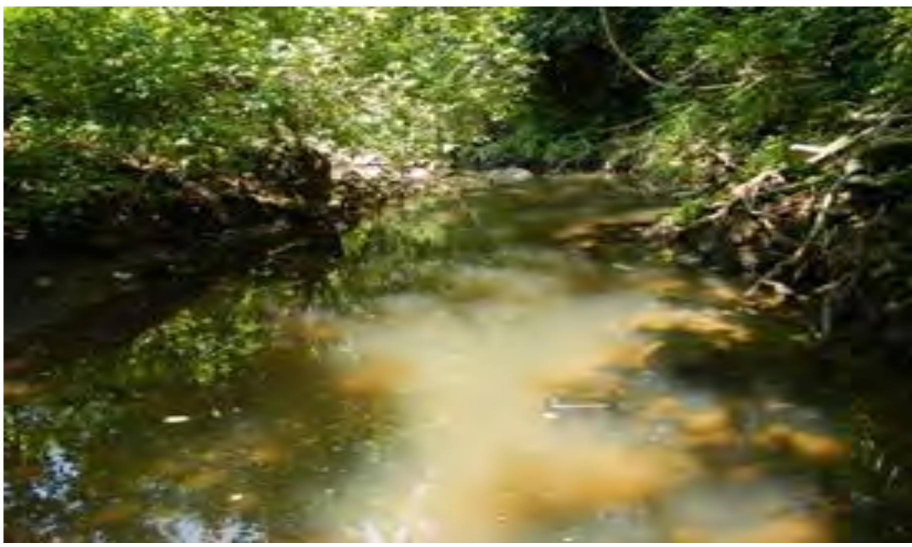
F_5 (Ayago South)
Location: 36 N 259055.2; E 381509.6; pH8.2; Temp. 25.0; Depth 1.4m

This survey site is on the Victoria Nile around the proposed inlet area for the Ayago HPP. The bank is lined by a riverine closed canopy forest. The Nile riverbed was sand and pebble with exposed rocks, flow was slightly turbulent over rocks (riffle) with 0.25m transparency. There was a small stream joining the Nile where small riverine bay formed with floating aquatic plants grow along the shore. Many young fish and smaller species were recorded around the aquatic plants.
17 Fish species;*Barbus bynni, Oreochromis niloticus, Laboe horie, Poecilia reticulata, Lates macrophthalmus, Sarotherondon galileus, Thoracochromis wangatii, Mormyrus kannume, Barbus* spp1, *Mormyrus niloticus, Barbus* spp1, *Lates niloticus, Mormyrus* spp1, *Gnathonemus longibarbis, Barbus* spp5, *Bagrus bajad, Oreochromis leucosticus*

F_6 (D10)
Location: 36 N 251520.1 E 380493.8; pH6.6; Temp. 22.0; Depth 0.2m

Small depression pond along Nanda route, probably man made and filled with storm flood water. Transparency was 0.01m, with mud bed. Surrounding environment was grassland.
Fish species; No fish was recorded

F_7 (DOSUTE)
Location: 36 N 259396.5 E 377027.8; pH 8.0; Temp. 26.0; Depth 0.3m



A small stream that runs through the valley proposed for dumping soil excavated from tunnel. The stream runs through forest, it has rapid and pool and transparency of more than 1.0m and had the clearest water. Streambed was pebbles and stones with some exposed rocks.
1 **Fish species:** *Barbus* spp6, *Barbus* spp4, *Barbus bynni*

F_8 (J24NP)
Location: 36 N 257445.3 E 378527; pH7.4; Temp. 20.5; 0.2m

Small depression pond surrounded by grassland and patches of bare land. Pond bed was mud with 0.01m transparency.
No fish recorded

F_9 (Lion River Junction)
Location: 36 N 259993.4 E 372572.4; pH 7.8; Temp. 25.0; Depth 0.4m

The survey site was downstream of the Lion River Camp (F_04), at a point where two small streams join the Lion camp stream making the channel wider. The banks were high with loose bare sand. The stream seemed to change water level in dry and wet seasons. Riverbed was mainly mud pebbles with some sand, and 0.15m horizontal transparency. The stream had small rapids and pools.

6 Fish species: *Barbus bynni, Oreochromis variabilis, Sarotherodon galileus,Clarias gariepinus, Labeo horie, Labeobarbus* spp1

F_10(Outlet)
Location: 36 N 260630 E 374251.8; pH 8.2; Temp. 24.9; Depth 1.2m

The location is on the Nile where the outlet is proposed. Dry stream valley joins at the point and forms a river mouth with floating and emergent aquatic plants. The Nile was mainly flat with some rapid over sand and pebble bed with 0.25m horizontal transparency. Fringed with riverine forest.

9 fish species: *Haplochromine* spp1, *Oreachromis niloticus, Thoracochromis wangatii, Lates niloticus, Barbus* spp1, *Mesobola bredoi, Clarias alluaudi, Lates macrophthalmus, Sarotherodoron galileus*

F_11(A10)
Location: 36 N 249201.3 E 383372.7; pH -; Temp. - ; Depth 0.2m

Small manmade depression pond along Nanda route. Surrounded by grassland. Depth was about 10cm; pond bed was mud, with 0.02cm horizontal transparency.
No fish recorded

Northern F_12(025)
Location: 36 N 264958.9 E 379704.1; pH 6.8; Temp. 22.0; Depth 1.5m

Small pool in the valley of a seasonal stream which joins the Victoria Nile. Surrounded by tall grass, deepest was about 1.5m with pond bed mainly sand with some mud and 0.30m transparency. Fishing equipment included handnets and cast nets.
4 fish species: *Barbus neumayeri, Barbus* spp3, *Barbus kerstenii, Barbus prince*

F_14(Ayago Junction)
Location: 36 N 259702.8 E 382026; pH 8.3; Temp. 25.2; Depth 2.5m

Junction of the Ayago river and Victoria Nile with 0.25m horizontal transparency; forms a river mouth fringed with floating and emergent aquatic plants, and marshes.

17 fish species: *Oreochromis niloticus, Barbus bynni, Aplochelichthys* spp1, *Sarotherodon galilues, Thoracochromis wangantii, Lates macrophthalmus, Hippopotamyrus graham, Marcusenius victoria, Mesobola bredoi, lates niloticus, Gnathonemus longibarbis, Mormyrus kannume, Mormyrus* spp1, *barbus* spp3, *Clarias gariepinus, Bagrus docmak, Bagrus bajad*

F_15(029)

Location: 36 N 265073.5 E 378385.3; pH 6.3; Temp. 25.0: Depth 1.2m

Pool in the valley of s seasonal small stream which joins the Victoria Nile; with 0.3m transparency, surrounded by tall grass and shrubs and 1.20m deepest. Pool bed was mainly sand with pebble.

No fish recorded

F_16(030)

Location: 36 N 265098.7 E 377684.1; pH 6.0; Temp. 25.0:; Depth 1.2m

Pool in the valley of a small seasonal stream the Victoria Nile. Surrounded by tall grass and shrubs, bed mainly sand with pebble, 1.5m deepest with 0.30m transparency.
5 fish species: *Barbus kerstenii, Barbus neumayeri, Clarias gariepinus, Barbus prince, Barbus* spp3

F_17(J31)
Location: 36 N 261822.9 E 372819.5; pH 8.1; Temp. 24.2; Depth 2.8m. On the Victoria Nile where a small steam inflow. At the junction is a river mouth with sand and mud bed, and emergent aquatic plants. The Nile was slow with 0.25m horizontal transparency over pebble and sand bed.
14 fish species: *Oreochromis niloticus, Haplochromine* spp1, *Aplocheilichthys* spp1, *Oreochromis leucosticus, Sarotherodon galileus, Poecilia reticulata, Lates niloticus, Thoracochromis wangatii, Labeo horie, Lates macrophthalmus, Pseudocrenilabrus multicolor, Mormyrus* spp3, *Barbus apleurogramma, Brycinus* spp1

Fish survey results

A total of 1231 fish specimens belonging maximum of 44 species, belonging to 20 genera and nine families were recorded from the 17 survey points. Out of 44, because of possibility of the fish being young form of the other species maximum is 44 and minimum of 42. A total of 15 species could not be identified. Out of 29 species that were identified, 23 species were on the IUCN red list, one was CR, 2 were EN, 18 were LC and two were DD (Table 73). Out of the 44 species at least six species are known to be introduced to Victoria Nile. The unidentified species are possibly either young forms or hybrid of identified species or undocumented species. In terms of numbers, *Oreochromis niloticus* (24.78%), *Poecilia reticulata* (13.97%) and *Barbus bynni* (12.92%) were the most dominant fish species.

Considering spatial distribution, *Oreochromis niloticus*, *Lates niloticus*, *Sarotherodon galileus*, *Thoracochromis wingatii* and *Lates macropthalmus* were the most widespread species. The highest number of species was recorded from Victoria Nile stations, at proposed inlet area F_5 (17), R. Ayago-Nile junction F_14 (17) and weir site F_13 (15). *Oreochromis niloticus* (43.54%), *Barbus bynni* (10.16%) and zebra *Haplochromine* spp (10.16%) were the most dominant fish species recorded from sites along the Nile.

There were many fish species recorded only from River Nile; nine species of Mormyridae, two of five haplochrominespecies, the two *Brycinus species*, were only recorded at sites along the Nile. These species might require constant high water volume conditions. The mormyrides were only recorded in the area with slow current. This could be due to their migratory behavior8. The Haplochromines spp might require submerged and exposed rock surfaces in addition to water volume. These conditions might be lacking from streams and ponds, which did not suit mormyrides and some haplochromines. So it is important not to drawn/ drain areas with slow current and submerged and exposed rock surfaces since they prime habitats for some fish species recorded within the project area. The areas where streams meet the Nile (river mouths), were fringed with marshes and in some cases with instream floating and rooted aquatic places. In these areas, there were many juvenile fish of cichlidae and smaller species of poecilidae recorded. These river mouth habitats and associated vegetation/wetland are very important for spawning, breeding and nursery[9], and refugia for small fish species.

The highest number of young and small fish species was recorded in streams. A good number of species (9) including three cyprinidae and one *Aplocheilichthys* unidentified species, and *Oreochromis variabilis* were only recorded from stream habitats. At the same 34.1% of fish species recorded from the Nile were recorded from stream habitats as well. Therefore, inflow streams are important as habitat for spawning, breeding, nursery and refuge, especially for vulnerable species.

The least number of species (5) were recorded from pond habitats. Only ponds in seasonal stream valleys within possibility of joining with the Nile, especially during wet seasons, yielded some fish. Depression ponds yielded no fish.

Table 77: Families and species of fish caught at various sampling sites on selected water bodies within Ayago HPP area

Family	Genus	Species	Total Number	Research Point																
				Streams Habitat				Victoria Nile Habitats						Pond Habitats						
				F_01 (Bula01)	F_02 (Bula02)	F_07 (Dosute)	F_09 (Lion R J)	F_03 (Bula03)	F_05 (Ayago S)	F_10 (Outlet)	F_13 (Ayago N)	F_14 (Ayago J)	F_17 (J 31)	F_04 (Lion C)	F_06 (D10)	F_08 (J24NP)	F_11 (A10)	F_12 (025)	F_15 (029)	F_16 (030)

[8]Okedi, J. 1969 Observations on the breeding and growth of certain mormyrid fishes of The Lake Victoria Basin (Pisces: Mormyridae). Rev. Zool. Bot. Afr. LXXIX, 1-2.

9 www.rufford.org/files/09.04.07%20Final%20Report.doc

Family	Genus	Species	Total Number	Research Point																
				Streams Habitat				Victoria Nile Habitats						Pond Habitats						
				F_01 (Bula01)	F_02 (Bula02)	F_07 (Dosute)	F_09 (Lion R J)	F_03 (Bula03)	F_05 (Avago S)	F_10 (Outlet)	F_13 (Avago N)	F_14 (Avago J)	F_17 (J 31)	F_04 (Lion C)	F_06 (D10)	F_08 (J24NP)	F_11 (A10)	F_12 (025)	F_15 (029)	F_16 (030)
MORMYRIDAE	*Mormyrus*	*Mormyrus kannume*	9						3		5	1								
		Mormyrus niloticus	2						2											
		Mormyrus macrocephalus	1								1									
		Mormyrus spp1	1						1											
		Mormyrus spp2	1									1								
		Mormyrus spp3	1										1							
	Gnathonemus	*Gnathonemus longibarbis*	3						1			2								
	Hippopotamyrus	*Hippopotamyrus grahami*	4									4								
	Marcusenius	*Marcusenius victoriae*	3									3								
CYPRINIDAE	*Barbus*	*Barbus bynni*	159			1	88		43		18	9								
		Barbus kersteni	36	12	18													3		3
		Barbus	16															1		3

Family	Genus	Species	Total Number	Research Point																
				Streams Habitat				Victoria Nile Habitats						Pond Habitats						
				F_01 (Bula01)	F_02 (Bula02)	F_07 (Dosute)	F_09 (Lion R J)	F_03 (Bula03)	F_05 (Ayago S)	F_10 (Outlet)	F_13 (Ayago N)	F_14 (Ayago J)	F_17 (J 31)	F_04 (Lion C)	F_06 (D10)	F_08 (J24NP)	F_11 (A10)	F_12 (025)	F_15 (029)	F_16 (030)
		neumayeri																3		
		Barbus apleurogramma	1										1							
		Barbus perince	2															1		1
		Barbus spp1	84	53	28				2	1										
		Barbus spp2	3	3																
		Barbus spp3	12									1						10		1
		Barbus spp4	26	12	4	7			3											
		Barbus spp5	1						1											
		Barbus spp6	11			11														
	Mesobola	*Mesobola bredoi*	5	1						1		3								
	Labeobarbus	*Labeobarbus spp1*	1				1													
	Labeo	*Labeo horie*	23	7	1		4		6		3		2							
ALESTIDAE	*Brycinus*	*Brycinus nurse*	3								3									
		Brycinus spp1	1										1							
CLARIIDAE	*Clarias*	*Clarias gariepinus*	14	5	1		5					1								2
		Clrias alluaudi	1							1										

Family	Genus	Species	Total Number	Research Point																
				Streams Habitat				Victoria Nile Habitats						Pond Habitats						
				F_01 (Bula01)	F_02 (Bula02)	F_07 (Dosute)	F_09 (Lion R J)	F_03 (Bula03)	F_05 (Avago S)	F_10 (Outlet)	F_13 (Avago N)	F_14 (Avago J)	F_17 (J 31)	F_04 (Lion C)	F_06 (D10)	F_08 (J24NP)	F_11 (A10)	F_12 (025)	F_15 (029)	F_16 (030)
BAGRIDAE	*Bagrus*	*Bagrus docmac*	2								1	1								
		Bagrus bajad	2						1			1								
POECILIDAE	*Aplocheilichthys*	*Aplocheilichthys centralis*	7		7															
		Aplocheilichthys spp1	24									8	16							
	Poecilia	*Poecilia reticulata*	172	113	40				5		5		9							
MASTACEMBELIDAE	*Mastacembelus*	Mastacembelus frenatus	1								1									
LATIDAE	*Lates*	*Lates niloticus*	22					1	2	3	8	3	5							
		Lates macrophthalmus	15		1			1	4	1	1	5	2							
CICHLIDAE	*Oreochromis*	*Oreochromis niloticus*	305		5			7	20	17	55	116	85							
		Oreochromis variabilis	39				39													
		Oreochromis	19						1		5		13							

Family	Genus	Species	Total Number	Research Point																
				Streams Habitat				Victoria Nile Habitats						Pond Habitats						
				F_01 (Bula01)	F_02 (Bula02)	F_07 (Dosute)	F_09 (Lion R J)	F_03 (Bula03)	F_05 (Avago S)	F_10 (Outlet)	F_13 (Avago N)	F_14 (Avago J)	F_17 (J 31)	F_04 (Lion C)	F_06 (D10)	F_08 (J24NP)	F_11 (A10)	F_12 (025)	F_15 (029)	F_16 (030)
		leucostictus																		
	Sarotherodon	*Sarotherodon galilaeus*	62				23	4	4	1	13	7	10							
	Pseudocrenilabrus	*Pseudocrenilabrus multicolor*	3								1		2							
	Astatoreochromis	*Astatoreochromis alluaudi*	1		1															
	Haplochromis	*Haplochromine* spp1	43	1	13				4	6	9	7	3							
		Haplochromine spp2	20							20										
		Haplochromine spp3	70										70							
9	20	44	1231	9	11	3	6	4	17	9	15	17	14	0	0	0	0	4	0	5

Mormyrus kannume

Distributed in Kenya and Uganda. It looks similar to *Mormyrus niloticus* but has shorter and wider snout. Its diet consists mainly of riverbed small organisms. It seems to come to open water at night like other *Mormyrus* species that were caught in a gill net and fyke net that was placed in open water.

Mormyrus niloticus

Distributed along River Nile. It looks similar to the *Momyrus kannume* but it has longer and slender snout. It was caught in the slow current area of river Nile where floating plants gather.

Mormyrus macrocephalus

It looks similar to the *Mormyrus* spp2 and spp3. It has wider and shorter snout than spp2. It has longer snout that spp3 and smaller eye. Main diet consists mainly of riverbed small organism. Only one was caught by a D-shaped hand net where aquatic plants grow in the River Nile.

Mormyrus spp1

It is a young *Mormyrus*. It is unclear whether it belongs to one of identified, unidentified or different new species. Only one was caught by the D-shaped Handnet in an area where aquatic plant grow on the River Nile margin.

Mormyrus spp2  It is considered to be an adult of *Mormyrus* species. It is similar to spp3 but the snout is longer and bent downward suggesting a different species. It was not identified, that it might be an accidentally introduced species or news species/hybrid. Diet consisted of small riverbed organisms. In this survey, one was caught by a gill net which was placed at Ayago river junction in an area with little current and unclear water with emergent aquatic plants.	***Mormyrus spp3***  It looks similar to spp2 but it has shorter snout and large eye. It was not identified that it may be accidentally introduced or new species/ hybrid. The diet consisted of small riverbed organisms. Only one was caught by a gill net in this survey point F_17 at Steam-Nile junction covered with instream emergent aquatic plants.
Gnathonemus longibarbis  Distributed in Lake Victoria, Victoria Nile and Lake Tanganika. One of the species of Gnathoemus with extended lower jaw. Diet consisted of small riverbed organisms. Three individual were caught in two locations. In all situations, they were caught by a gill nets set along under the emergent aquatic plants along the Nile margin.	***Hippopotamyrus grahami***  Distributed in Lake Victoria and surrounding river. It may look similar to *Marcusenius victoriae* but it is round and lower jar does not extend. It is considered to eat floating organism. Four individuals were caught at F_14, by a gill net placed in unclear water and under emergent aquatic plants.

Marcusenius victoria  It is EN in IUCN red list. It looks similar to Hippotamyrus grahami but it is slender with extended lower jaw. It is considered to eat floating organisms. In this survey, three individual was caught at F-14 where Ayago river join the Nile. It was caught by a gill net set under unclear water and emergent aquatic plants. Hippotamyus grahami were also caught at same place which they might compete for each other.	***Barbus bynni***  Three subspecies in known and distribute widely from East to West Africa. Within this survey, It was most common Barbus caught that it can be said it is the dominant Barbus species. It seemed to be a young individual growing in streams, since they were not caught in River Nile but in some stream. It was considered to eat benthic phytoplankton. Adults were caught where there was moderate current and open water with slow current.
Barbus kerstenii  It was only from stream habitats in areas with slow current.	***Barbus neumayeri***  This species had the longest barbes in all the Barbine species caught for this survey. Distributed widely in East Africa. Within this survey, this species was only caught in a small pond which connects to River Nile in the Wet season.

Barbus apleurogramma	***Barbus perince***
	
Distributed widely in East Africa. It does not grow more than 5.5cm. Only one was caught by a long handle hand net near emergent aquatic plants.	It looks similar to *Barbus karstenii* but this species has clear barbels and black spot in lateral line. Distributed from River Nile to River Nigel. In this survey, it was not found in River Nile but small ponds that connect to river Nile n wet season.
***Barbus* spp1**	***Barbus* spp2**
	
This species was caught mostly at Bulaya (F_1 and F_2). But a small number was caught in River Nile. It seems to be a smaller species at 2.5 cm long possess black matures color. It was not identified. It may be a species which is not recorded in Uganda or new species.	It looked similar to *Barbus* spp3 but it has larger scale. Three individuals were caught at Bulaya (F_1 and F_2). It was not identified, may be unrecorded in Uganda or new species.

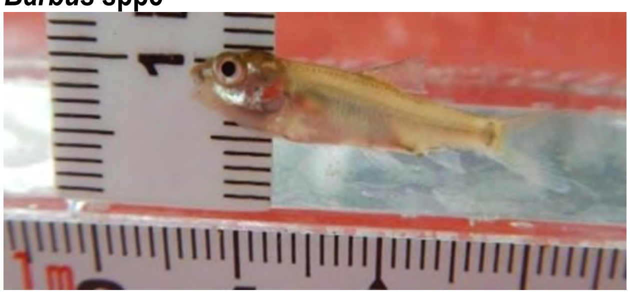
***Barbus* spp3**

It looks similar to the *Barbus* spp2; however this species has smaller scales. One individual was caught at River Nile and most of them were caught in ponds that become stream in wet season connecting River Nile. It was not identified, may be unrecorded or new species.

***Barbus* spp4**

It looks similar to the *Barbus kersteni*, however it has smaller eyes and round head to back fin. This photo is of a formalin specimen. It was mainly caught at Bulaya (F_1 and F_2) but also found in River Nile and other streams. It was not identified, may be unrecorded or new species.

***Barbus* spp5**

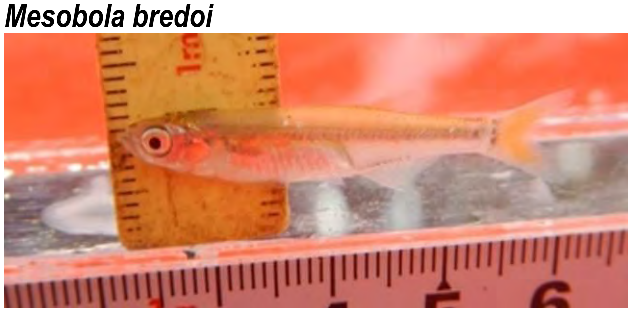


It was caught at site F_05 where a small stream joins the river Nile. It may be young of the species that is recorded in this survey but could not be identifed.

***Barbus* spp6**

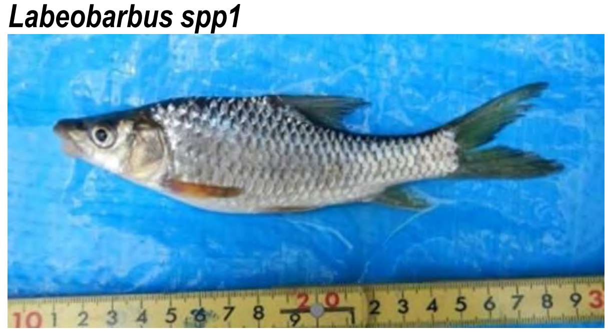
It was only found at site F_07 where it is planned to dump soil excavated from the tunnel. The stream had the clearest water of all the survey points which this species may require. It was not identified, may be unrecorded or new species.

Mesobola bredoi



It is said to be a Lake Albert species but found up the Murchison Falls. It is only one species of Mesobola known in Uganda. It was not much but also found in streams.

Labeobarbus spp1



It is the only one *Labeoburbus* found in this survey. It has very unique mouth (lips). In Uganda there are no records of labeoburbus species. One was caught by a cast net at F_09. It was not identified, may be unrecorded or new species.

Labeo horie

Only one species belonging to Labeo for this survey. It distribute widely along River Nile. In this survey, it was caught widely in streams and River Nile. When young it has mouth similar to other Barbines. Adult has retractable mouth for eating moss from rock surfaces.

Brycinus nurse

It belongs to Calacinidae. It is widely distributed in Africa. It is not known whether this species is introduced or not to Victoria Nile. Three individuals were caught at F_13. They were caught by gill net and cast net in areas with moderate current.

***Brycinus* spp1**

It looks similar to the *Brycinus* nurse; however this species has black spot only on the middle of tail. Only one was caught at F_17 by cast net where there was moderate current.

It was not identified, may be unrecorded or new.

Clarias gariepinus

One of the largest *Clarias* which maximum size reached 170cm. Widely distributed in Africa. As the large size, it was introduced to Europe and Asia where threatening native species. It can get the air directly from water surface that it can survive in low oxygen environment. In this survey, it was mainly recorded in streams and ponds, and a few from the Nile.

Clarias alluaudi

It belongs to genus Clarias, however it does not get as big as *Clarias gariepinus*, maximum of 35cm. Head is smaller and body is longer. There are no white spots on the stem of caudal like the *C.gariepinus.* It distribute in Lake Victoria and Lake Tanganika. In this survey one young individual was caught at F_10 by D-shaped hand net where aquatic plants grow in River Nile.

Bagrus docmak

The maximum size go over 1m. Distribute widely in Africa. It is usually nocturnal. But in this survey it was caught by cast net in daytime. Two were caught where there is moderate current in River Nile.

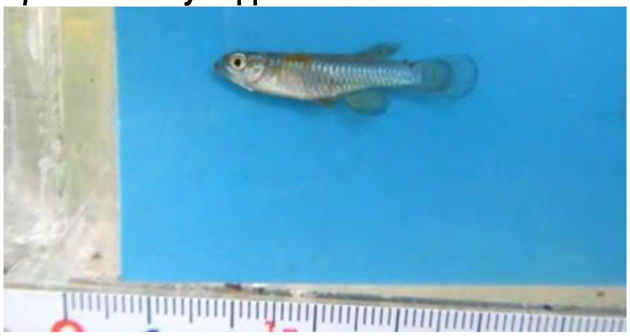
Bagrus bajad

Maximum size is over 1m. It is widely distributed in East and West Africa. It is generally nocturnal, however it was caught by cast net in daytime. Two individual were caught where there was moderate current in River Nile.

Aplocheilichthys centralis

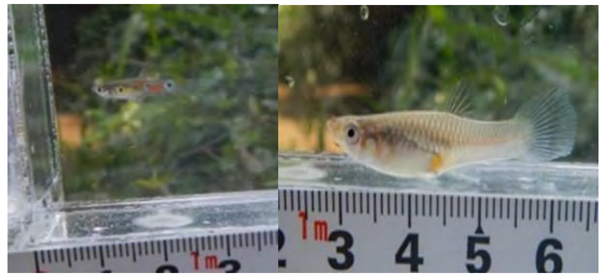
Distributed in Uganda and Tanzania. It is similar to the *Aplocheiliohthys* spp however comparing adult, it grow much bigger and wider. And it did not have purple color on the fin like Aplocheulichthys spp1. It was caught where there are aquatic plants. The *Poecilia reticulata* was also caught in same habitat. The Poecilia reticulate is threatening native species worldwide that this species might be in threat as well.

***Aplocheilichthys* spp1**



This was not found in Ugandan fish list. Similar species is *Aplochelichthys johnstoni* in Congo River which is EN in IUCN redlist. It is not known whether this species is introduced or native. This was caught in two wetland environment where small stream join the river Nile.

Poecilia reticulata



Originally from South America from where it was introduced worldwide. Left photo is male and right photo is female. The female keeps and hatches eggs in her stomach. Has highly adapted reproductive mechanism with subsequent high reproductive rates for conditions threatening other POECILIDAE species worldwide. Many *Poecilia reticulata* were caught from F_1, F_2 and many places in River Nile where aquatic plants grow.

Mastacembelus frenatus

It is distributed from Lake Victoria to Okapango delta in Africa. It eats small fish in the riverbed. Only one species of *Mastacembelus* is known in Uganda. In this survey, only one individual was caught by a gill net placed near aquatic plants at F_13.

Lates niloticus

Maximum size reaches 2m. It is listed in 100 invasive species of the world by IUCN. Especially Lake Victoria it is a serious threat. Introduction of this species caused extinction of native cichlids and destroying ecology. In Ayago area, this species was introduced from Lake Victoria and Kyoga. Young small individual were caught often near the aquatic plants by hand nets. Adult were caught at River Nile by cast net.

Lates macrophthalmus

It distributed originally only in Lake Albert. It resembles *Lates niloticus* however it has a slender caudal stem and lower jaw protrudes more compared in *Lates niloticus*. It only becomes 30cm. It is considered to be a fish eater and competes with *Lates niloticus.* It is listed as EN in IUCN red list but it is introduced species in the survey area. It was probably introduced with *Lates Niloticus*.In this survey, similar to the Lates Niloticus, young individuals were caught near aquatic plant by hand nets and adult by cast net in the River Nile.

Oreochromis niloticus

It is widely distributed from East Africa to Israel. It is thought to be introduced at the survey area. This species is introduced worldwide for food purpose and also considered threatening the native ecology.In this survey, It was found in F_02 stream and all the survey points at River Nile, and also recorded highest number in the survey. It is the most dominant species in the survey area. Also many young was recorded in the wetland at the stream- Nile River junction.

Oreochromis variabilis

It is CR in the IUCN red list. It distribute in Lake Victoria and up the Murchison Falls. It is said to be disappearing from many location in Victoria Nile. In this survey, 39 individuals were captured but only in one point F_09 suggesting the threatening. F_09 had no *O. niloticus* or *O. leucostictus*. It may remain where these two species do not occur.

Oreochromis leucostictus

Originally from Lake Albert to Lake Edward. It was not distributed from Murchison Falls to Lake Victoria but introduced. In this survey, it was caught by cast net in the River Nile. It was caught in a same place with *Oreochromis niloticus* but fewer suggesting that the two are competing.

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Sarotherodon galilaeus

It is originally widely distributed in Africa and small part of Eurasia with five sub-species; however it was introduced in Victoria Nile. In this survey it was caught in F_09 stream and all the points at River Nile. It varied in color from blue spot to yellow spot.

</td>
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Pseudocrenilabrus multicolor

It is distributed from Lake Victoria to Lake Albert. It is the only species in Uganda belonging to Pseudocrenilaburus. In this survey, It was caught in two locations at River Nile by long handle hand net and D-shaped hand net in areas where aquatic plants grow.

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Astatoreochromis alluaudi

Only one species of *Astatoreochromis* is known in Uganda distributed near Lake Victoria. In this survey, only one individual was caught at F_02 Bulaya with D-shaped handnet from an area with floating and rooted aquatic plants.

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<td>

***Haplochromine* spp1**

Haplichromines often interbreed and have little morphological difference that the definition of species often do not have consensus, that in this study all the Pseudocrenilabrnae species that was not identified was described as Haplochromine. This species had a black line from upper jaw to the head and cuadal fin turned black. Dorsal fin had three to five orange spots. It was captured in Bulaya and River Nile at the edge of water.

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***Haplochromine* spp2**	***Haplochromine* spp3**
 Haplochromines often interbreed and have little morphological difference that the definition of species often do not have consensus, that in this study all the Pseudocrenilabrnae species that was not identified was described as Haplochromine. This species had flattest body shape within the Haplachromine species captured for this survey. It had white lines in body and five to seven orange spot in dorsal fin. It was captured only in F_10 with rocky riverbed. From its body shape it should be a species that stick to rocks.	 Haplichromines often interbreed and have little morphological difference that the definition of species often do not have consensus, that in this study all the Pseudocrenilabrnae species that was not identified was described as Haplochromine. This species had round head to back fin line. The color was red orange yellow.It had 5～6 orange spot on dorsal fin. Seventy individuals were caught only at F_17.

Plate 9: Specimens for Fish Species Observed

1) Introduced fish species

Out of the 44 species at least six species are introduced and these can be a threat to native species. Two latidae species from genus *Lates*; *Lates macrophthalmus* and *Lates niloticus*. Both are introduced species to the Ayago area and are known to be piscivorous as juvenile and adult. The *Lates macrophthalmus* is listed as an endangered species in the IUCN red list, and endemic to Lake Albert ecosystem[10]. Lates niloticus is one of the top 100 invasive species in the IUCN list[11] and concerned to have impact to native species worldwide. Though not many were caught during the third survey, however considering that these piscivorous reaching 2m in size, can have huge predatory impact for the native species Plate 10.

10http://www.iucnredlist.org/details/60835/0
[11]http://www.issg.org/database/species/ecology.asp?si=89&fr=1&sts=&lang=EN

Plate 10: *Bagrus* found from *Lates niloticus* stomach

All tilapines recorded during the third fish survey, except *Oreochromis variabilis*, were introduced species to the Ayago area. These tilapines are natives of Nile from below Albert Nile to the delta. They are feared to cause environmental problems in aquatic environments with slow water renewal rates, especially *Oreochromis niloticus*. Because of their high reproductive rates, they overcrowd and out-compete native species[12]. 305 individuals of *Oreochromis niloticus* were captured which is about 25% of all the catch. In River Nile, it is the dominant species invading and threatening the habitat of native species. In the wetland, the percentage of the catch of young *Oreochromis niloticus* was very high. Most of the fish belonging to Cichildae including *Oreochromis niloticus* become highly territorial excluding other fish from reproducing habitat which behavior will also threaten other fish. They were registered in all habitats expect the pond habitats. Even in the wetland area, young *Oreochromis niloticus* was found which size was larger than average size of other fish. That is the predatory impact is starting from the juvenile stage.

One poeciliidae species from genus Poecilia; *Poecilia reticulata* was recorded. Poecidae are not native to Africa, have been introduced by accidental release from aquaria to African waters. *Poecilia reticulata* is a small size fish able to stay in shallow area and have high reproduction rate with highly adaptive mechanisms; ability of females to store sperms for later fertilization and giving birth to 20-40 live young[13]. *Poecilia reticulata* accounted for 13.97% and 28.2% of fish individuals caught from the study area and inflow streams, respectively, showing its dominance over the native species. Although, in Uganda no studies have been done on ecological impact of *Poecilia reticulata,* it is known elsewhere that *Poecilia reticulata* is considered a hazard to native cyprinids and killifishes, has been implicated in the decline of native fishes and damselflies, a known carrier of trematode parasites which may affect native fish populations, eats eggs of native fish species and acts as a host for the parasitic nematode *Camallanus cotti*, and the Asian tapeworm *Bothriocephalus acheilognathi*[14].

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[12]FishBase, 2007.
[13]Balon, E.K., 1990. Epigenesis of an epigeneticist: the development of some alternative concepts on the early ontogeny and evolution of fishes. Guelph Ichthyol. Rev. 1:1-48.
[14]http://www.issg.org/database/species/ecology.asp?si=683

Poecilia reticulata inhabits warm springs and their effluents, weedy ditches, and canals. It is found in various habitats, ranging from highly turbid water in ponds, canals and ditches at low elevations to pristine mountain streams at high elevations. This species accommodates a wide salinity range but requires fairly warm temperatures (23-24°C) and quiet vegetated water for survival[15]. Increase in turbidity of the water column would promote its dominance and subsequent impact on native fish species. In general terms, there was more fish belonging to introduced species recorded from the Victoria Nile habitats (Table 79), followed by streams and a few records of them in ponds. Therefore, streams and ponds are very important environments acting as reservoirs for native species.

Table 78: Introduced fish proportions (numbers) per survey Points within each Habitat type

Habitat Type	**Victoria Nile habitats**						
Research Points	F_3	F_5	F_10	F_13	F_14	F_17	
Total number	13	103	51	129	173	220	
Number of introduced fish	13	36	22	87	131	124	
% of introduced fish	100.00	34.95	43.14	67.44	75.72	56.36	
Habitat Type	**Streams' habitats**						
Research Points	F_1	F_2	F_7	F_9			
Total number	207	119	19	160			
Number of introduced fish	113	46	0	23			
% of introduced fish	54.59	38.66	0.00	14.38			
Habitat Type	**Ponds' habitats**						
Research Points	F_04	F_06	F_08	F_11	F_12	F_15	F_16
Total number					27		10
Number of introduced fish					0		0
% of introduced fish					0.00		0

Threatened, protected species, and threatening processes

Out of the 44 species, only 29 species were identified of which 24 species were on the IUCN red list, one was CR, two were EN, 18 were LC and two were DD

Table 79: Conservation Status and Percentage of Fish Species

Genus	Species	Total Number of individuals	Catch %	IUCN Category
Mormyrus	*Mormyrus kannume*	9	0.73	LC
	Mormyrus niloticus	2	0.16	DD
	Mormyrus macrocephalus	1	0.08	LC

[15] http://www.fishbase.org/summary/Poecilia-reticulata.html

Genus	Species	Total Number of individuals	Catch %	IUCN Category
	Mormyrus spp1	1	0.08	unknown
	Mormyrus spp2	1	0.08	unknown
	Mormyrus spp3	1	0.08	unknown
Gnathonemus	*Gnathonemus longibarbis*	3	0.24	LC
Hippopotamyrus	*Hippopotamyrus grahami*	4	0.32	LC
Marcusenius	*Marcusenius victoriae*	3	0.24	EN
Barbus	*Barbus bynni*	159	12.92	LC
	Barbus kerstenii	36	2.92	LC
	Barbus neumayeri	16	1.30	LC
	Barbus apleurogramma	1	0.08	LC
	Barbus perince	2	0.16	LC
	Barbus spp1	84	6.82	unknown
	Barbus spp2	3	0.24	unknown
	Barbus spp3	12	0.97	unknown
	Barbus spp4	26	2.11	unknown
	Barbus spp5	1	0.08	unknown
	Barbus spp6	11	0.89	unknown
Mesobola	*Mesobola bredoi*	5	0.41	Not Evaluated
Labeobarbus	*Labeobarbus* spp1	1	0.08	unknown
Labeo	*Labeo horie*	23	1.87	Not Evaluated
Brycinus	*Brycinus nurse*	3	0.24	LC
	Brycinus spp1	1	0.08	unknown
Clarias	*Clarias gariepinus*	14	1.14	Not Evaluated
	Clrias alluaudi	1	0.08	LC
Bagrus	*Bagrus docmak*	2	0.16	LC
	Bagrus bajad	2	0.16	LC
Aplocheilichthys	*Aplocheilichthys centralis*	7	0.57	LC
	Aplocheilichthys spp1	24	1.95	unknown
Poecilia	*Poecilia reticulata**	172	13.97	Not Evaluated
Mastacembelus	*Mastacembelus frenatus*	1	0.08	LC
Lates	*Lates niloticus**	22	1.79	LC
	*Lates macrophthalmus**	15	1.22	EN
Pseudocrenilabrus	*Pseudocrenilabrus multicolor*	3	0.24	Not Evaluated
Astatoreochromis	*Astatoreochromis* spp1	1	0.08	CR
Oreochromis	*Oreochromis niloticus**	305	24.78	LC
	Oreochromis variabilis	39	3.17	CR

Genus	Species	Total Number of individuals	Catch %	IUCN Category
	*Oreochromis leucostictus**	19	1.54	DD
	*Sarotherodon galilaeus**	62	5.04	LC
Thoracochromis	*Thoracochromis wingatii*	43	3.49	unknown
Haplochromis	*Haplochromine* spp1	20	1.62	unknown
	Haplochromine spp2	70	5.69	unknown
20	44	1231	100.00	23
* Introduced fish				

Fish species of conservation importance encountered and recorded in some surveyed sites within the proposed Ayago HPP area include: *Oreochromis variabilis* (Boulenger), *Lates macrophthalmus* and *Marcusenius victoriae* which are presently listed in the IUCN Red List of Threatened Species as Critically Endangered (IUCN, 2000), and the two Endangered B1ab (iii) ver 3.1, respectively.

Oreochromis variabilis and *Marcusenius victoriae* are endemic to the Victoria Nile and Lake Victoria and its satellite lakes while *Lates macrophthalmus* is endemic to the Lake Albert ecosystem. *Marcusenius victoriae* was caught at site F_14 at the Nile-Ayago confluence while *O. variabilis* was caught at site F_9 at the junction where three streams meet.

2) Major threats that have been identified include

Over-fishing, particularly using illegal methods and gear;
Competition for habitats and food with exotic species (introduced Nile tilapia and *Tilapia zilli*);

- predation by the introduced Nile perch;
- marked reduction of diatoms at the expense of 'unpalatable' Cyanobacteria;
- reduced breeding habitat;
- increased siltation and water turbidity; and
- eutrophication and anoxia due to domestic pollution.

3) Key Threatening Processes

Key threatening processes listed under the National Environmental Act (1994, Cap 153) relevant to the proposed Ayago HPP project that require consideration include:

- use, erect, reconstruct, place, alter, extend, remove or demolish any structure or part of any structure in, on, under or over the bed;
- excavate, drill, tunnel or disturb the bed otherwise;
- introduce or plant any part of a plant whether alien or indigenous in a lake or river;
- introduce any animal, or microorganism, whether alien or indigenous in any river or lake or on, in or under its bed;
- deposit any substance m a lake or river or in, on or under its bed, if that substance would or is likely to have adverse effects on the environment;

- divert or block any river from its normal course; and
- drain any lake or river.

5.3.9 Aquatic Ecology

Aquatic Habitats

At the time of sampling, the river shoreline had receded about 1.5 m and stream water levels had also reduced significantly. The ponds and sites along Victoria Nile that were investigated during fish surveys were not investigated because the ponds spots were dry and points along the Nile were not reachable at the time. Routes to such points had closed with over growth.

Victoria Nile

The Victoria Nile section within the proposed Ayago HPP project area was the only river surveyed. The Victoria Nile is the central watercourse for the proposed Ayago HPP project with dam (Inlet and outlet) and reservoir sites along its course. Three survey points (Nile1, Nile 2 and Nile 3) were investigated along the Nile section within the project area. The Victoria Nile within the Ayago HPP project area harbours many hippopotami making hard to access the deep and lentic water, samples were picked from the lotic shoreline. The habitats along the Nile, within the project area will be directly and indirectly impacted upon by project components and activities.

Table 76: Location and Habitat Characteristics of Stations Sampled for Plankton and Macroivertebrates

Stream 1: Location: 36 N 259396.5 E 377027.8;  A small stream that runs through the valley proposed for dumping soil excavated from tunnel. The stream runs through forest, it has rapid and pool and had the clearest water. Streambed was pebbles and stones with some exposed rocks.	**Stream 2:** Location: 36 N 259993.4 E 372572.4;  The survey site is at a point where three small streams join to form a wider channel. The banks were high loose bare sand with scattered vegetation. Riverbed was mainly mud pebbles with some sand and had small rapids and pools.
Stream 3: Location: N 36 250725.6; E 392290.4;	**Nile 1:**Location: 36 N 261822.9 E 372819.5; pH

 This site is located on River Bulaya upstream of Bulaya Bridge on Nanda route. At the investigation site, the stream is running through a closed canopy riverine forest, banks were covered with hanging vegetation and shoreline fringed with rooted aquatic plants in opened areas. Water flow was slow current (pool) over sand and mud riverbed.	8.1  On the Victoria Nile where a small steam inflow. At the junction is a river mouth with sand and mud bed, and emergent aquatic plants. The Nile was slow over pebble and sand bed.
Nile 2: Location: 36 N 259702.8 E 382026;  Junction of the Ayago river and Victoria Nile with 0.25m horizontal transparency; forms a river mouth fringed with floating and emergent aquatic plants, and marshes.	**Nile 3:** Location: 36 N 259055.2; E 381509.6 This survey site is on the Victoria Nile around the proposed inlet area for the Ayago HPP. The bank is lined by a riverine closed canopy forest. The Nile riverbed was sand and pebble with exposed rocks, flow was slightly turbulent over rocks (riffle) with 0.25m transparency. There was a small stream joining the Nile where small riverine bay formed with floating aquatic plants grow along the shore. Many young fish and smaller species were recorded around the aquatic plants.

Streams

There were 3 (Stream 1, Stream 2 and Stream 3) surveyed that flow towards and feed the Nile. Samples from the streams were picked from lotic water. These streams will be directly or indirectly impacted upon by the project component and activities.

Plankton

Generally fair plankton diversity and abundance were recorded from the Nile and streams within the project area. The diversity and abundance by the results is characteristic of slow flowing and backwaters environments[16]. A total 40 genera of plankton were recorded from sites on the Nile and selected streams within the project area. Twenty seven of them belonged to phytoplankton while thirteen belonged to zooplankton (Table 81).

Table 80: Classes and Genera of Phytoplankton recorded at Various Sampling Sites on the Nile and Streams within Ayago HPP Project Area

Taxa		Total	Nile 1	Nile 2	Nile 3	Stream 1	Stream 2	Stream 3
Cyanophyta	*Oscillatoria*	10	3					7
	Microcystis	27	13		9			5
	Merismopedia	4		2				2
	Anabeana	19			5		3	11
Chlorophyta	*Closterium*	26	9			6	7	4
	Draparnildia	3	3					
	Chlorella	17	4			6	7	
	Gloeotrichia	10	3		7			
	Desmidium	4	2					2
	Scenedesmus	29		5	7	15		2
	Pediastrum	78			52	8	5	13
	Chlamydomonas	3					3	
	Schizomeris	12		3	6			3
	Asterocystis	45		3	37			5
	Ankistrodesmus	5			5			
	Spirogyra	3						3
	Actinastrum	2		2				
	Carteria	9		2	3		2	2
	Tetraedron	2						2

[16] Allan, J.D. 1995. Stream Ecology: structure and function of running waters. Chapman and Hall, London. Pp. 388.

Flagellates	*Phacus*	63	32	5		11	6	9
	Euglena	83	75					8
	Trachomonas	28	10			5	3	10
	Synura	6	2					4
	Cosmarium	9			5		4	
	Peridinium	2						2
Bacillariophyta	*Nitzschia*	18		5	7		3	3
	Synedra	5		5				
	27	**522**	**11**	**9**	**11**	**6**	**10**	**19**

Table 81: Classes and Genera of Zooplankton recorded at Various Sampling Sites on the Nile and Streams within Ayago HPP Project Area

Taxa		Total	Nile 1	Nile 2	Nile 3	Stream 1	Stream 2	Stream 3
Crustacea	*Cyclops*	**19**				9	8	2
	Nauplii	**142**	2			34	9	20
	Calanoid	**23**				23		
	Moina	**23**				21		2
	Diaphanosoma	**5**				5		
	Ostracoda	**3**		3				
Rotifera	*Trichocerca*	**32**	9			8	13	2
	Filinia	**9**	4			5		
	Lecane	**26**	2	11			9	4
	Polyarthra	**33**	6			15	7	5
	Keratella	**4**		2				2
	Anureopsis	**24**			2		12	10
	Asplanchna	**18**		3		13		2
	Brachionus	**101**		5	7	47	31	11
3	**13**	**462**	**5**	**5**	**2**	**10**	**7**	**10**

Phytoplankton belonged to four major taxa; Cyanophyta (Blue-green algae), Chlorophyta (Green algae), Dinophyta (Flagellates) and Bacillariophyta (Diatoms). The green algae were the diverse with 15 genera, followed by flagellates (six), blue-green (four) and diatoms (two) were the least. Generally, more phytoplankton genera (23) and individuals (231) of phytoplankton were recorded from the Nile compared to 21 genera and (189) individuals from the streams.

Table 82: Classes and Genera of Phytoplankton recorded from Sampling Sites on the Nile

Taxa	Total	Nile 1	Nile 2	Nile 3

Cyanophyta	*Oscillatoria*	3	3		
	Microcystis	22	13		9
	Merismopedia	2		2	
	Anabeana	5			5
Chlorophyta	*Closterium*	9	9		
	Draparnildia	3	3		
	Chlorella	4	4		
	Gloeotrichia	10	3		7
	Desmidium	2	2		
	Scenedesmus	12		5	7
	Pediastrum	52			52
	Chlamydomonas	0			
	Schizomeris	9		3	6
	Asterocystis	40		3	37
	Ankistrodesmus	5			5
	Spirogyra	0			
	Actinastrum	2		2	
	Carteria	5		2	3
	Tetraedron	0			
Flagellates	*Phacus*	37	32	5	
	Euglena	75	75		
	Trachomonas	10	10		
	Synura	2	2		
	Cosmarium	5			5
	Peridinium	0			
Bacillariophyta	*Nitzschia*	12		5	7
	Synedra	5		5	
	23	**231**	**11**	**9**	**11**

Table 83: Classes and Genera of Phytoplankton recorded from Sampling Sites on selected streams

Taxa		Total	Stream 1	Stream 2	Stream 3
Cyanophyta	*Oscillatoria*	7			7
	Microcystis	5			5
	Merismopedia	2			2
	Anabeana	14		3	11
Chlorophyta	*Closterium*	17	6	7	4
	Draparnildia	0			

	Chlorella	13	6	7	
	Gloeotrichia	0			
	Desmidium	0			2
	Scenedesmus	17	15		2
	Pediastrum	26	8	5	13
	Chlamydomonas	3		3	
	Schizomeris	3			3
	Asterocystis	5			5
	Ankistrodesmus	0			
	Spirogyra	3			3
	Actinastrum	0			
	Carteria	4		2	2
	Tetraedron	2			2
Flagellates	*Phacus*	26	11	6	9
	Euglena	8			8
	Trachomonas	18	5	3	10
	Synura	4			4
	Cosmarium	4		4	
	Peridinium	2			2
Bacillariophyta	*Nitzschia*	6		3	3
	Synedra	0			
	21	**189**	**6**	**10**	**19**

The Nile recorded higher diversity and abundance compared to stream probable because samples were picked from the deep and almost stationary points which were free from Hippopotami, while on streams samples were picked from lentic environments. Zooplankton belonged to two major taxa; Crustacea and rotifera. Rotifera were more diverse with eight genera compared to Crustacea with five genera (see

81). Streams recorded more zooplankton genera (12) and individuals (381) (see **Error! Reference source not found.**81) compared to 10 genera and 56 individuals recorded from the Nile (see table 82).

Table 84: Classes and Genera of Zooplankton recorded at Various Sampling Sites on Selected Streams

Taxa		Total	Stream 1	Stream 2	Stream 3
Crustacae	*Cyclops*	**19**	9	8	2
	Nauplii	**140**	111	9	20
	Calanoid	**23**	23		
	Moina	**23**	21		2
	Diaphanosoma	**5**	5		

	Ostracoda	**0**			
Rotifera	*Trichocerca*	**23**	8	13	2
	Filinia	**5**	5		
	Lecane	**13**		9	4
	Polyarthra	**27**	15	7	5
	Keratella	**2**			2
	Anureopsis	**22**		12	10
	Asplanchna	**15**	13		2
	Brachionus	**89**	47	31	11
3	**12**	**381**	**10**	**7**	**10**

Table 85: Classes and Genera of Zooplankton recorded at Various Sampling Sites on the Nile

Taxa		Total	Nile 1	Nile 2	Nile 3
Crustacae	*Cyclops*	**0**			
	Nauplii	**2**	2		
	Calanoid	**0**			
	Moina	**0**			
	Diaphanosoma	**0**			
	Ostracoda	**3**		3	
Rotifera	*Trichocerca*	**9**	9		
	Filinia	**4**	4		
	Lecane	**13**	2	11	
	Polyarthra	**6**	6		
	Keratella	**2**		2	
	Anureopsis	**2**			2
	Asplanchna	**3**		3	
	Brachionus	**12**		5	7
3	**10**	**56**	**5**	**5**	**2**

Macroinvertebrates

A total of 1002 macroinvertebrates belonging to four major taxa (insecta, Mollusca, Annelida and decapoda) were recorded. Insecta were the most diverse represented by 13 families belonging to five orders including; Hemiptera (3), Coleoptera (3), Odonata (2), Ephemeroptera (3) and Diptera (2) followed by Mollusca represented by three families; sphaeriidae, pleuroceriidae and physiidea; Annelida and Decapoda one family each Oligocheate and Atydae respectively.

Table 86: Taxa of Macroinvertebrates recorded at Various Sampling Sites on the Nile and Streams within Ayago HPP Project Area

Taxa			Total	Nile 1	Nile 2	Nile 3	Stream 1	Stream 2	Stream 3
Insecta	**Hemiptera**	Corixidae	**24**	4	2	5	7	4	2
		Nepidae	**22**	3	1	3	4	2	9
		Naucoridae	**20**	2	3	1	5	2	7
	Coleoptera	Elmidae	**21**	5	1	2	4	2	7
		Dryopidae	**26**	3	5	2	5	4	7
		Hydrophilidae	**4**	0	1	1	1	1	0
	Odonata	Libellulidae	**37**	7	5	3	5	7	10
		Aeshnidae	**33**	4	3	4	9	6	7
	Ephemeroptera	Lestidae	**19**	3	3	1	7	3	2
		Baetidae	**18**	3	1	2	4	3	5
		Heptageniidae	**26**	1	4	2	7	4	8
	Diptera	Alblabesmyia	**55**	9	6	13	5	13	9
		Ceratopogonidae	**38**	11	7	3	6	4	7
Annelida		Oligocheate	**20**	8	4	7	0	1	0
Mollusca		Pleuroceridae	**43**	15	12	2	4	7	3
		Sphaeriidae	**72**	33	17	9	7	2	4
		Physiidae	**22**	1	6	2	3	4	6
Decapoda		Atydae	**22**	7	12	3	0	0	0
4		**18**	**1002**	**13**	**17**	**15**	**9**	**13**	**9**

The macroinvertebrate communities recorded from the Nile and streams did not differ much in terms of diversity and abundance. The Nile being larger than any of the streams, recorded one higher than[17] streams while streams recorded higher abundance. Plate 10 shows some of the macro invertebrates recorded.

Table 87: Taxa of Macroinvertebrates recorded at Various Sampling Sites on the Nile

	Taxa		Total	Nile 1	Nile 2	Nile 3

[17] Giller, S. and B. Malmqvist. 1998. The Biology of Streams and Rivers. Oxford University Press, Oxford. Pp. 296.

Insecta	**Hemiptera**	Corixidae	**11**	4	2	5
		Nepidae	**7**	3	1	3
		Naucoridae	**6**	2	3	1
	Coleoptera	Elmidae	**9**	5	1	2
		Dryopidae	**10**	3	5	2
		Hydrophilidae	**2**	0	1	1
	Odonata	Libellulidae	**15**	7	5	3
		Aeshnidae	**11**	4	3	4
	Ephemeroptera	Lestidae	**7**	3	3	1
		Baetidae	**6**	3	1	2
		Heptageniidae	**7**	1	4	2
	Diptera	Alblabesmyia	**28**	9	6	13
		Ceratopogonidae	**21**	11	7	3
Annelida		Oligocheate	**19**	8	4	7
Mollusca		Pleuroceridae	**29**	15	12	2
		Sphaeriidae	**59**	33	17	9
		Physiidae	**9**	1	6	2
Decapoda		Atydae	**22**	7	12	3
		18	**271**	**13**	**17**	**15**

Table 88: Taxa of Macroinvertebrates recorded at Various Sampling Sites on Streams

	Taxa		Total	Stream 1	Stream 2	Stream 3
Insecta	**Hemiptera**	Corixidae	**13**	7	4	2
		Nepidae	**15**	4	2	9
		Naucoridae	**14**	5	2	7
	Coleoptera	Elmidae	**13**	4	2	7
		Dryopidae	**16**	5	4	7
		Hydrophilidae	**2**	1	1	0
	Odonata	Libellulidae	**22**	5	7	10
		Aeshnidae	**22**	9	6	7
		Lestidae	**12**	7	3	2
	Ephemeroptera	Baetidae	**12**	4	3	5
		Heptageniidae	**19**	7	4	8
	Diptera	Alblabesmyia	**27**	5	13	9
		Ceratopogonidae	**17**	6	4	7

Annelida		Oligocheate	**1**	0	1	0
Mollusca		Pleuroceridae	**14**	4	7	3
		Sphaeriidae	**13**	7	2	4
		Physiidae	**13**	3	4	6
Decapoda		Atydae	**0**	0	0	0
		17	**228**	**9**	**13**	**9**

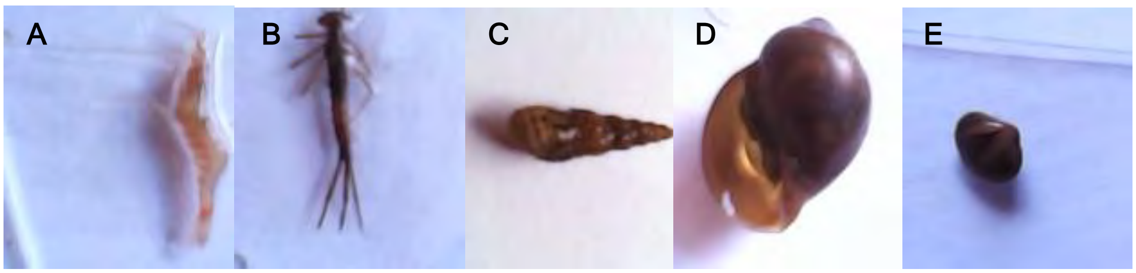

Plate 11 Sample macro inverbrates recorded from the project area

The plankton and macroinvertebrate assemblages' show that the Nile and streams are health un polluted bodies; absence of dominance of pollution tolerant phytoplankton genera[18] and presence of pollution sensitive taxa such as Ephemeroptera. Therefore, the construction, operational and decommissioning phases the proposed Ayago Hydro Power Project, measures should be put in place to avoid activities, as such ground stripping (soil erosion), littering of domestic and construction waste, spillage of fuel and fuel derivatives in and around these water resources.

5.4 Cultural Survey

The management of heritage resources in Uganda is under the Department of Museums and Monuments of the Ministry of Tourism, Wildlife and Antiquity. It operates through the Historical Monuments Act of 1967 and Amendment Decree of 1977. This document outlines the specific technical requirement for conducting terrestrial archaeological and built heritage impact assessments and is based upon the requirements of UNESCO to which Uganda is a signatory to as per the 1972 UNESCO Convention concerning the preservation and protection of cultural and natural heritage. The study used the NEMA guidelines and the Convention on Biological Diversity (2004). Akwé: Kon Voluntary Guidelines for the Conduct of Cultural, Environmental and Social Impact Assessment regarding Developments Proposed to Take Place on, or which are likely to Impact on, Sacred Sites and on Lands and Waters Traditionally Occupied or Used by Indigenous and Local Communities. Archeology survey points are indicated in Figure 58.

[18] Palmer, C. M. 1969. A composite rating of algae tolerating organic pollution. *J. Phycology.* 5: 78-82.

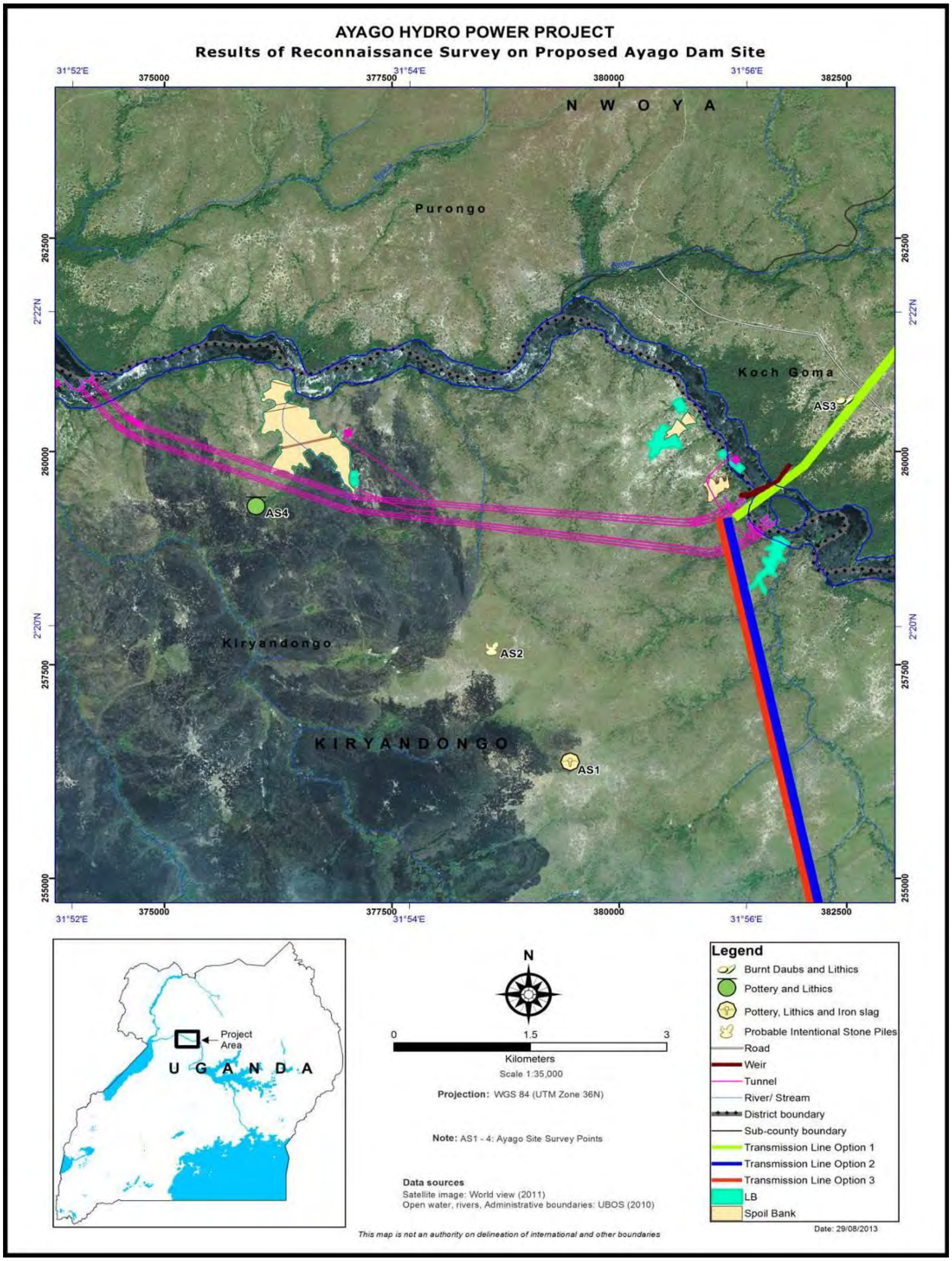

Figure 57: Archealogy Survey area

5.4.1 Archeological

<u>Ayago Site 1 (AS 1)</u>
Around 2km from Victoria Nile on the Southern Bank (located at coordinates 0379462mE 0256363mN), is a wide archaeological site with large scatters of pottery, lithics and iron slag (Plate 11). The site covers a very wide area on the hilly plain which has become grazing filed for the animals.

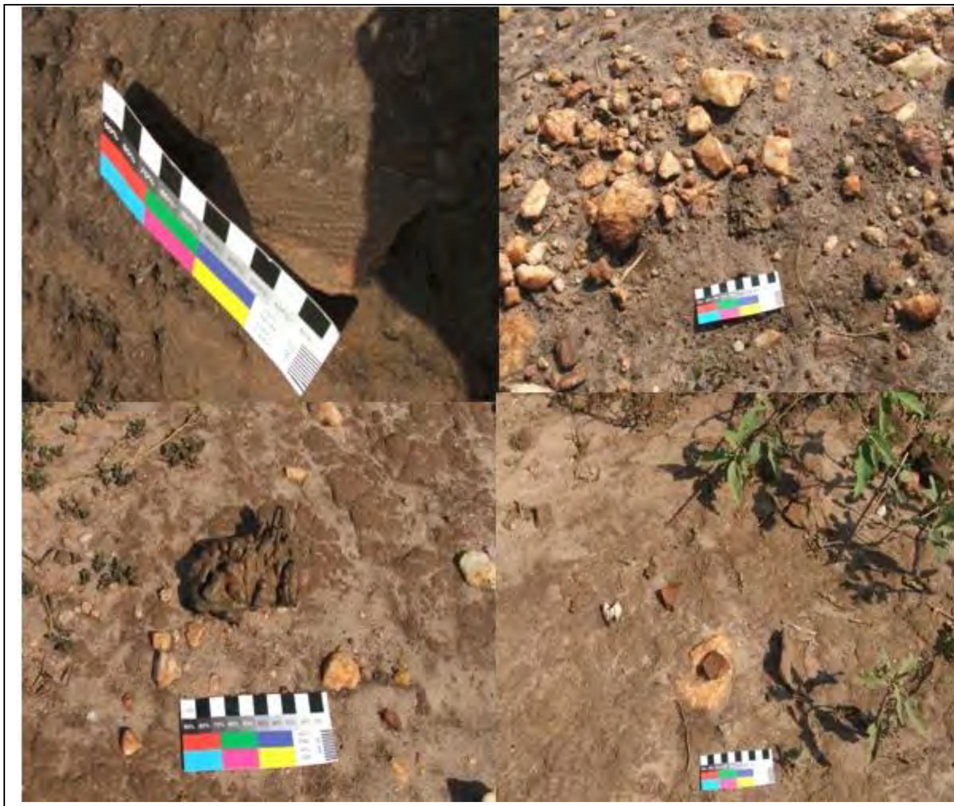

Plate 11: Cultural Materials scattered at AS 1

<u>Ayago Site 2 (AS 2)</u>
This is located on the Southern Bank of Victoria Nile (Coordinates 0378602mE 0257687mN), about 1km from AS 1. It is characterized by grassland that has attracted grazing animals. Here there are scatters of cultural materials all over. What seem unique here are somewhat intentional stone piles that could have been used for some activities by the past settlers (Plate 12). It is however not very clear what they were used for as it awaits further study.

Plate 12: Probable Intentional Stone Piles at AS 2

Ayago Site 3 (AS 3)
This is located on the Northern Bank very closed to the access road to the river side. The area has scatters of cultural materials along the road cuts especially burnt daubs and lithic materials (Plate 13). It is situated on 36 N 0382481 UTM 0260598 Elevation 900m.

Plate 13: Burnt Daubs and Lithic Material at AS 3

<u>Ayago Site 4 (AS 4)</u>
It was discovered on the clear ground of the Southern Bank around 1.6 km to the nearest water point. The site has scatters of pottery and lithics (Plate 14). The pottery are majorly roulette but of different types. It is located 36 N 0376004 UTM 0259365 Elevation 875m.

Plate 14: Pottery Appearing in Association with Lithics at AS 4

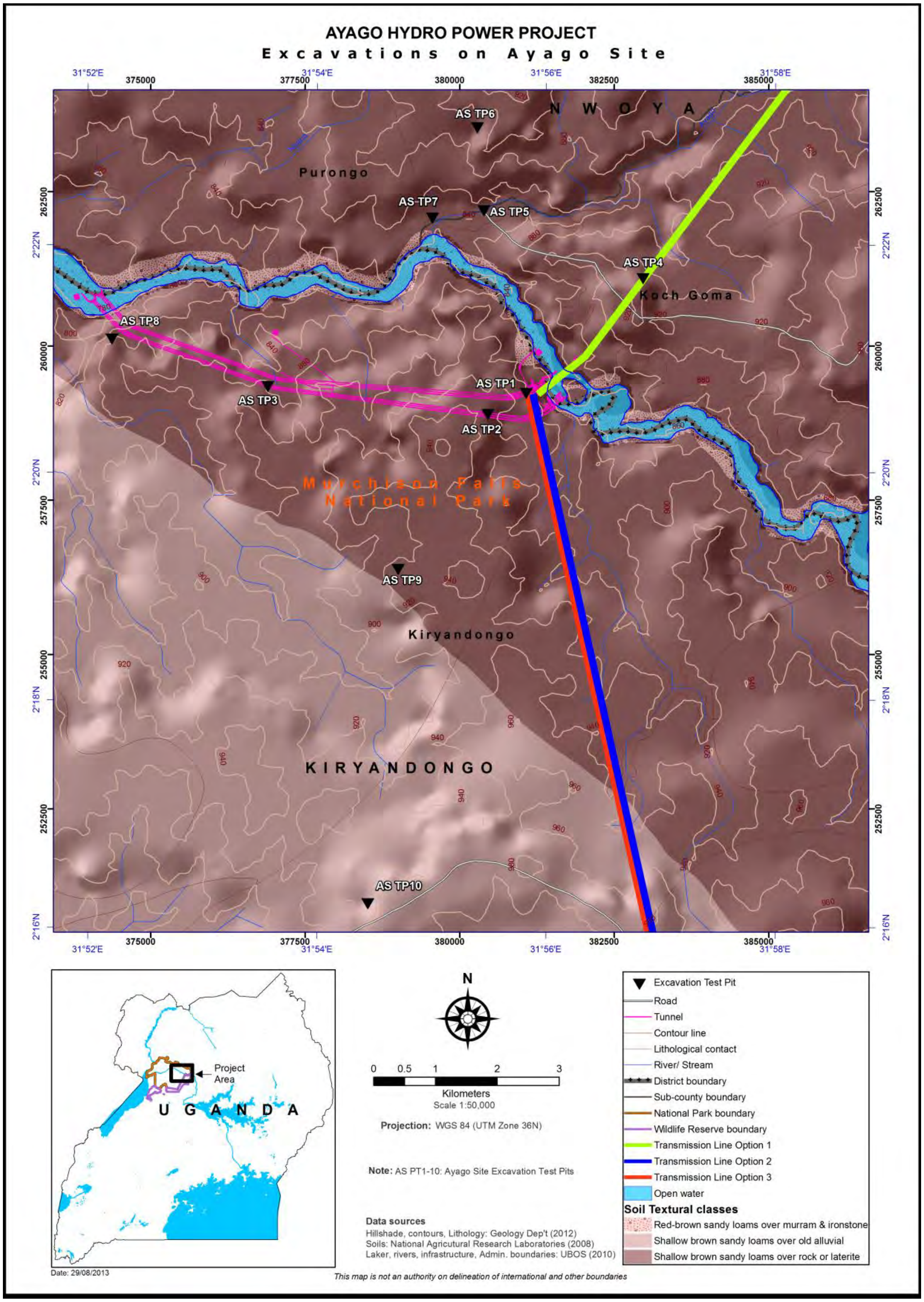

Figure 58: Excavations on Ayago Site

Results of Excavation on Ayago Site

Ayago Site Test Pit 1 (AS TP 1)

Based on the archaeological evidence that was observed on the surface during the survey, there was need to check what lies under the surface. In this cause, a 1x1 test pit excavation was established at 36 N 0381051 UTM 0259282 Elevation 890m (Plate 15). The excavation went arbitrarily in a spit of 10cm. It was observed that there was no artifacts on the top surface because of the bushy nature of the site but at level 1 (0-10cm), there was somewhat reddish soil particles appearing without any cultural materials. Level 2 (10-20cm) had a lot of pottery appearing in association with lithics, while level 3 (20-30cm) had a lot of pottery with unique decorations and at level 4 (30-40cm), a reconstructable pottery pieces were collected (Plate 16). The excavation was purposely stopped at this level because the intended purpose had already been achieved. In all, the test produced microlithic materials, pottery and burnt daubs as summarized below.

Plate 15: Excavation in Progress at Ayago Site Test Pit 1

Plate 16: Unique Pottery Recovered from Test Pit 1

<u>Ayago Site Test Pit 2 (AS TP 2)</u>

This was established at the Ayago local consultants' Camp on the Southern Bank of Victoria Nile Bank around 2km south of the station point on 36 N 0380435 UTM 0258936 Elevation 901m. The test produced microlithic materials with one probable potsherd that was not easily recognizable (Plate 17). In total, 20 microlithic materials were recovered.

Plate 17: Lithics and Probable Pottery Recovery from Test Pit 2

<u>Ayago Site Test Pit 3 (AS TP 3)</u>
This was also established on the Southern Bank located 36 N 0376875 UTM 0259391 Elevation 867m. The test indicated the presence of cultural materials as 4 pottery and 7 microlithic materials were recovered (Plate 18). The potsherds recovered from here were undecorated and this makes it difficult to tell or relatively date them. The lithic materials however are microlithic in nature indicating a Later Stone Age (LSA) industrial complex.

Plate 18: Lithics and Pottery Recovered from Ayago Site Test Pit 3

<u>Ayago Site Test Pit 4 (AS TP4)</u>
This was established on the Northern Bank it was located 36 N 0382947 UTM 0261138 Elevation 823m. There was presence of cultural materials in this side as indicated by 7 potteries, all undecorated, 6 lithic materials and 1 burnt daub (Plate 19). This confirms past human settlements.

Plate 19: Cultural Materials from Test Pit 4

<u>Ayago Site Test Pit 5 (AS TP 5)</u>

This was established on the Northern Bank. It was located 36 N0380372 UTM 0262239 Elevation 864m. It was a 1x1m test pit that was meant to test the presence/absence of cultural materials at the site. The soil in this area was so compact and the result showed that it was not productive since no any cultural material was recovered from the site.

<u>Ayago Site Test Pit 6 (AS TP 6)</u>

This was also established on the Northern Bank about 2km from the nearest water point of the river. It was located 36 N 0380267 UTM 0263586 Elevation 908m (Plate 20). It was also not productive as it indicated no presence of any cultural materials.

Plate 20: Excavation in Progress at Ayago Site Test Pit 6

Ayago Site Test Pit 7 (AS TP 7)
This was excavated much closed to the river on the Northern Bank. The site is located 36 N 0379536 UTM 0262123 Elevation 863m. But just like test 6, it was also produced no cultural materials at all.

Ayago Site Test Pit 8 (AS TP 8)
This was established on the south western side of the Southern Bank around 2km form the nearest water point. It is located 36 N 0374352 UTM 0260162 Elevation 860m. However the test also proved unproductive without any significant cultural materials.

Ayago Site Test Pit 9 (AS TP 9)
It was established on the Southern Bank on the southern part of the river located 36 N 0378981 UTM 0256427 Elevation 932m. Here 11 undecorated pottery pieces were recovered on the top surface and continuing up to level 1 (0-10cm) but after this, no any cultural material was recovered (Plate 21).

Plate 21: Excavation in Progress at Ayago Site Test Pit 9

<u>Ayago Site Test Pit 10 (AS TP 10)</u>
This was established on the Southern Bank closed to the Nanda-Paraa Road (about 50m away from the road) on 36 N 0378493 UTM 0251009 Elevation 972m. The pit had no significant cultural materials on the surface level as well as level 1. Level 2 (10-20cm) was productive with 6 decorated pottery, 10 undecorated pottery and 1 microlithic material (Plate 22). Level 3 (20-30cm) had 9 decorated pottery, 13 undecorated pottery, 4 burnt daubs and 1 microlithic material and Level 4 (30-40cm) had 5 decorated pottery, 15 undecorated pottery and 6 microlithic materials. What was so impressing here is that the test produced very unique pottery decorations that were not common in other parts of the survey area.

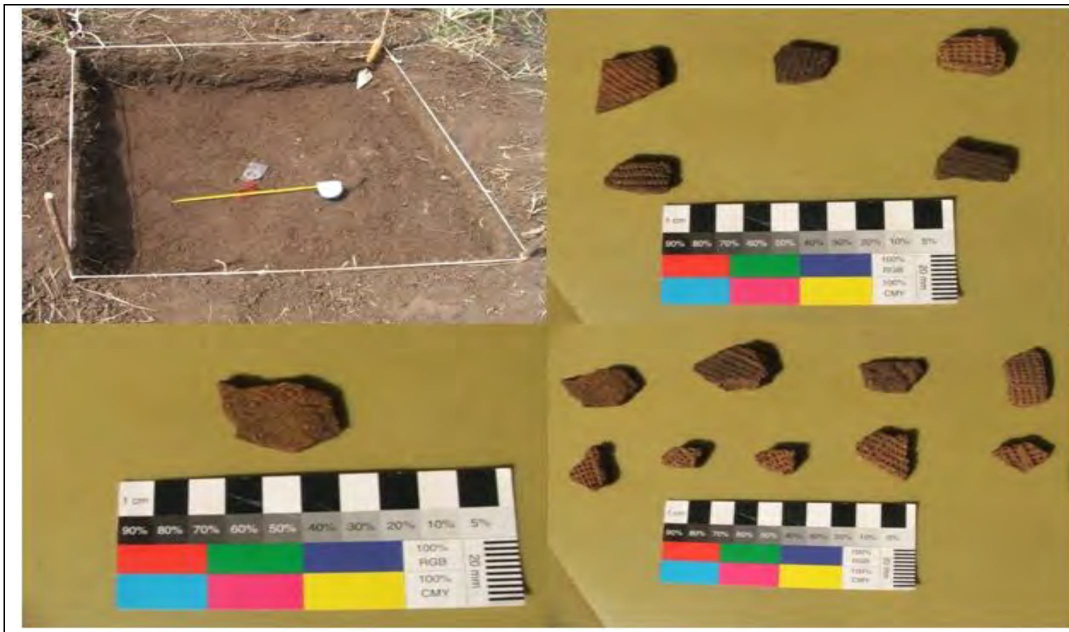

Plate 22: Ayago Site Test Pit 10

Table 89: Inventory of Materials from Excavations on Ayago Site

Site	GPS Location	Pottery		Burnt Daubs	Lithics
		Decorated	Undecorated		
ASTP1	36 N 0381051 UTM 0259282 Elevation 890m.	17	91	27	13
ASTP2	36 N 0380435 UTM 0258936 Elevation 901m.	-	01	-	20
ASTP3	36 N 0376875 UTM 0259391 Elevation 867m.	-	04	-	07
ASTP4	36 N 0382947 UTM 0261138 Elevation 823m.		07	01	06
ASTP5	36 N0380372 UTM 0262239 Elevation 864m.	-	-	-	-
ASTP6	36 N 0380267 UTM 0263586 Elevation 908m.	-	-	-	-
ASTP7	36 N 0379536 UTM 0262123 Elevation 863m.	-	-	-	-
ASTP8	36 N 0374352 UTM 0260162 Elevation 860m.	-	-	-	-
ASTP9	36 N 0378981 UTM 0256427 Elevation 932m.	-	11	-	-
ASTP10	36 N 0378493 UTM 0251009 Elevation 972m.	20	38	4	8
TOTAL		**37**	**152**	**32**	**54**

5.5 Social Environment

The project area for the hydropower plant lies only in Kiryandongo and Nwoya districts. Figure 60 is a map of the survey area showing the boundaries of the districts and sub-counties.

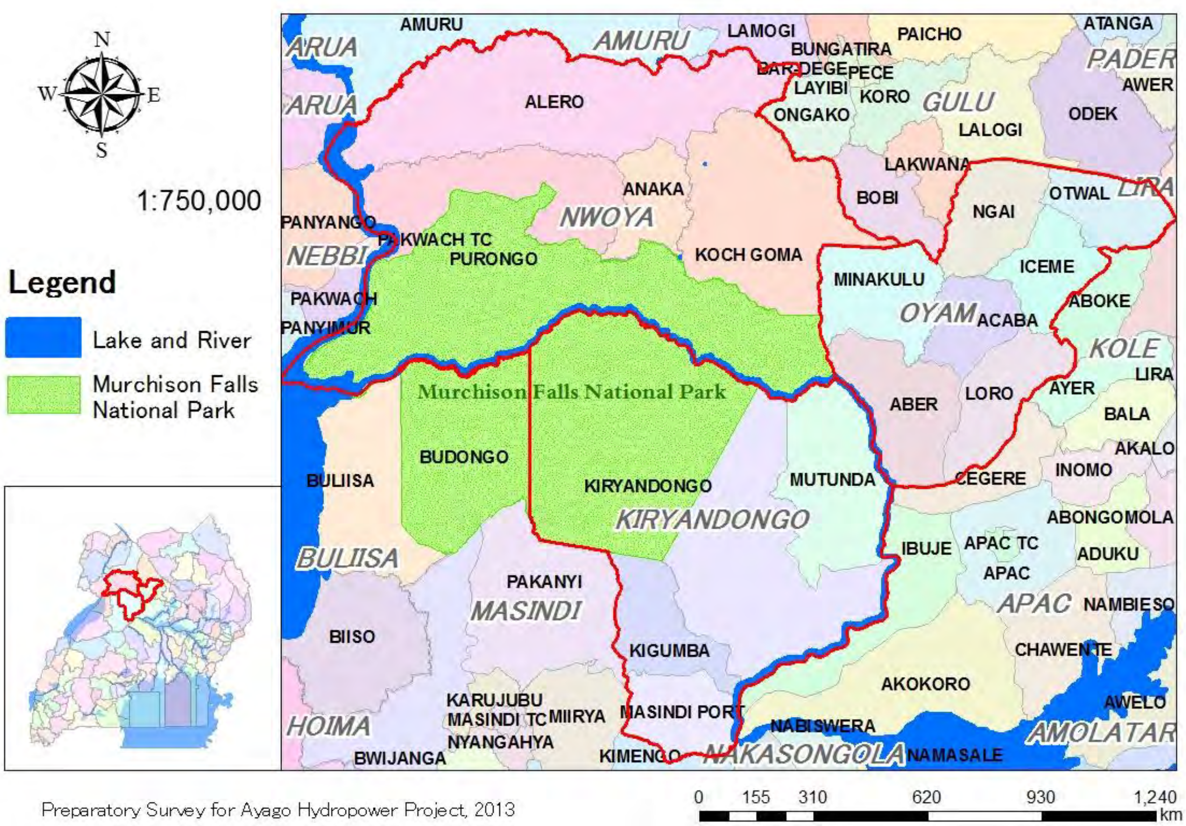

Figure 59. Administrative boundary map around the survey area

The specific sites consist of five sub-counties sharing borders with the national game park and therefore potentially likely to be affected by the development of the Ayago hydro power project process activities, actual construction and subsequent infrastructural and other developments.

The sub-counties are Purongo, Koch Goma and Anaka in Nwoya district and Mutunda in Kiryandongo district. According to the data from Uganda Bureau of Statistics, the population in 2012 is 228400, in which male is 112100, female is 116300.

In 2012, Uganda GDP is US$18.4 billion, the average GDP is US$540/per person, which is one of most undeveloped countries announced by UN. Uganda is an agricultural country with agriculture as leading industry, industry is undeveloped, and service industry develops quickly. The agricultural acreage in Uganda is 5 million ha, food is more than self - sufficient, food corps and cash corps has a great variety and fishery resources are also very abundant. Commodities such as coffee, tea, cotton, follow and fish are exported to EU and U.S.A, foreign trade of agricultural products plays an important role in the national economy. The industry in Uganda is undeveloped with a few enterprises, small scale, bad equipment and low usage efficiency.

Service industry, especially tourism is developed, according to the investigation, total tourists of Murchison Falls National Park in 2011 is 60273 persons, JuneSeptember and December-January is the peak season for tourism.

The main educational services in the project area are mostly primary and a few secondary and vocational schools, most of which are government-run. In 2011, the male literacy rate in north of Uganda is 77%, female is 52%, average is 64%.

The project area is lack of basic facilities with few medical institutions and lagging sanitary conditions, the main diseases are helopyra, parasitic infection, and disease of respiratory system, diarrhea and venereal disease.

The total acquisition area of pivot project is 471.62 hm^2, the type of occupied land is mainly grassland, bush forest land and woodland, in which permanent occupied land is 44.94 hm2, and temporary occupied land is 426.68 hm^2.

The cultural relics in the survey area are located in the two project Districts, Kiryandongo and Nwoya Districts. Here 173 burials, 1 traditional healer's shrine and 2 traditional cultural shrines were recorded in Kiryandongo District. The Nwoya District is located at the north bank of the project area .Here 11 pottery sites, 2 lithic sites, and 1 burial site were discovered.

Land Use and Land Ownership

Figure 61 shows the main land use patterns within the survey area.

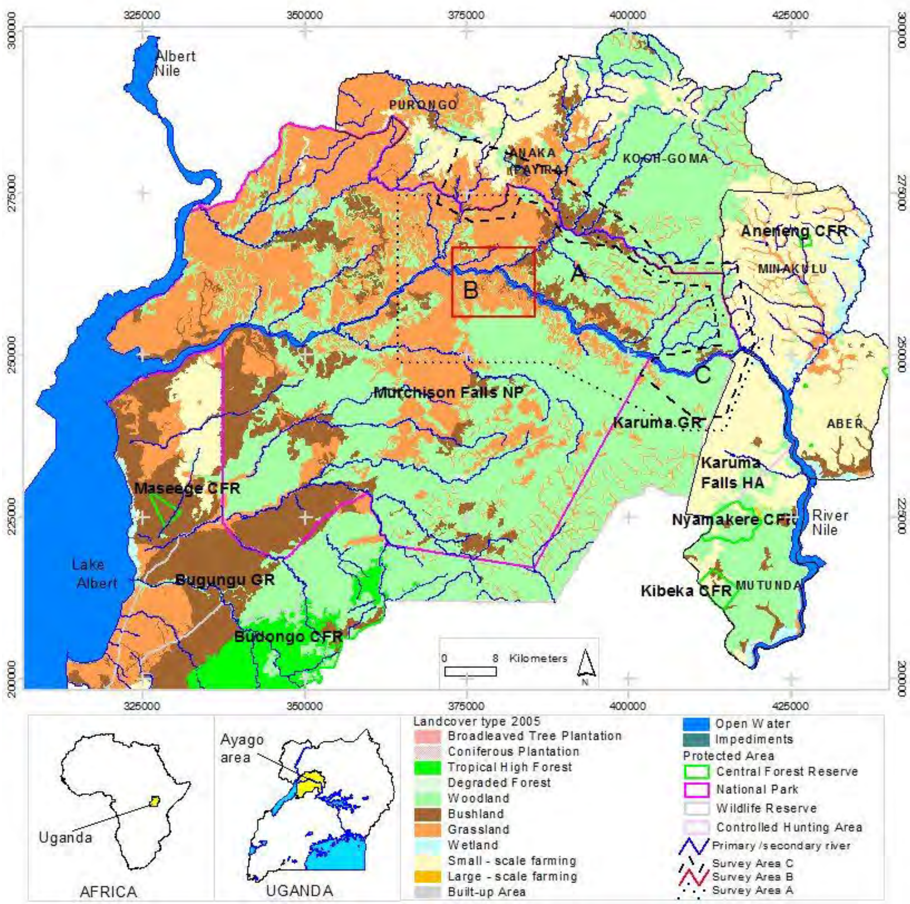

Figure 60. Map showing the land use patterns in the survey areas and environs

Much of the land here is government land mainly occupied by the Murchison Falls National Park. In pockets of community settlement, agriculture is the dominant form of land use. Land acquisition according to the district and sub-county development plans for the years including 2012, the majority acquire land through inheritance and a few others through purchase. Under customary tenure all members of village communities communally own land. All members of the community have usufruct rights that can be passed to the next generation through inheritance.

Land is one of the key resources of the people and the general community for it is the basis of their survival considering the major economic activities undertaken. The Acholi and Langi ethnic groups are originally cattle keepers and hunters but have gradually adopted agriculture as civil strife and Karimajong rustlers decreased their livestock herds. The land is commonly owned under customary land tenure where the authority to grant land rights is vested in the clan elders or chiefs. The right holds as long as the grantee actually uses the land. Customary tenure actually means that the right to use land is regulated by local customs and linked to family inheritance and lineage. In the northern region in general, the system features as communal holdings and also as specific holdings as long as a particular (and recognised) group of individuals use the land. The clan heads have powers regarding access and use rights by the clan members. This means that communally owned land cannot be disposed off/transacted unless there is the general consent of the stakeholders represented by the clan heads. However, since the emergence of a cash economy, it is possible for individuals to acquire land and secure certificates of titles.

Population

Table 91 summarises the population of the survey area based on the projections made in 2010 by Uganda Bureau of Statistics (UBOS). Because of the war and the associated displacements, the people within the surveyed area have not lived a sedentary life. As such there have been lots of population movements due to insecurity until just recently. The population figures presented are projections for 2010 which were informed by the last housing and population census of 2002[19].

Table 90: Population estimates of the survey area by sex (2010 projections)

No	Sub-county	Male	Female	Total
01	Anaka	7,600	8,100	**15,700**
02	Purongo	4,100	4,200	**8,300**
03	Koch Goma	5,500	5,100	**10,600**
04	Mutunda	35,200	36,900	**72,100**

Source: UBOS Sub National Projections report northern Uganda 2008-2012

Etnic Groups

According to the baseline survey report of 1994 on the communities around the Murchison Falls National Park and Karuma and Bugungu game reserves, the communities living in the area surveyed are from two major ethnic groups-the Luo and Bantu. The Luo dominate the north and south west while the south east is mainly occupied by the Bantu. Luo People migrated from North Africa along the Nile via Bar-el Ghazel in Sudan and reached Uganda by the 16th century. They first settled in the present park area on the southern bank of the river. Later they dispersed and a major group crossed the Nile to Acholi land while one of the three other groups continued to Bunyoro land to form the Babito dynasty. Another group crossed the Nile to form the Alur tribe in Nebbi district.

The Bantu migrated to Uganda in the 14th century from Zaire's equatorial forest. They dispersed into West, Central and Southern Uganda. They had a central system of government with the king as the head. The Bantu speakers around the park include the Bagungu at the shore of Lake Albert in Bulisa district where they have mixed with Alur immigrants from Zaire and Nebbi. Pakanyi and Kiggumba sub counties are dominated by Banyoro tribes. Bagungu are mainly fishermen and cattle keepers while the rest of Masindi district are both agriculturalists and cattle keepers.

The majority of the settlement areas within the survey area are occupied by mainly Luo speaking tribes. Some Alur immigrants also live scattered in the south-east- Kiryandongo district. In Purongo, Anaka, and Koch Goma, are mainly Acholi settlers while in Kamdini and Aber sub counties are Langi in Oyam district and in Mutunda of Kiryandongo are mainly the Chope/Paluo tribe and some Banyoro and Bahiima (the latter comprising the cattle keeping tribe here.

[19] The document containing the population projections however does not provide a break down of the population age group where we would have for example the under five years, the adolescents, adults/middle age and elderly or ageing population. Nevertheless the information obtained is vital for estimating the potential beneficiaries of the prospective hydro power.

Internally Dispalced Persons

For over 23 years, the Lord's Resistance Army (LRA) and the Government of Uganda (GoU) were engaged in a war that affected nearly two million civilians. The insurgency was historically confined to the region known as Acholiland (present day Amuru, Nwoya, Oyam, Gulu, Lamwo, Kitgum, Agago and Pader Districts) consisting of the then Districts of Kitgum, Gulu, and Pader, though since 2002 violence also spilled over into other Ugandan districts.

The prolonged consequences of this war have undermined the culture and social fabric particularly of the Acholi society causing a crop of Internally Displaced persons who until 2007, were found in several camps dotting the Acholi and Langi sub region. However, the issue of IDPs is no longer significant as most displaced persons have since returned to claim their palces of origin

One legacy of war and displacement however, is the creation of a sharp divide between the young and old amongst the Acholi people. This results partly from generations that were born in IDP camps and are accustomed only to life in camp environments. These youths have become dependent upon camps for survival. Evidence of this is still found in Purongo, where there was an IDP camp and to a lesser extent, Karuma that now retains young people (between 17 to 35 years of age) who survive on trade and other services[20]

Local Economy

The population in the survey area derives their livelihood from agricultural activities. The crops grown for income and food include; ground nuts sim sim, millet, sorghum, sweet potatoes, peas, sunflower, beans, maize and cassava. These major food crops now constitute what we call the non-traditional cash crops. Being largely peasant farmers they consume domestically what they produce and sell the surplus for money. Other activities include petty businesses such as operating small kiosk grocery shops in the village and trading centres, charcoal burning and selling, and road side sale of farm produce.

Animal rearing is also a key economic activity although small numbers of cattle goats, pigs, sheep, pigs, duck and turkey are kept. It was reported that the war that raged on for 20 years in the areas made large scale animal rearing difficult since most of the population during the war time were in the internally displaced peoples' camp. It is worth noting that the small scale-nature of the activities does not permit for substantial sales of the products hence the income derived is low. Consequently the population in the survey sub counties and the northern region as such economically perform worse than the rest of the regions of the country. (UBOS 2008: Spatial trends of poverty and inequality in Uganda).

Education

Figure 62 indicates the distribution and location of education institutions in the survey area.

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20 http://www.c-r.org/our-work/accord/northern-uganda/causes-dynamics.php Dr Otunnu -Assistant Professor of African History Refugee Studies and Contemporary Global Issues at DePaul University (Chicago).

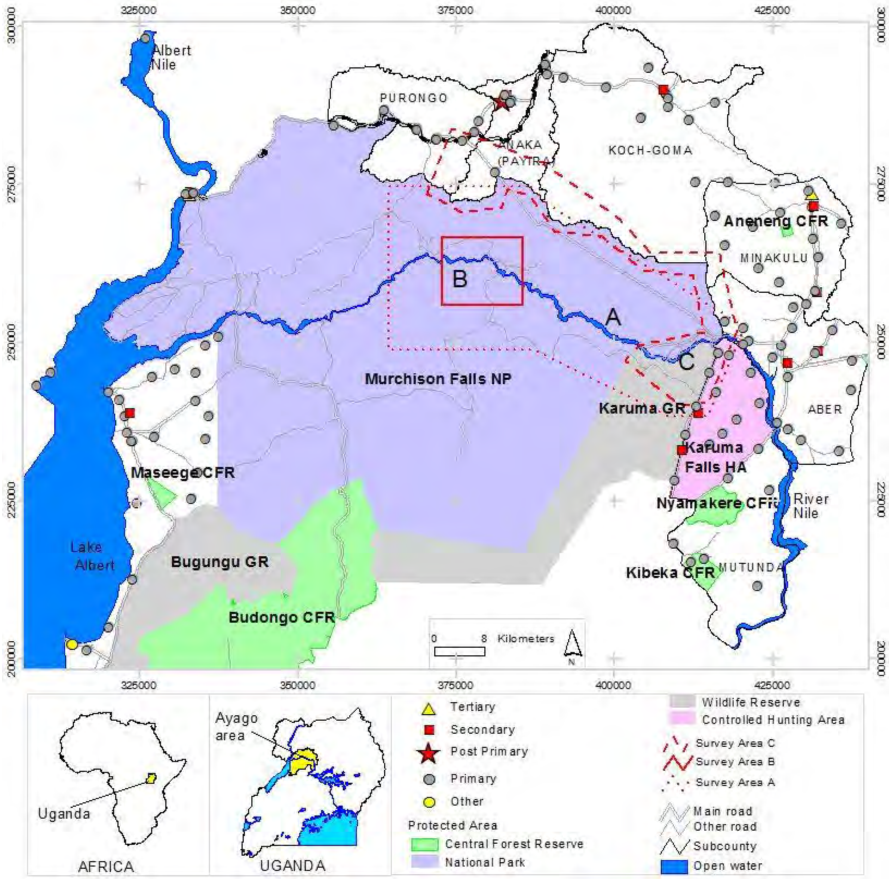


Figure 61. Map showing locations of educational institutions in the survey area[21]

From literature reviewed, there is a fair distribution of the educational institutions in each of the sub counties surveyed (Sub county and district development plans for 2010/2011). The interviews conducted with the local leaders further corroborated the fact. The institutions in question are mostly primary and a few secondary and vocational schools most of which are government run. The need for building more schools in some areas still underserved was expressed in the number of meetings held during field data collection. Even though no quantitative information was provided on schools academic performance our interview respondents felt the academic standards were poor since most schools do not achieve grade one marks during national examinations. The poor examinations results was attributed to lack of parental involvement in their children education, unqualified teaching staff, lack of electric power to enable night reading and teaching science subjects.

[21] The term "post primary" institution as applied here is used interchangeably with "tertiary" institution to mean education institutions that after primary school, a pupil can qualify to join other than secondary education such as vocational courses.

Health Services

The map in Figure 63 indicates the location of health facilities in the survey area.

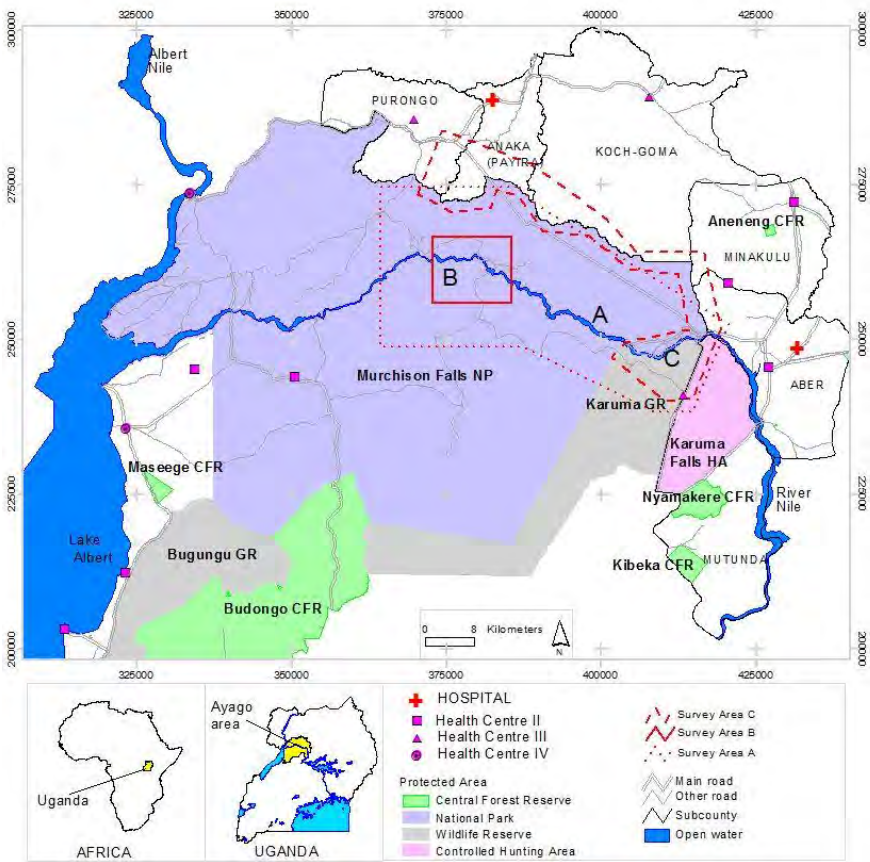


Figure 62. Map showing location of health facilities in the survey area[22]

The public health facilities are mostly grade 111 and 11 except in Anaka that have hospitals. The health centres including hospitals in the survey area are not only few but also fall short of the expected service standards. The most frequently raised complaint raised against the health facilities is inadequate drugs and supplies, unqualified health workers and long waiting period before getting the services. The long waiting time at the health centre also means that there are limited health facilities within the survey area. As a result some people obtain health care services from private for profit health outlets such as clinics and drug shops.

HIV/AIDS situation

The map in Figure 64 shows the HIV prevalence by region based on the Uganda AIDS indicator Survey 2011.

[22] See Appendix 4 for details.

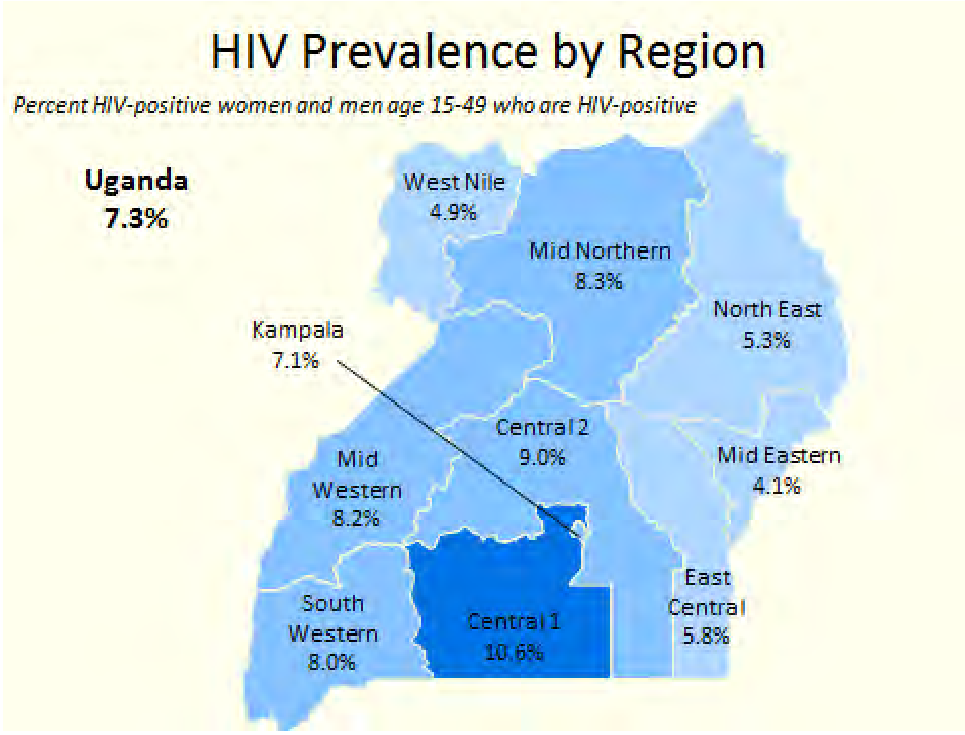


Figure 63. HIV/AIDS Prevalence by Region

Source: Uganda AIDS Indicator Survey 2011

Going by the results of the last (2011) Uganda HIV/AIDS indicator survey, there is high HIV/AIDS prevalence in the region where the project falls. Indeed survey results for the project region (Mid North) indicate high prevalence rates among women compared to men of the same age range (10.1% of women between the ages of 15 – 49 years HIV positive compared to men in the same age group 6.3%). This means women are more vulnerable than men. Overall the HIV prevalence in mid North stood at 8.3% which was higher than the 7.3% national average prevalence and then several regions (see map excerpted from the survey report).

According to the survey report under review this high prevalence of HIV/AIDS is attributed to high level of unemployment among the youth. This has negatively affected social life of the adjacent communities. Most youth in these areas are idle and due to this life style, they get involved in illegal activities like taking marijuana and other drugs, and going for discos. Such actions have accelerated the spread of AIDS in the area and this has a disastrous impact on labour force. Youth idleness and HIV/AIDS link can also be traced back to the insurgency years when families were herded in camps as internally displaced persons (IDPs).

Water Use

The map in Figure 65 shows the water points by technology in the survey area.

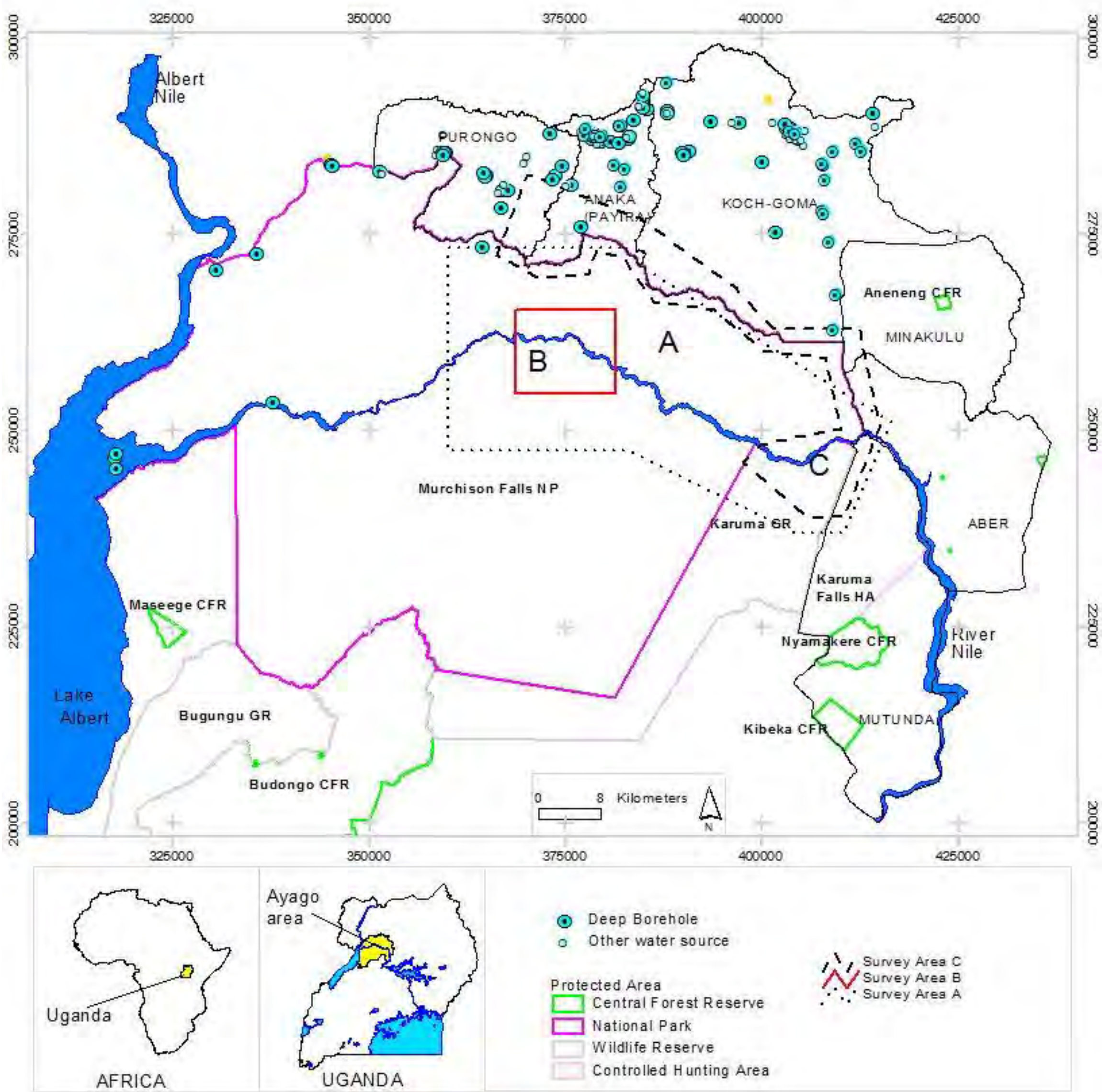


Figure 64. Map showing the water points by technology in the survey area

The major source of water in the survey area includes rivers, boreholes, shallow wells, rainwater, streams but these differ from sub-county to sub-county and parish to parish.

5.6 Tourism in MFNP

Number of Tourists

The MFNP is Uganda's leading tourist park providing various attractions to tourists. Tourism in the MFNP is on the increase with a total of 60,803 tourists visiting the park in 2012, with the peak tourism seasons occurring from June to September and from December to January. It should be noted that the majority of tourism activities are accessed through the Project area.

Table 91: Visitors to National Parks (citizens and foreigners) over the years

	2006	2007	2008	2009	2010	2011	2012
Murchison Falls N.P	26256	32049	36752	39237	53460	56799	60803
Queen Elizabeth N.P	43885	51749	53921	62513	76037	88407	58172
Kidepo Vally N.P	959	795	1558	2924	3208	2452	2300
L.Mburo N.P	12508	14264	16539	17521	20966	20864	22927
Rwenzori Mts N.p	948	1583	2020	1281	1529	1798	1565
Bwindi impenetrable N.P	10176	9585	10128	11806	15108	16997	18259
Mgahinga N.p	2071	2676	3244	1886	3328	6661	2497
Semiliki N.P	2584	1940	2701	2701	3393	3152	3591
Kibale N.P & Katonga	7741	8440	7733	8247	9482	7530	10372
Mt. Elgon N.P	2964	3472	3708	2943	2660	2334	1565

Source: *Wild Life Link, Uganda Wildlife Authority 2012*

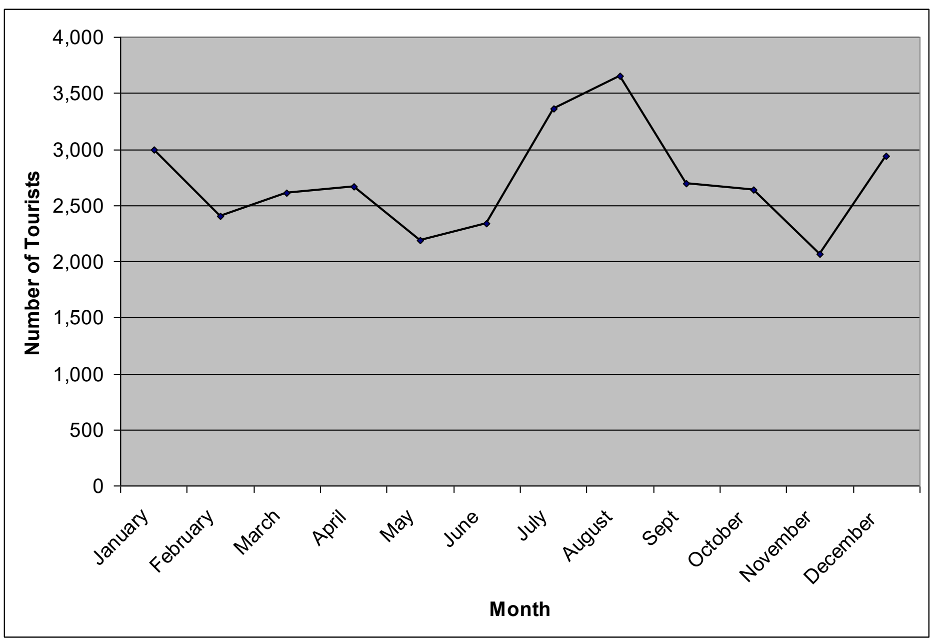


Figure 65. Average Tourism Seasonality within the MFNP (1996 - 2010)

Source: *Uganda Wildlife Authority 2010*

Tourist Attractions

It should be noted that the majority of tourism activities are accessed through the Project area. The MFNP provides various attractions to tourists, the major one being the river launch trip up the Victoria Nile River to Murchison Falls from Paraa. Other tourist attractions include: game viewing, sport fishing, bird viewing, and walking safaris. A general consensus across all lodges and tourism operators was that the key tourist movement areas in the MFNP are as follows:

- Game drives along the north western bank of the Nile River, towards the Delta (along the Albert, Buligi, Queens and Victoria tracks); and
- Boat trips across the stretch of Nile River from Murchison Falls to the Delta.

The larger tourist lodges like Paraa Safari Lodge employ over 100 staff, while the smaller lodges like Red Chill employ just over 20 staff. Non-locals are usually only employed to carryout jobs that require a semi-skilled to skilled (chefs, managers, receptionists etc.) labour force. As such, the tourism industry is a relatively large provider of jobs in the immediate area.

A large number of staff are accommodated in staff accommodation onsite, while a few commute daily from the more nearer communities. A review of the draft General Management Plan (2012) prepared by UWA reveals a range of actual and potential tourist attractions that if well harnessed stand to increase the park revenues in the coming years. They are outlined and described in this section.

a) Murchison Falls

This is characterized by external force between water and rocks. It is an important scenic feature. The falls are one of the most spectacular features (Plate 23). The Victoria Niles' rapids and cataracts are among the longest stretches of white water in the world.

Plate 23. Tourist Attractions in MFNP - Murchison Falls

b) River Nile

This is a beautiful area for boat riding along the Nile to the foot of Murchison Falls (Plate 24). Here mammals, birds and reptiles can be viewed. The stretch from the falls to the delta is a fish breeding area on which communities downstream around Lake Albert depend.


Plate 24. Tourist Attractions in MFNP – River Nile

c) Nile Delta

This calm stretch of water where the Victoria Nile flows into L. Albert is a key area for birds. Its papyrus–lined banks are boosting with bird life including goliath herons, great egret & Africa fish eagles and shoebill a rare species (Plate 25). It is a Ramsar site and is a breeding area for fish.


Plate 25. Tourist Attractions in MFNP – Nile Delta

d) Buligi game tracks

The Buligi game tracks stretching between Victoria and Albert Niles and are the most popular tourist sites and Safari destinations. Because it is a long stretch of grassland, woodland and acacia vegetation, most of the park's game can be viewed from hence during the day and evenings hence an attractive area for tourists (Plate 26).


Plate 26. Tourist Attractions in MFNP – Buligi game tracks

e) Paara

Paara in Luo language means a home of many hippos. It is the park's tourist's hub (Plate 27). All parks access roads converge here as the northern & southern banks are linked by a passenger ferry and several accommodations are located nearby. Additionally, there is a museum and a gift shop. Most game drives, launch trips and venture walks commence here.


Plate 27. Tourist Attractions in MFNP – Paara

f) Karuma Falls

Karuma falls are located in Chobe in North East sector of the park. It is an ideal place for sport fishing. The roaring waterfalls of the Victoria Nile are made of a series of natural rock formations which cause waters to ripple and give a white foamy appearance.

g) The rich cultural and historical sites

The rich cultural and historical sites which are located within the protected area and outside the protected area are important for tourism, cultural and spiritual purposes. These include; Pearson, Bugungu port, Old Stone Age sites in Chobe and Pakuba hill in Jonam.

h) Kaniyo Papidi Forest

In the South of Murchison falls conservation area Kaniyo Pabidi contains black and white colobus and blue monkeys, olive baboons and chimp group which can be tracked. The place has Elephant, buffaloes, lions and leopards. It also has chocolate backed king fisher and other many forest birds which are found nowhere in East Afica. Kaniyo Pabidi has a campsite, cottages for accommodation, forest walks and bird watching. All these facilitate tourism in the area.

i) Rabongo Forest

This area covers an area of $4km^2$. This area is considered to be a paradise of birds because it has endangered species and it is ideal for educational tours.

Tourist Facilities and Investments

The park has a number of facilities for tourists and these include Paraa Safari Lodge which has a capacity of 112 beds, Sambiya river Lodge[23] with 54 beds (Plate 28), Red Chill has 52 beds and one camp site, Chobe a newly refurbished is a five star hotel with 200 beds and Pakuba Lodge which has been concessioned out to the private developer- the Acacia Safaris.

Plate 28. Tourist Facilities in MFNP – Chobe Safari Lodge and Sambiya Lodge

There are a number of tourism lodges and tour operators in the Project area, which are situated along the southern banks of the Nile River particularly within Buliisa District. These include: Murchison Falls River Lodge; Neul Lodge; Nile Safari River Lodge; Paraa Safari Lodge; Red Chilli; Sambiya Lodge; Sunrise Lodge; Wild Frontiers; and Yebo Safari.

[23] See: www.sambiyariverlodge.com

Tourism lodges in the area generally only provide overnight accommodation for their guests and do not provide tourist activities such as game viewing, fishing and boat trips. Instead, tour operators bringing guests to the various lodges will take their clients on game drives and game walks along the northern and southern embankments of the Nile River respectively. Although Paraa Safari Lodge and Wild Frontiers have a concession to carryout boat/fishing trips up and down the Nile River (from Murchison Falls through to the Delta), lodges in the area generally use Wild Frontiers for such activities. According to Wild Frontiers they host guests on boat/fishing trips and game drives every day of the year.

Current Concessions and Concessionaires

There are concessions and concessionaires established to promote tourism within the Murchison Falls National Park. These include the following:

- On accommodation, Paraa Safari Lodge by Madhavan group in 1993, Sambiya River Lodge by Afri Tours and Safaris Ltd in 1994, Chobe Safari Lodge by Madhavan group in 1996, Red Chilli Camp by Red Chilli Ltd in 2000 and Pakuba Lodge by Acacia Safaris Ltd.
- On recreation, concessions were extended to G&C boats by G&C Tours (Wild frontiers) in 2008 and Paraa Lodge boats by Madhavan in 2008.
- On collaborative Management, Kabwoya WR by L. Albert Safaris in 2005 and Luwero-Nakaseke Wildlife Association by Uganda Wildlife Safari. In 2000 MTN put up Mast and in 2009 warid also came in.

Wild Frontiers Uganda

Wild Frontiers Uganda was established in 1996 under the operational name G and C tours Ltd. In 2008, it introduced a boat safari operation in Murchison Falls National Park to cater for river trips and sport fishing. It is a full member of Uganda Tour Operators Association. Its safaris include scheduled tours with private fully inclusive tours for individuals or groups or specialist visitors.

Tourism Revenue

The list of tourism activities in MFNP and the corresponding fees are shown in Table 93 below.

Table 92: Tourism Activity Fees in Murchison Falls National Park in 2013

Activities	Age/Class	Foreign Non-Residents	Foreign Residents	East African Residents
Entrance	Adult	US$40/day	US$30/day	Ush 15,000/day
	Children (5-15 years old)	US$20/day	US$10/day	Ush 5,000/day
Game drives	Day time drive	US$20/guide	US$20/guide	Ush 20,000/guide
	Night time drives (7.00-11.00pm)	US$30/guide	US$30/guide	Ush 30,000/guide
Guided Nature Walk	Day Nature Walk	US$30/person	US$15/person	Ush 10,000/person
	Night Nature Walk	US$40/person	US$20/person	Ush 15,000/person
	Murchison Falls Experience	US$15/person	US$10/person	Ush 10,000/person
	Students guided walk	Ush 10,000/6 persons	Ush 10,000/6 persons	Ush 10,000/6 persons
Sport Fishing	Day permit	US$50/person	US$50/person	US$50/person
	Up to 4 days	US$150/person	US$150/person	US$150/person
	Annual Permit	US$200/person	US$200/person	US$200/person
Boat / Launch Trip	Adult/Children (5-15 years old)	US$30/trip	US$30/trip	Ush 30,000 (Ugandan Citizens)

Source: Uganda Wildlife Authority

Table 94 shows the tourism revenue of Murchison Falls National Park in 2009. It indicates that most revenue was collected through the entrance fees. Tourism activities such as boat ride, nature walk, game drive and fishing are not major sources of the revenue. It means that currently, many of the visitors are on self-drive and they do not pay anything except entrance fee to see all beautiful wildlife in the Park.

Table 93: Murchison Falls National Park Tourism Revenue in 2009

Tourism Activity	Annual Revenue in Ush.	%
Entrance fees (visitors)	1,649,033,319	63.7
Entrance fees (vehicles)	192,906,513	7.4
Canping fees	40,526,570	1.6
Landing fees	10,775,951	0.4
Photographic fees	29,938,677	1.2
Ranger Guide Fees	51,735,529	2.0
Ferry Crossing	301,849,052	11.7
Fishing Permits	39,960,836	1.5
Nature Walk fees	71,325,277	2.8
Lauch Hire	71,768,241	2.8
Vehicle Hire	3,941,737	0.2
Accomodation Bandas	16,452,950	0.6
Accomodation Ugandan Students	31,449,980	1.2
Boat rides	78,722,312	3.0
Total	**2,590,386,944**	**100.0**

Source: Uganda Wildlife Authority

According to the interviews with UWA official responsible for MFNP area conservation in the Financial Year 2011/2012, Murchison Falls National Park collected 6.8bn Ushs. This was attributed to aggressive marketing, the development of new tourist attractions and the new expedition led by Juliana Fisher of the Royal Geographical Society.

Planned Tourist Activities

a) Waisoka public campsite

Apart from the aforementioned activities currently in the park, a number of other activities have been planned for. It is planned that a public campsite shall be developed at Waisoka near Bugungu WR headquarters to provide overnight accommodation and picnics for visitors that come for bird watching and visiting Waisoka falls. A new track from Bullisa to Waisoka will be surveyed and developed into a camping picnic area.

b) Birding trails

Apart from the falls, there is a potential for bird watching, a bird inventory is to be developed and a trail developed along Waisoke River because the area is endowed with both savannah and west land birds.

c) Marabou stork area (Murchison grand canyons)

A trail is planned along the rim of canyon to ease scenic view of land forms and those interested in bird watching. Guided walks with armed rangers are envisaged. The anticipated developments include: forest walks around Kibaa river, bird watching, sport fishing and, development of game viewing tracks linking to tebito and falls area, white water rafting and walking safaris. It is however feared that the proposed dam construction and oil and gas exploration are likely to affect these developments like the scenic falls, rafting and sport fishing; therefore there is need for mitigation measures in place to avoid losing these benefits arising from tourism.

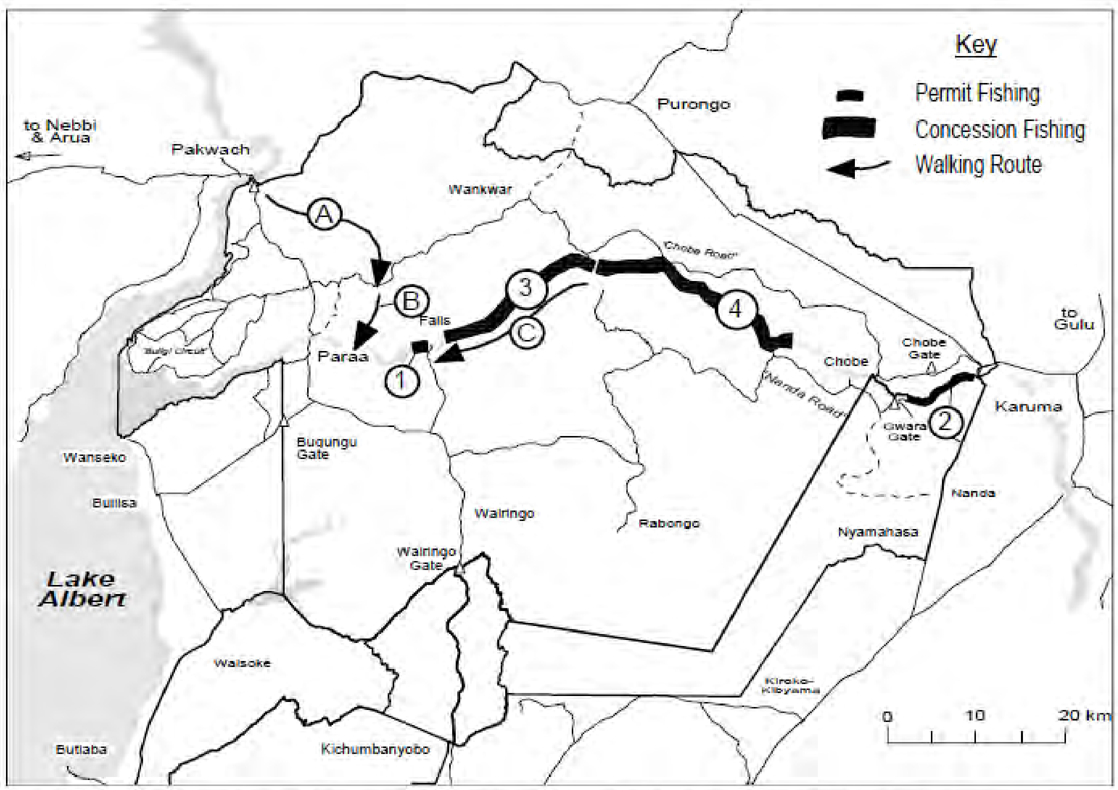
d) Hot Air balloon flights

It is intended that new aerial experiences be introduced to view wildlife and land scape by visitors. Uganda Wildlife Authority Management is planning to identify an operator and concession out this activity.

Tourism Opportunties

The proposed future development goals highlighted in the General Management Plan of MFNP include diversifying tourism opportunities by opening up new areas for tourism, access to the Murchison Falls area, walking safaris and game viewing, promoting sport fishing and low budget tourism, and improved access to the MFNP by road, boat and air.

The need for diversification of tourism opportunities (Figure 69) is also emphasized during the interview with UWA officials. The diversification strategies include opening up new areas such as "Heart of Murchison" and Chobe, so that there will be no more concentration of tourism activities in Paraa area. Walking Safaris, sport fishing, and white water rafting are described as potentials, and a proposal for long term fishing concessions are key strategies. The locations are indicated in the figure below.



1: Falls Permit Fishing Area, 2: Karuma Permit Fishing Area, 3: Kibaa Concession Fishing Area, 4: Ayago Concession Fishing Area, A: Tangi Walk, B: Nyamsika Walk, C: Nile Walk

(Source: Murchison Falls Protected Area General Management Plan for 2001-2011)

Figure 66. Diversified Tourist Activities in MFCA

1) Walking Safari

Walking safaris provide visitors with the opportunity to experience MFNP's landscapes and wildlife at close quarters. It will be conducted along the following routes: A and B: Along Tangi river to Te Bito (possible vehicle pickup), then along Nyamsika river and down to the Victoria Nile for pickup by boat. Currently, the starting point is Nyamsika Cliff about 20km North East of Paraa Safari Lodge. It takes six to eight hours to reach Victoria Nile. The distance is 12km. C: From a central drop-off point on the south bank of Victoria Nile, near 'Kisangani Falls', following the river to the Top of the Falls.

2) Sport Fishing

MFNP offers some of the finest sport fishing possibilities. According to the guidebook published by UWA in 2002, fishing sites are located along the 40km stretch of Victoria Nile between the foot of the Falls and Chobe. Fishing for Nile perch is the major attraction in theMFNP. The most exciting place to fish is the fast flowing waters above the Falls and just below the Falls. The recorded fish taken from the bank below the Falls is 108 kg. UWA has a plan to auction off two fish concessions; Kibaa and Ayago. These concessions will guarantee the winner of each exclusive fishing and camping rights within the defined 3-10 km stretch of the river. It is important to note that walking safaris will be permitted through these fishing concession areas. MFNP will also retain a number of fishing sites for use by fishermen who buy a daily fishing permit from UWA. The most prominent permit-fishing site is the foot of the Falls. Another permit-fishing site will be at Karuma, between the new Gwara Gate and Karuma Falls. Different fees will be set for each site taking into consideration quality of site and possibility of making record catches.

3) White Water Rafting

UWA considers rafting as a high-risk activity with the potential to injure or lead to death of participants, since there are many crocodiles and Hippopotamus in the river. However, UWA accepted the proposal for rafting in MFNP by a qualified and experienced company (Adrift) to conduct an exploratory expedition. Currently, the company is planning the detail activities and locations.

5.7 Relationship between MFNP and Community

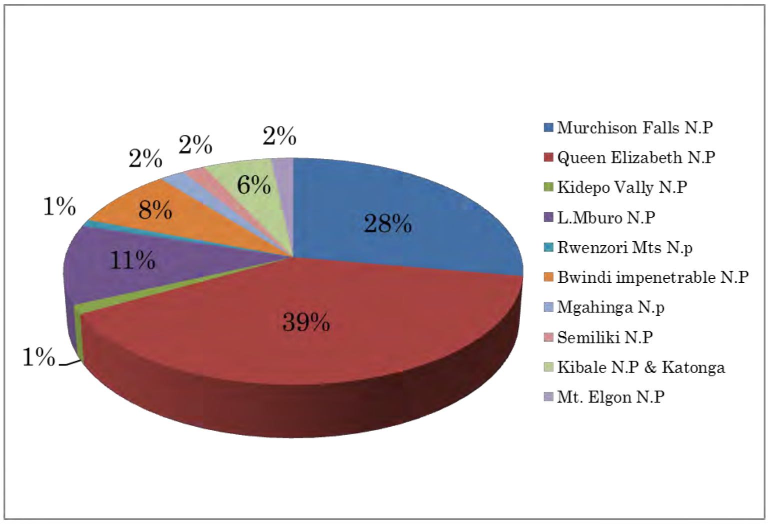
a)Revenue Sharing

In 1995, Uganda National Parks established a policy to share its revenues with the neighbouring communities to the national parks. However this took effect in 1996 with the enactment of Uganda Wildlife Act under section 70 (4) that Uganda Wildlife Authority was legally authorized to share 20% of its entry fees with local governments surrounding it. This was due to the fact that these adjacent communities endure a burden of costs associated with conservation and at the same time the gains are minimal. Therefore the reason for this revenue sharing is to allow the communities adjacent to experience economic benefits accruing from these protected areas.

The overall goal of this revenue sharing is to ensure that local communities living adjacent to Protected areas (PAs) obtain benefits from existence of these areas to improve their welfare and ultimately strengthen partnerships between UWA, local communities and local governments for sustainable management of resources in and around the PAs. Following this arrangement, in 2000 Uganda Wildlife Authority established implementation guidelines for its revenue sharing program. These guidelines defined the goals and objectives for revenue sharing, strategies for its implementation, roles and responsibilities of various parties, establishing procedures for selecting projects and the location, the approach for disbursing the funds and monitoring and evaluation mechanisms.

The guiding principles for the revenue sharing are that funds are remitted to the beneficiaries through the CPI who vet the projects for funding. This policy had loopholes and a new policy was drafted and in the new guidelines, funds are remitted to the beneficiaries through the district local government financial and planning system. Projects for revenue sharing are identified by the village planning team, forwards it to the parish planning committee and then incorporated into the sub county development plan.

Since the establishment of revenue sharing program, communities adjacent to the protected area have been able to benefit from improved infrastructure, such as schools and health units as well as income generating projects. As shown in Figure 68, the Survey team found out that Murchison Falls National Park has been popularly visited National park (accounting for 28% of all visitors to the national parks in Uganda) compared to the Queen Elizabeth National Park (39%) that stood first.



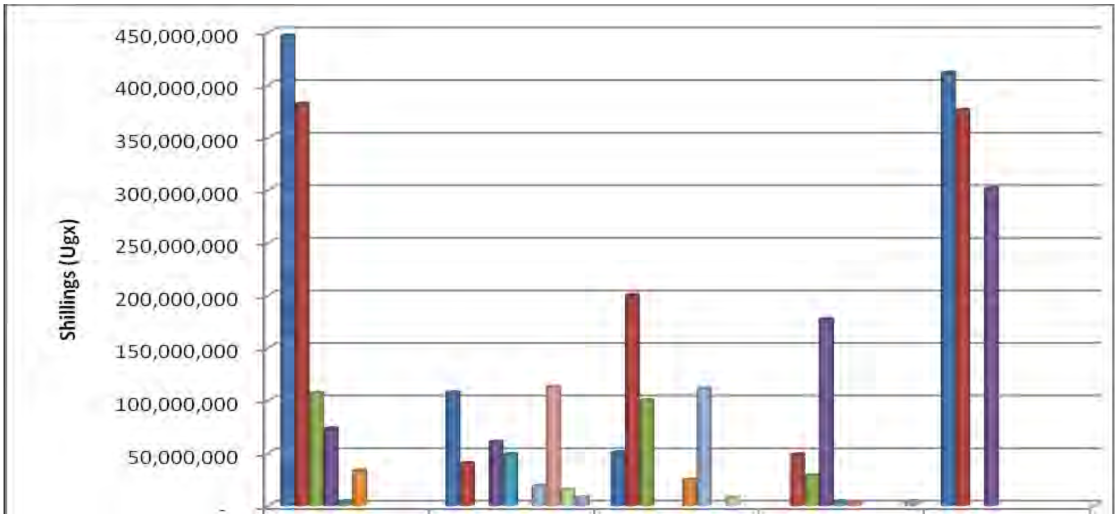
Visitors Murchison Falls	
Year	**Nr. Vistors**
2006	26,256
2007	32,049
2008	36,752
2009	39,237
2010	53,460
2011	56,799
2012	60,803
2013	70,798
2014	66,844

Figure 67. Distribution of Visitors to National Parks between 2006 - 2012

Source: *Ministry of Tourism Wild Life and Heritage 2012 Sector Statistical Abstract*

Lake Mburo occupied the third position (with 11%). The three collectively accounted for about 80% of the visitors to the National Parks. Figure 72 provides a highlight of the revenue sharing trends amongst Uganda's National parks between 2007 and 2011. The Revenue sharing trends reveal that in 2007 and 2011, Murchison Falls contributed a significant proportion of revenue sharing funds with communities.

The Fund is disbursed to the sub-county local government upon receipt of satisfactory project proposals endorsed by the councils and is geared towards meeting the needs of the communities living adjacent to the Pas. Indeed according to one of the revenue- sharing circulars dated 14th. June 2011 from UWA's finace department of MFNP to the Chief administrative Officer for Kiryandongo district local government, sixty three million was disbursed. This was to finance projects earmarked in Kiryandongo, Kigumba and Mutunda sub counties involving seven parishes of Kyanhende, Kikuube, Kichwabugingo, Mboira, Nyamahasa, Diima and Kigumba 1.



	2007	2008	2009	2010	2011
Murchison Falls	446,919,365	107,500,000	50,555,000		411,589,000
Queen Elizabeth	382,064,100	40,229,000	200,195,190	48,600,800	376,075,200
Bwindi Impenetrable	107,000,000		100,004,000	28,575,825	
Lake Mburo	73,260,695	60,634,236		177,294,500	301,531,075
Rwenzori Mountains	4,000,000	48,781,600		4,000,000	
Mount Elgon	33,270,550		24,500,000	2,500,000	
Mgahinga Gorilla		18,634,375	111,180,000		
Kibale		112,932,951			
Semliki		15,000,000	7,750,000		
Toro-Semiliki WR		7,750,000		4,000,000	

Figure 68. Distribution of revenues (in Ug. shs) shared with communities across National Parks

Source: *Ministry of Tourism Wildlife and Heritage 2012 Sector Statistical Abstract.*

Another circular dated 20th May 2012 revealing approval of Four hundred million, six hundred fifty nine thousand shillings only (400,659,000) was reviewed. This money was approved for funding various projects under the Revenue Sharing Program affecting Murchison Falls Conservation Area (MFCA). The commonest projects indicated are: goat-rearing while others are furnishing works, procurement of machinery, trench maintenance, eco-tourism camp site, piggery, maize grinding mill/Hullery, construction of teachers' houses, consolation funds for burial expenses and medical treatment of people affected by problem animals, sensitization campaigns on environment conservation by local leadership.

However, as already indicated this revenue sharing initiative has its limitations in terms of contributing and strengthening partnerships in conservation efforts. Clearly individual interests override community benefits that currently accrue to the communities/villages adjacent to the park. Above all, poaching which is a major threat to conservation efforts as we found from the community discussions is not preserve of people living adjacent to the park and therefore who benefit from the revenue- sharing funds provide by UWA. It was noted that some poachers come from villages which are not considered as adjacent to the park.

Community access to MFNP Resources

Murchison Falls Protected Area is a significant reservoir of resources which are of direct and indirect socio-economic benefit to the adjacent communities. The question that UWA has been grappling with is how the resources could be utilized in a sustainable manner to contribute to improvement in livelihood and poverty reduction. In this endeavour, the survey team found that communities are allowed regulated access to some key resources that may not be found outside protected areas. Under the guidelines agreed upon between the local community and Uganda Wildlife Authority, local communities are allowed to access resources within the protected area on a sustainable basis.

The Draft Management Plan (2012) for MFNP makes provision for firewood gathering and collection of grass in specific parts of the Murchison Falls National Park Protected area. These areas are North East of Tangi gate, areas near Tangala outpost, Waisuke in Bugungu Wildlife Reserve and the stretch along Kampala- Gulu high way near Nyamahasa in Karuma Wildlife Reserve. However, the collection of poles is not allowed. The communities are encouraged to develop alternative sources outside the protected areas so that in the long run these zones are abolished.

Resources use in this zone takes place only after an assessment has been made to determine the availability of resources within the target area to determine the amount of off-take that is sustainable and the ability of the management and the community to effectively control the resource use.

After establishing the status of resources and the ability to control, a memorandum of understanding between the community and Protection Area Management specifying how the monitoring is to be done, depending on the resources available and this becomes a basis for this access.

One of the practical strategies adopted by UWA is involving the communities in conservation of the protected areas. MFNP provides restricted access to the park for certain groups. This is done by UWA entering a Memorandum of Understanding (MoU) with each of the groups that express interest to gain access to Pas. The signed MoUs have terms and conditions of access and also number of years that access is permitted.

Allowing communities resource access is adopted as one of the practical strategies UWA is using to involve the communities in conservation of the protected areas. All MoUs according to UWA officials[24] interviewed have the cross cutting objectives, which are:

1. To allow the neighbouring community access to park resources through an arrangement that is facilitated by that resource use committee
2. To enhance community involvement and support in protected area management guided by the set regulations
3. To harmonize the relationship between the local community and the protected area management and foster better understanding of each other's role in natural resource and protected area management.

[24] The survey team was not successful in getting all MoUs from UWA.

In addition to the broad objectives for each user group, there are also specific elements of the MoUs such as conditions governing the group operations, geographical scope of groups' activities, duration of MoUs, contributions and responsibilities of UWA and also of the resource user groups and their respective committees, contributions and responsibilities of local governments, penalties and fines.

The involvement of the communities (especially those with MoUs) using this strategy is thought to promote a sense ownership of the park. Their main role is therefore to observe vigilance in its protection by among other ways creating awareness to the young and old about the importance of conservation and also where possible making reports to UWA the elements in society that are threatening conservation. Some of the prominent groups identified by UWA for support in conservation efforts include the Fishing group, Firewood gatherers, Bee Keepers and X-poachers. Some of these groups already have MoUs while others have not. It is interesting to note that these groups although they already benefit from the MoUs and park access opportunities, they feel they deserve more from the park and without exception, they all expect UWA to allow them under some arrangement to access more park resources and most of all game meat.

One illustrative example of the groups with a MoU with UWA is the Karuma United Fishing Group whose summary profile we provide here under. Karuma United Fishing Group is a four year old registered group with 230 members most of whom hail from Mutunda Sub-county and others are from across the river i.e. Nora in Oyam district. The Group has an MOU with UWA which is initially for three years subject to renewal.

It has an executive board of 14 members and advisory board of 5. It was formed to engage in a range of income generating activities for the benefit of individual members and the group. The formation was also based on the realization that their dependence on the park resources was temporary ad therefore they needed to have own sustainable sources of survival.

As such they pool money and members borrow at small interest to meet their financial obligations or start small enterprises. They have also started tree-planting projects based on the understanding after UWA stops them access to firewood, the group can provide for themselves. Other projects implemented or planned included: goat-rearing whereby each members is given a goat.

The group--savings and park entry charges to members are the main sources of funding for the group activities and plans. The monthly group income from park entry charges was reported to be around Ug.Shs 1,500,000/= (one million five hundred thousand only). The little money that group contributes to the park is given back and is used for development project-revenue-sharing

The groups serves as a watch dog for UWA and reports to park rangers any illegal activities in the park and also engages as per the MoU in community sensitization about park conservation.

In concluding this section it is clear the conservation of MFNP is still a challenge despite all the initiatives made by UWA especially those for bringing on board local governments and communities as active players. The initiatives include revenue sharing and permission for restricted access to park resources. This is evident from the fact that poaching and community hostility towards stray wild game (problem animals) are still issues yet to be resolved by UWA and other stakeholders. This may necessitate exploring the idea of compensation to individuals and families affected by problem animals and also beefing up park patrol staffing.

Problem Animals

This study established that Human WildlLife Conflict is a reality and therefore a key conservation and management issue to be tackled in order for wild life and human beings to exist. This conclusion is based on the interviews with UWA staff constituting the top management of MFNP, the local leaders and community members in areas surrounding the park. UWA staff based at MFNP noted that some wild game still meander outside the park boundaries and cause harm especially to crops and property of the families living along. The affected villages/communities are in Mutunda, Purongo, Koch goma, Myene, Minakulu, and Kamdini sub counties. This was found to be the source/cause of animosity between the affected communities and park management.

The animals cited as being culpable in the destruction of the crops and property includes: elephants, bush pigs, buffalos, primates (includes monkeys, baboons), hippos, crocodiles, Rhinos, wart hogs, pythons and snakes. The worst animals in the eyes of the communities in terms of damage caused were reported to be elephants, buffalos and primates. It was further established that some of them such as hippos and elephants and buffalos kill or cause injury to human beings in the event that they are assaulted/attacked by the crop/property owners.

This study found that actions taken by problem animal-affected communities working with UWA at MFNP have not yielded the desired outcomes. It was for instance reported that UWA periodically organizes community education meetings on environment conservation including topics on how to deal with problem animals and generally the importance of natural resources conservation. Among the community response actions as per UWA sensitization education advice either to keep back problem animals or to drive them away are: 1) making of alarms/noise for game rangers to hear and come to scare shoot the animals, 2) making fire using local dry materials or use of torches 3) pepper sprays 4) the digging of trenches along park boundaries and 5) burning foul-smelling substances such as car tyres.

The ineffectiveness of the measures for reducing the burden imposed by problem animals leaves the communities in a vulnerable and precarious situation. This is exacerbated by the fact that there is not any compensatory arrangement by UWA for the families which lose life or property due to the marauding wild game. This was evident from UWA staff interviews and further from a review of the Wild Life Act Cap 200 of Laws of Uganda. Due to the lack of provision for compensation, the local population feels they are losers rather than winners in the MNFP conservation collaboration.

It is clear, communities perceive the losses they suffer as a result of the existence of MFNP as far out weighing the gains from the park. Several community meeting participants for instance observed that problem animals cause damage or injury to individual property owners yet the revenue-sharing funds are allocated for community projects. This means those members of the community who lost directly suffer locally especially that they do not have money to buy food which they would have harvested if the animals did not raid and destroy their crops. They also complain that when problem animals are identified in their crop farms and they decide to kill the animals they get arrested but when their animals destroy crops or kill people UWA does not mind. However, it was reported that in some rare instances, UWA organizes some consolation support for instance when a problem animal kills somebody. This is usually financial support towards burial expenses and nothing else yet they explained that often the deceased has left behind a family with young children with nobody to support them.

Poaching

Broadly and operationally defined for this study poaching refers to all those activities undertaken within a protected natural resource without explicit permission from the management of that resource. This study established that poaching is still a challenge for MFNP management despite the vigilance exercised by UWA staff and legislation against it and the related penalties provided for. The perpetrators are none other than the people who live around the park.

The poaching activities/offences recorded with UWA included illegal entry into the park as well as illegal activities while therein. They include: illegal possession of wild game meat, illegal possession of other animal products such as elephant ivory, hippo or crocodile skins, illegal fishing, illegal possession of fishing gear, illegal possession of lethal hunting weapons such as spears and traps/snares, grazing domestic animals on protected area/park land, destruction of vegetation such as cutting of trees and grass.

According to UWA monthly records for only year 2012 obtained from the office of the Warden Law Enforcement, the highest number of poaching offences was recorded for Buliisa and Nebbi districts while the least number was recorded for Masindi and Nwoya districts respectively as illustrated by figure 17 and 18. Nearly the same trend remained after analysis was done for villages/communities where poachers were arrested from.

Further analysis reveals a mixed pattern regarding peak months for poaching during 2012 (Figure 70). It shows that the highest number of poacher- arrests was in June with 20 cases, 13 in February while March, May and September each recording 11 arrests. However, according to the Conservation Manager, the vice increases normally during the dry season during which, sometimes up to 50 arrests are made and reduces to 10-20 people in off peak months. This trend may be possible to discern if one reviewed poacher arrests over more than one year. It should be observed here that poaching activities may be more than is recorded since some of the poachers are never caught.

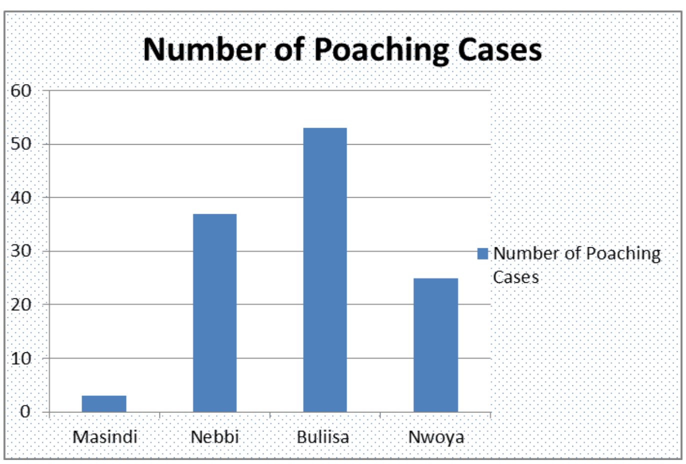


Figure 69. Number of Poaching Recorded by District throughout the Year 2012

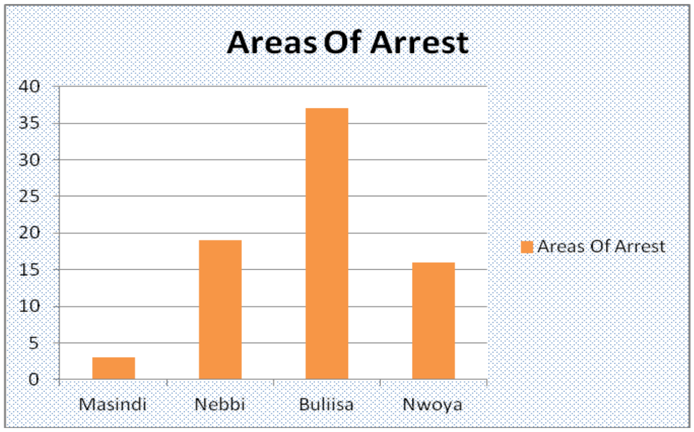


Figure 70: Number of Areas of Arrest per District

Local government and Community perspectives on poaching. The local government leadership appreciates the need for conservation and UWA's initiatives towards collaborative management of the park resources. They commend the revenue sharing idea and reported that it is the major source of revenue for the affected sub counties and therefore funding for the identified community projects. The sub county leaders interviewed therefore hold strong views against poaching and poachers and feel the law should take its course when the culprits are caught.

However based on the community meetings and discussions held in villages around MFNP, the local population has an ambivalent attitude towards conservation of the protected areas. This was evident from their views on poaching. Everyone in the discussions appeared to know the importance of conserving the flora and fauna in the protected areas and the benefits they get from the park as a community and some individually. The groups with restricted access to the park particularly, the fishing, firewood gatherers, bee keepers and X-poachers groups knew how important it is to conserve the natural environment of the protected areas. However, they also believed they should not lose ties with the park as their historical source of food, building materials, firewood, medicine and income from sale of wild game products claiming they do not have alternative sources yet. This study found that some X- poachers denounced poaching and conceived income generating projects that UWA funded. However, others whose applications for funding have not materialized and are still darkness about their fate threaten to revert to poaching if nothing comes of their applications.

There is a lot they expect from UWA on top of what they already get. They do not want revenue sharing funds to be channelled through the sub county offices but it should instead be channelled to organized groups so that individual members can determine their own projects and benefit as individuals who can in turn use the proceeds to fend for the needs of their immediate families.

There are yet those who felt that UWA should at least occasionally allow them to gain entry into the park to access park resources including game meat all of which they claim they have a natural (God- given) entitlement. It is interesting to note that some even would like to be given part of MNFP arable land for farming. This study found that some households do not own land while others have small acreages with most having less than five acres based on the transect walks within the two Ayago hydro power transmission line option 2 and 3 and surveyors' findings.

Collaborative Management

According to the General Management Plan 2001-2011, UWA has promoted better relationships with the local communities. The objectives of community collaboration are the followings.

- To conserve and protect resources in MFNP, in collaboration with the adjacent communities
- To minimize the impact of problem animals and vermin on the local communities
- To support the local communities in implementing benefit-sharing programmes
- To develop programmes to enable the local communities to use MFNP resources in a sustainable manner

The idea of community collaboration was conceived as a means through which the conservation of the array of wild life, vegetation and landscapes within the park boundaries would be achieved. Under community collaboration the park management works with the communities especially through the community protected area institutions to increase awareness on the various environmental issues but particularly related to the conservation of the park ecosystem

Community participation does not only reflect in conservation of the ecosystem but also partaking of the resources within and from the national park. Hence the revenue sharing policy and the arrangements for enabling the communities to access some of the resources in the park in sustainable manner are initiatives that are part and parcel to the community collaboration approach to park management.

Revenue Sharing

UWA is obliged under the Uganda Wild Life Act (Cap 200 of Laws of Uganda) to pay 20% of park entry fees to the local governments neighbouring the protected areas from where the fees is collected. The overall goal of this revenue sharing is to ensure that the local communities living adjacent to MFNP obtain benefits from the existence of these areas to improve their welfare and ultimately strengthen partnerships among UWA, local communities, and local governments for sustainable management of resources in and around protected areas.

The fund is disbursed to the sub-county local governments upon the receipt of satisfactory project proposals endorsed by the councils and is geared towards meeting the needs of the communities living adjacent to MFNP. Indeed, according to one of the revenue sharing circulars dated 14th, June 2011 from UWA's finance department of MFNP to the Chief Administrative Officer for Kiryandongo district local government, Ush 63,000,000 was disbursed. This was to finance projects earmarked in Kiryandongo, Kigumba and Mutunda sub-counties involving 7 parishes of Kyanhende, Kikuube, Kichwabugingo, Mboira, Nyamahasa, Diima, and Kigumba I.

Another circular dated 20th, May 2012 revealing approval of Ush 400,659,000 was reviewed. This amount was approved for funding various projects under the revenue sharing programs. The commonest projects indicated include goat rearing, furnishing works, procurement of machinery, animal trench maintenance, eco-tourism camp site, piggery, maize grinding mill, and construction of teachers' houses, consolation funds for burial expenses and medical treatment of people affected by problem animals, sensitization campaigns on environment conservation by local leadership.

Access to Park Resources by Local Community

One of the practical strategies adopted by UWA is involving the communities in conservation of the protected areas. MFNP provides restricted access to MFNP for certain user groups. This is done by UWA entering a Memorandum of Understanding (MoU) with each of the groups that express interest to gain access to MFNP. The signed MoUs have the terms and conditions of access and also number of years that access is permitted. The involvement of the communities, especially those with MoUs is thought to promote a sense of ownership of MFNP. Their main role is therefore to observe vigilance in its protection by creating awareness of the people on the importance of conservation and by making reports to UWA on the elements in society that are threatening conservation. Some of the prominent groups identified by UWA for support in conservation efforts include the fishing group, firewood gatherers, bee keepers, and ex-poachers. Some of these groups have MoUs while the others do not. It is interesting to note that although these groups already benefited from the MoUs and park access opportunities, they feel that they deserve more from MFNP, so they all expect UWA to allow them under some arrangement to access more park resources and most of all game meat.

It was gathered from the community meetings and interviews with district and sub county officials that as a result of implementing the collaborative park management policy, the communities have played an instrumental role in protecting and conserving the flora and fauna within the park. In particular the motivation to participate was attributed to the revenue-sharing between the park and the neighbouring communities. The beneficiary communities have undertaken development projects upon consultation with the local leaders. The verbatim quote below illustrates how the communities have benefited.

"20% of the revenue generated by the National Park is given to Purongo sub-county, which is then divided equally among the 45 parishes directly bordering the park. We have benefited greatly from this revenue sharing, for from this revenue we were able to construct Purongo Primary School and Purongo Vocation Technical School, though both of these schools are not yet functional. For example, out of the money that we have received from this revenue sharing, we have been able to put up Lamoki Primary School"(Interview with Purongo sub county officials)

" There is some slight revenue sharing from gate collections which is shared in the communities and for Mutunda sub-county specifically, that money has helped to construct some classrooms like at Nanda primary school and some Maternity ward but now the emphasis has been put on development projects. Each parish gets 8 million but for the whole of Mutunda only two parishes benefited that is Nyamahasa and Diima because they are neighbouring the park." (Key informant interview Mutunda Sub-county)

Conservation Education and Awareness Drives

UWA has undertaken community-awareness campaigns on conservation benefits and the expected roles of the communities. The resource user groups and the local governments are also tasked with similar sensitization role in the communities under their jurisdiction. No schedule was reported to exist for these sensitization campaigns but every forum is expected to be used to remind everyone about the importance of good environmental conservation practices. The main contents of the messages include information on how to deal with wild animals, merits of wildlife conservation-revenue for government and financing public infrastructure and how to protect themselves against elephants.

In addition, UWA is focused on promoting wild life education and encourages school visits as evidenced by the low cost accommodation in place for school children and other organized groups. It is assumed that through these education excursions pupils and other groups learn and appreciate the beauty of nature and about wild life in the National Park. However this strategy has a number of challenges because the school administrators are supposed to meet transport expenses hence limiting the number of schools visiting the park. Again during school conservation program, pupils and students are encouraged to form wildlife club of Uganda. However, the efforts are scanty on the ground.

According to the Uganda Wildlife Authority Murchison Falls Management Plan, Murchison Falls National Park has become an important area for research and education. A good number of school children, university students and independent researchers come to visit the park. It is anticipated that as more people become aware of this importance, they will visit for education and awareness purposes.

Gender aspects in conservation efforts

The survey team noted that for all the initiatives by UWA to involve the communities neighbouring the park in conservation efforts, participation is open to both men and women. However, we found some interesting patterns regarding the group formations. Women groups for instance were found to have exclusive access rights to the park for firewood while the self-proclaimed X-poachers group members were predominantly men. It was explained during community group meetings that culturally men hunted while women were and still are responsible for food production and preparation in the home.

Overall, other resource use groups reflected no gender bias as both men and women were eligible to join as long as they met the entry requirements such as ability to raise entry fees and the routine monthly contributions. In view of the foregoing both men and women are targeted and tasked by UWA to be at the frontline in desisting from practices that pose a danger to conservation and also to create awareness in the communities about the need for conservation of the flora and fauna in MFNP.

Through participation in conservation, the concessions (park access rights) given to the men and women groups are meant to empower them to meet their livelihood needs either directly or indirectly. Income generating projects like apiary no doubt generate income for the groups which they can use to meet their individual basic needs and group interests. On the same plane, firewood gathering becomes indirect in the sense that it the source of energy for food preparation.

One of the note-worthy projects linked to community conservation and its outcomes is the Boomu women's groups. The survey team found that subsistence farmers from the villages of Kihaguzi and Kigaragara in northern Uganda came together and formed the Boomu group with the aim of reducing poverty and malnutrition and providing an income for the members to be able to pay their children's school fees. They are located strategically on a major tourism route and decided to get a portion of the visitors passing around. What began as a craft group has evolved into a wonderful community tourism project, with traditional accommodation, a restaurant, unique guided tours and well-tended gardens? Today, there are four Africa style cottages for visitors to stay in.

6. PUBLIC CONSULTATION AND INVOLVEMENT PROCESS

6.1. Stakeholder Analysis

There are several stakeholders performing different functions and who may have interests or be affected by the proposed development of the Ayago hydropower project. These include:

Households	Relying for their livelihoods on a combination of tourism, gathering of medicinal products and other non-wood forest products, hunting, farming, herding, fishing or forestry activities within and along the areas proposed for the hydropower plant and transmission lines respectively.
The District and Lower level Local Governments of Kiryandongo, Oyam and Nwoya	Together with the Community level leaders and decision makers with responsibilities for land resource allocation and developing and applying local by-laws
National and international NGOs and Civil society organizations	Such as Environmental groups and associations, water use associations
Lead Agencies	Such as ERA, UWA, NEMA, DWRM, MGLSD, Internal Affairs ministries among others. These are responsible for regulation, monitoring and supervision

6.2 Classification of Relevant Stakeholder

Stakeholders can be divided into two very broad groups: those ultimately affected, ***primary stakeholders*** (who expect to benefit from or will be adversely affected by development of proposed hydropower project and related interventions) - and those with some intermediary role - ***secondary stakeholders.***

Primary stakeholders include Uganda Wildlife Authority (UWA), local governments, and communities whose activities directly rely on or impact on natural resources available where the proposed energy project and its supporting infrastructure is expected to be developed. The Ministry of Energy and Mineral Development (MEMD) is itself a primary stakeholder, with its own perspective, culture and agenda.

Secondary Stakeholders include the donors, public sector agencies (ministries, regional/provincial or local governments, government mandated agencies, etc.), private sector, donors, and NGOs.

Stakeholders can further be classified by the scope of geographical coverage to identify four categories of key stakeholders:

a) ***Key Nationwide stakeholders*** comprise basically of national institutions within Uganda in charge of providing and enforcement of regulatory framework, planning, implementation and monitoring. Comprise basically of institutions with nationwide scope of operation and influence in Uganda. Their activities often have significant nationwide effect on the direction of energy sector resource use and activities. Many public sector institutions MEMD (and other line ministries), NEMA and Parliamentary committee on Natural Resources fall within this category. Their activities may affect resource use and activities. An analysis of these stakeholders is presented in Table below.

b) ***Key Regional Stakeholders*** likely to have stake in the energy sector These Comprise major Technical Support organizations covering at least two countries within the East, Central and Southern African region such as the Nile Basin Initiative, East African Community and Lake Victoria Commission. They stress coordination and effective participation in regional Resource use; Compliance with regional energy, environmental and Climate change related obligations and protection of national energy related interests. They also harness and provide technical and logistical support in decision-making, planning, and implementation of projects in the Energy sector. They are influential in project planning and implementation process. An analysis of these stakeholders is presented in Table 5.

c) ***Key International Stakeholders*** likely to have stake in the Renewable energy sector like regional institutions, these comprise major Technical Support organizations with a global perspective such as the African Development Bank, World Bank and Kfw/GIZ. They stress coordination and compliance with international energy, environmental and Climate change related obligations and are very influential in project planning and implementation processes as they provide financial and technical support based on internationally applied regulations and guideline (often have strict terms under which they provide their financial and technical support to guard against mismanagement of funds).

d) ***Local Stakeholders*** The majority of local stakeholders likely to be directly affected include the Indigenous people and Community (Men, women, youth) actively utilizing resources within the country and eking out a living from exploiting natural resources or whose source of livelihood is affected by the establishment and development of energy related activities. Most notable in this category are Uganda Wild Life Authority, Organizations with tourism development concession agreements; the communities and Local Governments surrounding the proposed development site. Based on their individual mandates, consensus needs to be arrived regarding their interests as they influence in the decision-making and planning processes. They also include the cultural leaders who stand out so prominently in Uganda. An analysis of these stakeholders is presented in Table 7.

e) Education and Research Based stakeholders undertaking studies related to Environment, ecology such as:

- Makerere Institute of Environment and Natural Resources – The Institute offers graduate level training courses in Environmental Management and Wetlands Conservation.
- National Meteorological Training Centre – Offers certificate and diploma level technical and practical training to meteorology observers, technicians and officers.
- Water Resources Institute - The Faculty of Technology of Makerere University has undergone restructuring aimed at transforming it into a College of Engineering and Technology. Under the proposed college, an Institute of Water Resources Research and Management will be created in addition to the main line civil engineering disciplines in order to provide specialized undergraduate and graduate level training in the following areas; Water Resources Engineering, Water Resources Planning and Management, Water Resources Assessment, Hydrology, Groundwater Hydraulics, Water Supply and Sanitation, Wastewater Management, River Engineering, Hydraulic Engineering, The major challenge to the Water Institute however is financial, physical infrastructure and human resources constraints. All these institutions are very important in broadening the knowledge base and development of Human Resource Capacity. In the current setting, they do not directly participate in the planning and decision-making processes in the energy sector or hydropower development in particular and are thus not very influential in this regard.

f) Private Sector and Civil Society Organizations (CSO) The private sector is not very influential in the decision- making and planning processes since their main interest is to do business and make a profit. Their most noticeable influence is in lobbying for contracts and for policies and laws that enhance their participation. However, the CSO form an important advocacy front with strong capacity to disseminate and mobilize local community support.

6.3 Mobilization

In order to plan for the stakeholder engagement exercise, stakeholder analysis and mapping was undertaken. Based on the different interest of the stakeholders, Table 95 outlines the stakeholders groups that were consulted by the members of the ESIA team and their sub-consultants and summary of the information requirement.

Table 94: Description of stakeholders, consultation purpose and the information required for Ayago HPP

Stakeholder	Project Interest	Information Requirements	Engagement Mechanism
UEGCL	Need for electricity generation, sustainable project implementation	Sources of energy generation, Power potential of the country, growing energy demands and its shortage	Formal/Periodic Meetings
Ministry of Energy and Mineral Development	Implementation of the project and their environmental effects	Policy guidance in the development and exploitation of the energy resources, technical data in order to establish the energy	Formal/Periodic Meetings and Site visit
Ministry of Local Government	Community mobilization, sensitization and dispute resolution	Information on agriculture, landuse pattern, demography and etc. of the affected district area	Formal Meetings and site visit as per requirement
The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) (Department of Fisheries)	Sustainable management of fish and fisheries, Provision of Agricultural Advisory Services to farmers	Information on breeding grounds and fish stocks in the Nile River, Current strategy available for affected areas on the target, capacity available in areas to increase production, opportunities for marketing and value addition.	Formal Meetings
Directorate of Water Resources Management	Access to water resources	Kyoga Nile river water level and their uses, Likely indicators of water pollution and recommendations for	Meeting and site visits

		mitigation.	
Uganda Wildlife Authority	Management and conservation of wildlife resources	Impact on wildlife resources.	Regular Meetings and Site visit
Ministry of Tourism Trade and Industry	Aspect of trade	Interest of tourist and any tourism impacts.	Meeting
Ministry of Gender, Labor and Social Development	Protection of women, orphans, elderly and physically challenged	Aspects related to equity and equal access to water sources, How the project will address social injustices in water access and current guidelines for gender mainstreaming and budgeting.	Meeting
Local Governments	Project benefits to the local community, Improvement in local community infrastructure, resolution of disputes on land holding	Basic infrastructure facilities in the affected project area.	Periodic Meetings and Site visit
Private Sector	Valuable resource for design, construction, operation and maintenance of water and sanitation facilities. Conduct training and capacity building for both central and local government staff. Provision of other commercial services including mobilization of financial resources for water sector development activities.	Current capacity development needs, Existing financial services for the water user groups.	Meetings and Informal discussions
Non Governmental Organizations	Supplement the public sector efforts and ensure that concerns of the underprivileged/poor are catered for. Provision of financial and planning support to communities and local governments.	Current interests of the local nongovernmental organizations in participating in social development and environmental restoration activities with the project	Meetings and Informal discussions

The mechanisms used for this assignment included information sharing meetings with the national and district officials of the government organizations, communities and local government staff and local leaders and non governmental organizations. The concerns and issues raised during consultation are discussed as below:

6.4. Consultation Activities

Consultation was undertaken with local, regional, national and international interests and stakeholders. The purpose of these consultative meetings was to introduce the project with the stakeholders and to identify their comments and expectations with respect to the proposed Ayago project and ESIA process.

Annex 2 provides the details of the issues captured during consultative meetings.

6.4.1. Summary of Major Concerns Raised by Stakeholders

The views of the national and district official are discussed in line with negative and positive impacts that the project would have on their sectors. These include impact on local communities, watershed management, water flow management, and tourism and management issues as well. The major concerns raised by the officials are discussed as follows:

i. Tourism Concerns

The main concern of stakeholders from the Ministry of Tourism, Trade and Industry was regarding the visual impacts and water level due to new design of underground scheme under the Ayago HPP. Furthermore, they are also concerned about the downstream effects and possible impacts on the wildlife as the project lies within the national park. They also felt that during construction phase poaching might occur and therefore penalty measures would have to be put in place. On the concern of water levels, the environmental and social impact assessment team noted that they would definitely be affected but water will be discharged back.

The ESIA team consulted management of Chobe Logde regarding local investments in the area, which revealed that management was very concerned on the tourism impact. The management authority also informed that no Government Agency ever asked for their opinion. According to management, tourist inflow might decrease, if impacts are not properly addressed. Currently Chobe Lodge is being marketed as a fishing destination apart from game and bird viewing. Consultations with staff at Uganda Wildlife Authority, it was noted that the authority did not know the impact of the reduced water budget and their effect on the Kyobe spot fishing site. The team agreed that the project may have impact but the study will determine the extent. However, appropriate mitigation measures would be proposed to reduce any impact.

ii. Natural Resource Management Concerns

Consultations with National Environment Management Authority focused on compliance of the project plan to the existing environmental legislation. NEMA will review the EIA and they are also concerned that aspects of the river banks and lake shores would be adequately addressed in the ESIA process. The agency would also be interested in knowing whether there is degradation at the moment and whether then 100 meters buffer zone is observed by community members since the current trend is that people living or cultivating up to the water bank do not respect it. They also show concern on the growing problem of water hyacinth and has an opinion design should look at possibility of reducing water weeds and protected area. These must be looked as per the regulations of Uganda Wildlife Authority.

iii. Biodiversity Conservation Issues

Major concern of the officials of Uganda Wildlife Authority was regarding the biodiversity affected due to the flow diversion, human settlement with park especially during construction phase, increased poaching etc. UWA raised the concern that the proposed Ayago HPP lies within an area habited by big populations of wildlife especially aquatic species e.g. crocodiles that might lead to animal migrations and loss of tourism value. They were also interested to know how the amenity flow was determined.

iv. Equity, Responsiveness and Rights Concerns

During the field visits, it is noticed that communities within the Ayago area already experiences different forms of vulnerabilities given that they are going through a post conflict situation. Consultations with the Ministry of Gender Labor and Social Development focused on exploring the options to include local communities in the development process. The ministry recommends that a review of the staff to be established including neighboring project area districts. These staff will be responsible for community mobilization, sensitization etc. These CDOs have to be oriented and trained in social mobilization, and should become part of the project management team. The people at the management level should make sure that they will include a community development officer, who will take care of gender responsiveness and inclusion. In terms of gender responsiveness, the ministry has policy guidelines which require that gender impact analysis should be undertaken as part of the project appraisal. It was recommended that a consultant, who can do gender analysis and include the specific heads of people, should also be brought on board. Additionally, occupational safety and health should be assessed and addressed in the project design.

Consultations with the Equity and Rights Department of the Ministry of Gender, Labor and Social Development suggested that the local people need to be consulted regarding the project and resettlement process. The people should be resettled and they should also know the progress of the project. Incase of displacement, they need to address the economic activities of the people, and the project should support income generating activities as well as provision of social services like construction of schools. In line with the equity principles and rights based approaches, it is recommended that project affected persons should be consulted adequately so that they can be compensated and the compensation should be worth the property that they own. Alternative ways of earning income should be provided to the people because displacement might interfere with their daily income activities. People in that locality might have been using water body as a source of their water and should be put into consideration in ESIA. Safety measures should also be taken into consideration, as the project authority will use hazardous equipments. Finally, the project implementation unit should liaise with the department of equity and rights and get advice on local leakages and the legal and local frameworks available. Additionally, it should liaise with the equal opportunities commission on issues of complaints and alternative disputes resolutions and mandated institutions should also be involved in the project implementation process.

v. Water Abstraction and Discharge Issues

Consultations with the Ministry of Water and Environment raised concerns regarding the new type of technology to be used and affected diverted flow. The team recommended that unnecessary diversions of the Nile be avoided so that water flow continues normally having no or limited effects on water access for community members and other sectors like the fisheries sector. However, if they are going to use the old type of technology for example the one that was used in 1952 to construct Owen Falls Dam in Jinja, then it will significantly affect the ecosystem. Regarding effluent discharge, staff within the ministry noted that there will be no effluent discharge expected before it complies with the national discharge standards. All water abstracted and waste water discharged into the environment shall be metred.

vi. Agricultural Related Concerns

Consultations with the Ministry of Agriculture Animal Industry and Fisheries focused on the impact of water abstraction in Ayago in their respective sectors. It was observed that since both the energy and agricultural sectors are competing for the same resource, there are likely chances of impacts due to the project. For example the local people will need the swamps, springs, and fishing from the same place. Positively it will be good for them because they will be able to get water upstream which is good for fisheries. However it should be noted that the Ayago HPP is not located in the community but in a national park. So no community will be impacted on by the Damming at Ayago HPP.

vii. Other Socio-economic Issues

Concerns raised by non governmental organizations involved in the project area recommended that the design execution of the project should have adequate considerations for environmental like social, cultural and minority groups. Furthermore, there should be clear and sound interests and political interests should also be put into consideration because of the nature of the community. The community should be given a chance to access and appraise the project. There should be EIA and there should be participatory mechanisms of implementing the project at the communities so that people's views/stakeholders are taken into account. In terms of site specific concerns, staff at Future Dialogues international noted that project approaches should be multidimensional given their site specific conditions.

A local area councillor raised concerns relating to potential population increase as a result of the project, the little resources amidst limited resources within local governments. She recommended that a plan be put in place to ensure that communities are able to cope with health issues especially regarding diseases like HIV/AIDS and malaria which can not be ruled out. On education side, political leadership noted that there are only 2 to 3 primary schools which are incapable to handle the influx hence, need for construction of more schools. Demand for water is likely to increase and therefore more boreholes would be needed. In terms of natural resources political leadership wondered whether the remaining running water after intake would be enough to the aquatic life. Furthermore, due to the influx and land being a fixed asset, could pressure on the wildlife reserve to be gazetted in Oyam and Nwoya as demand for land for settlement increases. Moreover, there are no gazetted areas for dumping waste prior to and after construction.

6.5. Community Meetings

At the community meetings, information on the socio-economic studies, environment impact studies and other engineering related to the Ayago HPP was discussed. The stakeholders and community members were then given an opportunity to raise their concerns regarding the proposed hydropower dam. Communities consulted included: Piiyakeyo village, Nanda Game, Laboke Kololo, Talaboke, Alanyo, Pii Alenyo, Diima A, Diima B, Ban Dulere, Oganyo A, Abino A, Ogwara 2, Ogwara 3, Bedmote, Ayuda, and Karuma.The key issues raised by the local community are presented in Table 96. The details are presented under Annex 2.

Table 95: Major issues raised by the local community during consultative meetings

Issue	Community concern

Employment opportunities	• Will the youth within neighboring project area be given first priority during the recruitment exercise? • There is need for entrepreneurship training and provision of loans to the youth so that they can cope with changes in environment.
Utilities and Social Services	• There is need for the communities to benefit from the project for there are few boreholes and communities have limited access to safe water. • Need for health services within communities especially where labour camps will be established.
Grievances on human – wildlife interaction	• Problem animals and communities affected - Most affected are villages near the park i.e. Gwara, Ayuda, Gwara III, Abindo, Diima A, Piakeyo, Baradugu • Crops have been destroyed by the animals • We don't sleep during animal raids e.g. elephants come for paw paws in the compounds, for some households they have been destroyed their pawpapws • Also stay awake driving away the animals for instance by drumming to keep them at bay or chase them a way
Illegal Fishing	• Yes they are still there and when we know, we make report to some park rangers.

7. NEED FOR THE PROJECT AND ANALYSIS OF ALTERNATIVES

7.1 Introduction

The study of alternatives focused on information derived from the assessment of other power sources by the Master Plan study on Hydropower development in Uganda and the feasibility study for the Ayago hydropower plant (March, 2013). Among the alternatives, different power sources were analysed, technology options, location. The analysis has focused only on the power generation facility and not the transmission line. Analysis of the ransmission line alternatives shall be discussed in the EIA for the transmission line of the Ayago HPP.

7.2 Justification

The demand for electricity in Uganda has been growing at an annual rate of 8% and this trend is expected to continue for the foreseeable future (Grid Development Pan 2009). Peak demand presently stands at just over 450 MW. The generation infrastructure is insufficient with installed capacity at 600MW, yet there is up to 2,000MW technically feasible potential for large hydropower generation. The National Development Plan for 2011 – 2015 lists Ayago HPP as one of the priority projects for development to ensure adequate electricity supply to achieve accelerated development and sustainable economic growth. Karuma and Isimba Hydro Power Projects are already in advanced stages of implementation, with contractors on site and major works on going.

Despite this vast hydro potential, hydroelectricity constitutes only 2% of energy consumption in Uganda. At present only 8% (as low as 2% in rural areas) of the population have access to power from the national grid. Planned electrification schemes aim to increase this to 10% by 2012. The distribution of power consumption in 2006 was 57.5% for industrial use, 13.2% for commercial use and 29.3% for domestic and other related uses (MEMD, Energy Sector Performance Report 2008).

7.3 Energy Alternatives

A wide range of fuels and power-generating technologies are currently available. Because this project is to produce electricity primarily from running water, the potential alternative energy sources should consider those that might be used in Uganda as well as for sale to neighbouring countries. Among the options available for Uganda, Diesel engine (Petroleum), geothermal solar wind biomass and Energy import would be the alternative source of power as compared to the proposed hydropower as all are readily available and can be harnessed for electricity generation.

Table 96: Analysis of Energy Sourcess

Energy Source	Production Method	Advantage	Disadvantage
Hydropower	Derived from the force of moving water	Once a dam is constructed, electricity can be produced at a constant rate. If electricity is not needed, the sluice gates can be shut, stopping electricity	Dams are extremely expensive to build and must be built to a very high standard. The high cost of dam construction means that they

Energy Source	Production Method	Advantage	Disadvantage
		generation. The water can be saved for use another time when electricity demand is high. Dams are designed to last many decades and so can contribute to the generation of electricity for many years / decades. The lake that forms behind the dam can be used for water sports and leisure / pleasure activities. Often large dams become tourist attractions in their own right. The build up of water in the lake means that energy can be stored until needed, when the water is released to produce electricity. When in use, electricity produced by dam systems do not produce green house gases. They do not pollute the atmosphere	must operate for many decades to become profitable. The flooding of large areas of land means that the natural environment is heavily disturbed. The building of large dams can cause serious geological damage. Dams built blocking the progress of a river in one country usually means that the water supply from the same river in the following country is out of their control. This can lead to serious problems between neighbouring countries. Building a large dam alters the natural water table level. For example, the building of the Aswan Dam in Egypt has altered the level of the water table. This is slowly leading to damage of many of its ancient monuments as salts and destructive minerals are deposited in the stone work from 'rising damp' caused by the changing water table level.
Solar Thermal	Technology for harnessing solar energy for thermal energy (heat) requirement in industries	Solar energy is free although there is a cost in the building of 'collectors' and other equipment required to convert solar energy into electricity or hot water. Solar energy does not cause pollution. However, solar collectors and other associated equipment / machines are manufactured	Only harnessed when it is daytime and sunny Solar collectors, panels and cells are relatively expensive Solar power stations can be built but they do not match the power output of similar sized conventional power stations. They are also very expensive. Large areas of land are required to capture the suns

Energy Source	Production Method	Advantage	Disadvantage
		in factories that in turn cause some pollution. Solar energy can be used in remote areas where it is too expensive to extend the electricity power grid. It is estimated that the world's oil reserves will last for 30 to 40 years. On the other hand, solar energy is infinite (forever).	energy. Collectors are usually arranged together especially when electricity is to be produced and used in the same location. Solar power is used to charge batteries so that solar powered devices can be used at night. However, the batteries are large and heavy and need storage space. They also need replacing from time to time.
Geothermal	Harnessing heat from the earth (naturally hot rocks)	It is a renewable source of energy. By far, it is non-polluting and environment friendly. There is no wastage or generation of by-products. Geothermal energy can be used directly. In ancient times, people used this source of energy for heating homes, cooking, etc. Maintenance cost of geothermal power plants is very less. Geothermal power plants don't occupy too much space and thus help in protecting the natural environment. Unlike solar energy, it is not dependent on the weather conditions.	Only few sites have the potential of Geothermal Energy in the country. Most of the sites, where geothermal energy is produced, are far from markets or cities, where it needs to be consumed. Total generation potential of this source is too small. There is always a danger of eruption of volcano. Installation cost of steam power plant is very high. There is no guarantee that the amount of energy which is produced will justify the capital expenditure and operations costs. It may release some harmful, poisonous gases that can escape through the holes drilled during construction.
Diesel engine (Heavy Oil)	Requires diesel engine to run a generator coupled to it	Plant layout is simple. Hence it can be quickly installed and commissioned, while the erection and starting of a steam power plant or hydro-plant takes a fairly long time. Quick starting and easy pick-up of loads are possible in a very short time.	Plant capacity is limited to about 50 MW of power. Diesel fuel is much more expensive than coal. The maintenance and lubrication costs are high. Diesel engines are not guaranteed for operation under continuous, while

Energy Source	Production Method	Advantage	Disadvantage
		Location of the plant is near the load center. The load operation is easy and requires minimum labors. Efficiency at part loads does not fall so much as that of a steam plant. Fuel handling is easier and no problem of ash disposal exists. The plant is smaller in size than steam power plant for same capacity. Diesel plants operate at high overall efficiency than steam	steam can work under 25% of overload continuously.
Biomass cogeneration	Uses waste wood and horticultural materials as fuel for production of thermal and electrical energy	No Harmful Emissions: Biomass energy, for the most part, creates no harmful carbon dioxide emissions. Abundant and renewable. Biomass products are abundant since they come from living sources and since life is cyclical, these resources may never run out Reduces dependancy on fossil fuels and the size of the landfills Can be used to creat different products ie ethanol production, fertilizer generation, can produce thermal and electric energy at the same time.	Expensive, as living things (trees, cows,) have to be looked after to produce material for the energy Inefficient and harmful to the environment through production of greenhouse gases Requires large expanses of land for the powerplant and consumes more fuel. Land used for energy crops will take up land required for food production.
Wind energy	Wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this	The wind is free. Once the wind turbine is built the energy it produces does not cause green house gases or other pollutants Although wind turbines can be very tall each takes up only a small plot of land. This means that the land below can still be used. Remote areas that are not	The strength of the wind is not constant and it varies from zero to storm force. This means that wind turbines do not produce the same amount of electricity all the time. There will be times when they produce no electricity at all. Wind turbines are sometimes a negative asthetic impact to rural landscapes.

Energy Source	Production Method	Advantage	Disadvantage
	mechanical power into electricity	connected to the electricity power grid can use wind turbines to produce their own supply Wind turbines are available in a range of sizes which means a vast range of people and businesses can use them. Single households to small towns and villages can make good use of range of wind turbines available today.	Wind turbines are noisy When wind turbines are being manufactured some pollution is produced. Therefore wind power does produce some pollution. Large wind farms are needed to provide small communities with enough electricity
Nuclear Energy	Nuclear energy originates from the splitting of uranium atoms in a process called fission. At the power plant, the fission process is used to generate heat for producing steam, which is used by a turbine to generate electricity	It is reliable, doesnt depend on weather, and easy to control output Small volume of waste is produced A lot of fuel is produced from a small mass of fuel. Therefore reduction on transportation costs No smoke particles are produced therefore particulate matter contamination is law It doesnt contribute to carbon emissions therefore doesnot contribute to global warming Plants donot require large expanses of land	Nuclear waste is very harzadous (lasts 200-500yrs) and therefore disposal is very expensive Decommissioning is very expensive as alot of security concerns have to be adhered to to prevent pollution Any accident can spread radiation producing particles over large areas Increased insecurity as it can be a terrorist target with disastruous concequences The legacy of environmental contamination and health costs for miners and mines has been catastrophic

7.4 Plant Type

Three types of electricity generation were considered for the hydropower project. A dam, Dam & Conduit and run-of-river hydropower generation types were considered in the alternatives and have been discussed in Table 94. From the viewpoint of topography, Victoria Nile falls steeply toward the section of the lower Victoria Nile, and the topographical feature of the riverbank is mostly gentle except the the junction between Victoria Nile and Ayago rivers, so that construction of dam is disadvantageous (Table 95). Run-of-river type hydropower plant is more suitable in the proposed area than both dam type and dam & conduit type hydropower plant. The reason is that run-off-river type hydropower plant only requires an intake weir whose height is, in most cases lower than that required for the dam.

Table 97: Analysis of alternative poweplant

Type of Power plant	Layout of waterway	Description

Dam & Conduit	Right Bank	▪ Concrete gravity dam is arranged at the downstream of the junction of Victoria Nile and Ayago rivers. ▪ Dam height and length of the crest are 45 m and 1,400 m respectively. ▪ The length of the waterway is almost 6.1 km. ▪ Although the waterway can be arranged at both right and left banks, layout arranged at left bank is excluded to be studied in comparison of the length of the waterway. ▪ The powerhouse is arranged at the upstream of the waterway. ▪ Peak load power plant. ▪ Amount of river flow decreases between the intake and the tailrace outlet.
Run-of-river	Left Bank	▪ Intake weir is placed at 3 km upstream of the junction between Victoria Nile and Ayago rivers. ▪ Length of the water way is about 7.9 km. ▪ The powerhouse is arranged at the upstream of the waterway. ▪ Base load power plant. ▪ Amount of river flow decreases between the intake and the tailrace outlet
Run-of-river	Right Bank	▪ The intake weir is placed at the same site as above. ▪ Length of the water way is about 9.9 km. ▪ The powerhouse is arranged at the upstream of the waterway. ▪ Base load power plant. ▪ Amount of river flow decreases between the intake and the tailrace outlet.

Table 98: Advantages and Disadvantages of plant type options

Type of Powerplant	Advantage	Disadvantage
Dam & Conduit (Right Bank)	▪ Lowest volume of spoil produced ▪ Shortest length of waterway	▪ Quarry for aggregate is required for this option (heavy impacts in quarry sites) ▪ Submerges/floods a large area therefore can release vast amounts of greenhouse gases from decomposition of submerged organics ▪ Large impact on Biodiversity
Run-of-river (Left Bank)	▪ Construction cost is low ▪ Impact on biodiveristy is the lowest with this option	▪ Area of land acquisition is the ▪ largest (but, the area is out of ▪ MFNP).
Run-of-River (Right Bank)	▪ Heavy impact on cultural and historical heritage is high (see section 5.4.1)	▪ A high cost of construction will be incured ▪ A Large volume of spoil will be produced ▪ This option has the longest waterway - large impacted area

NB: Analysis of alternatives for other project components (i.e access roads, camps etc) shall be discussed in their respective EIAs by the contractor durring detailed design stage.

7.5 Construction layout principles

(1) Reasonable and overall planning and layout of various temporary facilities shall be made according to the layout forms of construction cofferdam, concrete dam, underground power house, tailrace tunnel and other buildings, as well as according to the scale of construction facilities.

(2) The construction layout shall be based on the actual conditions, beneficial to the production, convenient for life, easy to manage, and shall simplify the construction enterprises and downsize the temporary construction works as far as possible.

(3) The construction layout shall be compact and reasonable, save the land, make the best use of wasteland, bottomland and gully, and minimize the environmental impact on the Murchison Falls National Park.

(4) The construction sites arranged in the flood land and gully shall meet the flood season requirements.

(5) The construction site layout and the transportation route layout shall be dynamically integrated to minimize the return transportation.

(6) Such flammable and combustible sites as oil depot and explosive magazine shall be arranged separately from other construction sites.

(7) For the material source selection, the excavated materials of the project shall be made full use of, so as to facilitate the environmental protection and reduce the investment. The selection and layout of waste disposal area and stockyard shall meet the requirements of environmental protection, water conservation, safety and so on.

7.6 Environmental Consideration

Considering the sensitivity related to serious adverse effect on the Murchison Falls National Park and Environmental problems the alternative of having an open channel within the protected and/or Conservation area were not considered. To minimise the impacts of the project on the Murchison Falls National Park, most the project support facilities will be located outside the conservation area.

7.7 Social Considerations

From the location point of view, apart from the project support infrastructure such as the camp, the project will not displace people as all the major project components are located within the Murchison Falls National Park which is a restricted area. The impacts related to acquisition of land will only be limited to the land for the project. The location of the camp is a sparsely populated area, with minimal human habitation and activity.

8. IMPACT ASSESSMENT AND MITIGATION MEASURES

8.1 Introduction

This section presents the discussion of impacts, the identification and the mitigation that are likely to affect the environment is based on the period of:

- Pre-construction and construction of project facilities, and
- Operation of the power plant

The environmental impacts are analyzed for three major elements:

- the social environment (including the positive impacts)
- the physical environment
- the biological environment

8.2 Impact Assessment

This is the process of identifying the anticipated or actual impacts of a development intervention, on those social, economic and environmental factors which the intervention is designed to affect or may inadvertently affect. Potential impacts have been identified based on proposed activities to be undertaken, through specialist studies and through a consultative process with key stakeholders. To establish impact significance, the following key concepts will be utilized as follows: The identification of all the possible impacts of the Project followed a systematic approach, which included consideration of the following:

- **Project Description**- an analysis of the Project design, Project phases and activities and the processes involved, which has resulted in a clear understanding of the Project activities that have the potential to give rise to impacts;
- **Project Scope of Assessment** – the scope of assessment has highlighted the potential environmental and social/socioeconomic components that may be impacted upon during a certain timeframe and over a certain distance;
- **Stakeholder Input** – the input of key stakeholders was considered in identifying the potential impacts that are of concern to those parties that may be impacted by the Project;
- **Expert knowledge** – expert knowledge from scientists and regulators familiar with tunnel works as well as prior experience of pipeline engineers and EIA specialists with experience gained from similar Hydropower projects has contributed to the preliminary identification of impacts;
- **Project/Environment Interactions** - A Project activity/environment interaction matrix was developed, which summarized the possible interactions between Project activities and the main resource/receptor types during the phases of the Project.
- **Cumulative impacts**: are those arising from a large number of activities that are for the most part individually insignificant, but together have had regional or even global repercussions. Discussion of these impacts will be done qualitatively and possible mitigations suggested banking on similar projects, in the absence of the national framework for identifying/addressing cumulative impacts.

Two different forms of impact are assessed within this ESIA:

- Planned impacts; those impacts that result from a planned event. Such impacts are expected to occur during the course of the Project (e.g. an increase in turbidity levels in the water column due to a disruption of seabed sediments);
- Unplanned impacts; those impacts that result from an unplanned or non-routine event. Such impacts are not expected during the Project but nevertheless the probability of the impact occurring is assessed (e.g. occupational hazards).

The impact assessment methodology for planned impacts takes into consideration an impact's nature, type and degree of reversibility, its magnitude and nature of the resource/receptor to yield an impact's overall significance. Unplanned impacts are assessed by using an impact's significance which is termed 'consequence' in this respect, and introducing the concept of probability, or the likelihood of an impact occurring. In both cases, impacts are assessed following the implementation of mitigation measures.

Nature, Type and Reversibility of Impact

Impacts are initially classified according to their nature, either negative or positive, their type and their degree of reversibility. Type refers to whether an impact is direct, indirect, secondary or cumulative. The degree of reversibility refers to the capacity of returning an impacted resource/receptor to its pre-impact state.

Impact Magnitude

Predicted impacts are defined and assessed in terms of a number of variables. This would comprise an assessment into the scale, duration and intensity of an impact. These variables collectively determine an impact's magnitude. Awarding values is, for the most part objective, due to the limits in place. However, awarding a value to variables, such as intensity, requires professional judgment in that the extent of change is difficult to define. Expert judgment and prior experience of the ESIA team has ensured a reasonable degree of consensus on the value placed on an impact variable. Determining magnitude is typically a combination of quantifying scale, duration and intensity, where relevant, and applying professional judgment/past experience.

The Nature of a Resource or Receptor

It is imperative to place some form of value (low, medium and high) on a resource or receptor that could potentially be affected by Project activities (Table 96); expert judgment and stakeholder consultation ensures a reasonable degree of consensus on the intrinsic value of a resource or receptor. The allocation of a value to a resource/receptor allows for the assessment of resource's/receptor's sensitivity to change (impact). Various criteria are used to determine value/sensitivity including, amongst others, resistance to change, adaptability, rarity, diversity, value to other resources/receptors, naturalness, fragility and whether a resource/receptor is actually present during a Project activity.

Impact Significance

Virtually all human activity imposes some disturbance to components of the environment because of physical impacts on natural systems or due to interactions with other human activities and human systems. Often such impacts are slight or transitory and have an effect that may be regarded as insignificant. There is no statutory definition of significance and the determination of significance is therefore necessarily subjective.

Table 99: Overall significance criteria for the ESIA

	Low magnitude	Medium Magnitude	High Magnitude
Low sensitivity	Minor	Minor	Moderate
Medium Sensitivity	Minor	Moderate	Major
High sensitivity	Moderate	Moderate	Major

Impact significance	
No Impact or insignificant	Impacts are indistinguishable from the background/natural level of environmental and social/socioeconomic change.
Minor Significance	Impacts of low magnitude, within standards, and/or associated with low or medium value/sensitivity resources/receptors, or impacts of medium magnitude affecting low value/sensitivity resources/receptors.
Moderate significance	Broad category within standards, but impact of a low magnitude affecting high value/sensitive resources/receptors, or medium magnitude affecting medium value/sensitivity resources/receptors, or of high magnitude affecting medium sensitivity resources/receptors.
Major Significance	Exceeds acceptable limits and standards, is of high magnitude affecting high or medium value/sensitivity resources/receptors or of medium magnitude affecting high value/sensitivity resources/receptors.

Mitigation Measures

A key objective of the ESIA is to identify means of reducing the impact of the Project on the receiving environment. To achieve this, mitigation measures have been developed and integrated into the Project design in response to impacts that are anticipated to be of significance. These mitigation measures have been established through legal, best practice industry standards or specialist environmental input from the ESIA team.

Unplanned Impacts

In addition to the predicted impacts, those impacts that could result in the event of an accident or unplanned event within the Project (e.g. accidents at worksite), or in the external environment affecting the Project, are taken into account. These impacts are termed unplanned impacts and are defined as being a combination of event or incident frequency (probability) and the environmental consequences of the event or incident. Unplanned impacts are considered in much the same way as predicted impacts save for the inclusion of the probability factor. Probability and consequence are elaborated upon in Table 101.

Table 100: Overall unplanned impact Significance

Potential Consequence (Significance)	Frequency of Event/Incident Occurrence (Probability)		
	Low	Medium	High
Minor	Minor	Minor	Moderate
Moderate	Minor	Moderate	Major
Major	Moderate	Moderate	Major
Low	Continuous Improvement Zone		
Moderate	ALARP Zone – demonstrate that the likelihood of the environmental impacts has been reduced to As Low As Reasonable Practicable and that contingency measures are in place to minimize the consequences.		
High	Intolerable Zone: Unacceptable to the countries of origin, affected countries and Nord Stream.		

8.3 Positive Impacts

These are the positive impacts anticipated at the onset of project activities;-

- Employment of local communities during the pre-construction/mobilization and the construction phase;
- Employment of Ugandan nationals during the operation phase of the project;
- Local revenue to the communities, UWA, and the Nwoya District;
- Improved power supply to the national grid meeting the increased demand of power;
- Income generation; the lands taken by the project for the transmission will be sold out to the contractor and the households that sale the land will get income through the process;
- Also the proposed large scale hydro power project will widen the tax base for the Ugandan government through the remittance of taxes to the national treasury and licenses from government.

These will be enhanced during the onset of activities to help offset some of the negative impacts.

8.4 Potential Negative Impacts

This section presents the potential negative impacts anticipated to occur at the onset of project activities including pre-construction, which includes (land clearing, access road construction, mobilization of equipment, set-up of workers camps). This section further discusses the potential impacts that would arise out of the construction phase and eventual operation and decommission activities. Mitigations are also proposed in this section basing on preferred state by the lead agencies, communities, and international best practice standards.

8.5 Pre-construction Phase Impacts

These are anticipated impacts that are likely to occur in the period preceding construction activities.

1) Land uptake for the workers camp, power house, reservoir location

The impacts associated with set-up of workers camps like vegetation clearing, construction impacts shall be addressed in a separate ESIA for the associated facilities to the dam project, therefore will not be repeated here.

2) Access road construction

About 30 km long access roads will be constructed to enable project vehicles and workforce move from the proposed campsite to the diffenet construction sites. This will entail vegetation clearing, which would lead to loss of plant species, possible colonization by invasive species, habitat fragmentation especially for the amphibians and crawlers (snakes, snails) that are accustomed to movement within vegetated landscape. The impact magnitude is medium because the road will be short, therefore the clearance will be minimal, and the receptor sensitivity is high, since this will be in a National park, where there are various wild animals (birds, small mammals) dependant on this vegetation for foliage and as a means to hide from predators. Therefore the impact significance is moderate before mitigation.

Mitigations

- Siting of the road and support facilities (Construction Camps) to avoid critical terrestrial and aquatic habitat (e.g. thick wooded grassland, the riverine forests, wetlands, and fish spawning habitat);
- While opening new areas for access, the top soil shall be stockpiled and preserved for future restoration use
- The developer will utilize existing transport corridors whenever possible;

- Design and construction of wildlife access to avoid or minimize habitat fragmentation, taking into account motorist safety and the behavior and prevalence of existing species;
- In liaison with UWA, identify and map out animal trails, migratory routes and or feeding or breeding grounds; and try as much to avoid them during construction activities.
- Encourage native vegetation to re-grow after the construction;
- Active management of invasive species such as *Mimosa pigra* through allowable (by UWA) practices like manual removal (uprooting) and burining.
- Preventing short and long term impacts to the quality of aquatic habitats by minimizing clearing and disruption of riparian vegetation, especially that nearest the river;
- The developer will provide adequate protection (e.g rip rap, grassing, gabions, settlement ponds etc) against scour and erosion; and giving consideration to the onset of the rainy season with respect to construction schedules;
- On the construction site, the part-cut part-fill mode is adopted. In the main works design, the anchor pile, shotcrete and water interception/ drainage measures are taken for the excavated upper slope; and the cement laid stone masonry retaining wall and other measures are taken for the backfilled slope toe, all of which will contribute to the conservation of soil and water. Before construction, the surface soil within the construction site is removed and piled together, and temporary fencing and protection measures are taken; during construction, the drainage ditch is made around each construction site; upon completion of construction, the land reclamation measures including the removal of hardened land surface and ground leveling, should be undertaken in the construction areas and the vegetation should be restored by means of planting native arbors, shrubs and grass.
- Prevention and control measures for spoil disposal areas - For the Project, there are altogether 3 spoil disposal areas, i.e., Upstream Spoil Disposal Area 1, Upstream Spoil Disposal Area 2 and Downstream Spoil Disposal Area 3, all of which are of channel type. Before spoil disposal, a spoil-intercepting dam is set up at the foot of the spoil-stacking slope in the spoil disposal area following the principle of "interception before disposal"; in order to prevent the spoil from being eroded by the water in the upper reaches and around the channel and ensure that the water drainage of the spoil is unobstructed, it is proposed to take slope water and channel water treatment measures around the spoil disposal areas, and the spoil bottom seepage channel is made; the spoil is stacked in layers, the berm and platform with a height as required are made, and the spoil slope is protected with cement laid stone masonry grid; with the advance of the spoil, the spoil drainage ditch is built on the surface of the spoil disposal areas and the berm, mainly including the spoil drainage ditch and berm drainage ditch; upon completion of spoil disposal, the land reclamation measures, mainly including the ground leveling, should be taken on the surface of the spoil disposal areas and the spoil slope, and the vegetation on the surface of the spoil disposal areas should be restored by means of planting native/indigeneous arbors, shrubs and grass and that of spoil slope should be restored by planting shrubs and grass.
- The location, land take, height of spoil disposal areas shall be determined by the contractor in liaison with UWA

3) Noise and vibration generation from mobilization of equipment

Heavy trucks moving equipment and materials in preparation for the construction will generate a considerable amount of noise and vibration within the park. The measured noise levels are typical of undisturbed environments except at busy road junctions therefore any increment from the norm will inevitably lead to varying degrees of disturbance to the wildlife. The receptor sensitivity in this case ishigh because the area scheduled for the construction is both a conservation and wildlife habitat. The impact intensity is medium because already there are other vehicles on the road transporting tourists to and from within the park, so the impact produced by noise and vibrations from these activities is cumulative of what is already existent in the park, producing an overall impact severity of major ranking.

Mitigation

- Sound-control devices on equipments should be maintained in good condition. Regular servicing of equipment and machinery shall be emphasized.
- Appropriate and sufficient PPE for noise protection shall be provided to all workers and visitors to highly active sites;
- Construction activities that may generate harmful noise should be limited only to day time, e.g. 6 am to 7 pm and only outside of breeding periods;
- The contractor shall be required to obtain a license incase he emits noise beyond the permissible noise levels.
- Put in place signages for reduction of speed in highly sensitive areas like corners, areas of known trails, breeding grounds so that shock events are reduced to manageable levels by animals;
- Adhere to the speed limit of 40kph within the national park
- Selecting equipment with lower sound power levels and installing suitable mufflers on engine exhausts;
- The developer will limit the hours of operation for specific pieces of equipment and operations, especially mobile sources operating through sensitive areas.
- Re-locating noise sources to less sensitive areas to take dvantage of distance and shielding will be employed in as far as applicable;
- Taking advantage of the natural topography as a noise buffer during facility design;
- Put in place sound proof enclourses for the equipment

After the application of the above mitigations, the impact magnitude from the mobilization of equipment is expected to be moderate. However, the proponent will develop a mechanism to record and respond to complaints especially from relevant stakeholders especially UWA and or tourists and tour operators to check on effectiveness of the applied mitigations and to get insight on how to address these concerns in due time.

8.6 Construction Phase Impacts

Typical activities during the construction phase of a hydropower project include ground clearing and removal of vegetative cover, grading, excavation, blasting, trenching, drilling, vehicular and pedestrian traffic, and project component construction and installation among others. The impacts and mitigation measures are proposed to reduce the impact magnitudes to minor/negligible levels.

8.6.1 Biophysical Impacts

1) Influence on hydrological regime

Construction of the reservoir will change the hydrological regime such as fluvial morphology, river level, surface width and flow rate. Water depth upstream the dam will be increased, water flow rate in the reservoir decreased gradually from the tail area to the upstream, flow pattern changed from torrents to subcritical flow and will be changed locally depending on stretch of and space between the two sides of the bank. After implementation of the Project, a water reduced river reach will be formed at about 9.4 km downstream the dam. However, the Project has taken an ecological basic flow of 50 m^3/s let down from the reservoir, so it is unlikely for the water reduced river reach to run dry. In addition, Ayago river flows into the Nile at 3.3 km downstream of the dam site, so water in the river reach will increase, which will alleviate influence on the water reduced water reach at a certain extent. Before dredging, a permit shall be acquired from the water resources directorate.

Mitigation

- Assess the impact of rapid water level fluctuations downstream on the outlet and wier during operation and shut down.Emphasis should be given to these fluctuations in case Ayago HPP is to be operated as a peaking plant.
- The water difference between Oriang HPP tail waters and Ayago reservoir should be atleast 10 meters.
- Before dredging, the Contractor should obtain the necessary statutory permits from the relevant Agencies and Government Departments.
- Provide a write up on the hydrological regime upstream of the dam-and the extent of inundation.

2) Air quality (emissions)

Potential emissions generated during the construction phase include vehicle fumes; diesel emissions from large construction equipment and generators ; VOC emissions from storage and transfer of fuels for construction equipment; small amounts of carbon monoxide, nitrogen oxides, The impact intensity in this case is medium because there are natural dust emission enablers like the unpaved roads within the park from tourist and/or maintenance vehicles accessing the park on a daily basis. Sections of the areas where particulate material was observed included those with vehicles on murram roads however the rest of the areas had no detectable levels of SO_x, NO_x and H_2S. This presents a good quality environment and a high dilution potential for any pollutants produced. The receptor sensitivity is therefore medium, with a moderate impact severity before mitigation.

Mitigation

- All vehicles will be instructed to switch off engines on arrival at site. More pollutants are released during idling as compared to a vehicle in active movement;
- All non road mobile machinery (NRMM) to use ultra low sulphur tax-exempt diesel (ULSD) where available;
- Observance of speed limit within the park (≤40km/h) will be implemented, to prevent raising dust and the developer will engage in activities that preserve carbon sinks (trees and natural resources
- All trucks delivering materials to the site will be maintained in good working order as inefficient fuel combustion is key in the release of NO_2, SOx CO, and NO from vehicle exhausts; Timely and efficient servicing of vehicles and machinery
- Vehicle drivers will be encouraged switch engines off when not in use because an idling truck releases more emissions than one in active movement.
- Monitor air quality within the tunnels and provide adequate ventilation

3) Air quality (Dust Emissions)

Particulates from blasting activities; and fugitive dust from many sources such as disturbing and moving soils (clearing, grading, excavating, trenching, backfilling, dumping, and truck and equipment traffic), mixing concrete, storage of un-vegetated soil piles, and drilling and pile driving. The volume of work anticipated is high likely to release vast amounts of said pollutants into the air and the impact intensity are medium. The receptor sensitivity is low because the receiving environment is very pristine with a thick vegetative buffer, to sink most of the pollutants released during the construction, blocking it from animals. The heavy cover of foliage by dust may however hinder plant growth by blocking gaseous exchange and sunlight capture, especially if it persists before any rains wash it off.

Mitigation Measures

- No bonfires for waste will be encouraged in the park, as this causes dust raising situations;
- The developer will be encouraged to plan the site layout – machinery and dust causing activities should be located away from sensitive receptors;
- Dust generating activities will be minimized especially on windy days to prevent dust raising in the park;
- Water will be used as dust suppressant where applicable to subdue any dry particles from becoming airborne during windy days in the dry period;
- Enclose stockpiles in temporary or keep them securely sheeted to prevent dust spreading;
- All loads entering and leaving site to be covered to prevent windblown dust along the route to and fro the site;
- Land clearing, removal of topsoil and excess materials, tips and stock piles, will be planned with due consideration to meteorological factors (e.g. precipitation, temperature, wind direction, and speed) as well as the locations of sensitive receptors;
- A simple, linear layout for materials- handling operations to reduce the need for multiple transfer points will be designed and appropriately installed;
- Roads around the construction site will be adequately compacted and periodically graded and maintained. This reduces dust raising events during materials haulage by the heavy trucks;
- Water spraying of roadways and exposed stockpiles using a sprinkler system or will be implemented;
- Trucks will be covered with tarpaulin during transportation to prevent particles rising and contaminating local air around the transportation routes;
- Workers engaged in activities likely to raise dust will wear dust masks at all times during this phase;
- Areas near exposed surfaces of stockpiled materials should be vegetated.

4) Destruction of cultural resources

The construction process will pose potential impacts such as Complete destruction of the resource if present in areas undergoing surface disturbance or excavation; Degradation or destruction of near-surface cultural resources on- and off-site resulting from changing the topography, changing the hydrological patterns, and soil movement (removal, erosion, sedimentation) and Unauthorized removal of artifacts or vandalism as a result of human access to previously inaccessible areas; the impact magnitude in this case will be high because these are areas that have been under active conservation for long periods, therefore its possible that most of the artefacts are very rare and important to the country, and the receptor sensitivity is high because these resources are very sensitive in that none can be replaced after destruction. The impact severity in this case is major before the mitigations.

Mitigation

- The Developer and the contractor shall develop and implement a chance find procedure for the Ayago HPP.
- Where the developer/contractor has encountered tangible cultural heritage that is replicable and not critical, the personnel will apply mitigation measures that favor avoidance;

- Minimize adverse impacts and implement restoration measures, in situ, that ensure maintenance of the value and functionality of the cultural heritage, including maintaining or restoring any ecosystem processes needed to support it;
- Where restoration in situ is not possible, restore the functionality of the cultural heritage, in a different location, including the ecosystem processes needed to support it;
- Where the project site contains cultural heritage or prevents access to previously accessible cultural heritage sites being used by, or that have been used by, Affected Communities within living memory for long-standing cultural purposes, the developer will, based on consultations allow continued access to the cultural site or will provide an alternative access route, subject to overriding health, safety, and security considerations;
- Where an encounter has been made with artefacts, the developer will ensure that the project personnel doesnot disturb any chance find until further assessment by competent professionals has been made and the find has been rendered replicable in another area or be preserved in its current state;
- The developer/contractor will work in close collaboration with the UWA officials on any find and develop a procedure for addressing chance finds especially during excavations.

5) Soil erosion

Soil erosion is expected to arise from large quantities of excavated soil from the construction of weir, head and tail race powerhouse and access road. The soils in the region have been characterized as Acrisols of low productivity that are highly susceptible to erosion. The impact intensity in this case is medium, since large areas are scheduled for the excavation and the receptor sensitivity is medium because of the nature of the soils, predisposes them to a high susceptibility to erosion. The erosion is likely to deposit vast amounts of sediment in the rivers, or neighboring water bodies. The impact magnitude is therefore moderate before mitigations are applied.

Mitigation

- Project activities will be scheduled to avoid heavy rainfall periods (i.e. more activities during the dry season) to the extent practical;
- The developer will encourage contouring and minimizing length and steepness of slopes to reduce erodibility;
- Mulching using vegetation previously cleared from the areas will be used to stabilize exposed places;
- Re-vegetating areas promptly after activities. This helps to stabilize soils after excavation activities;
- Spoil and stock piling areas should have properly designed channels to direct runoff away from the areas to prevent material erosion;
- Designing channels and ditches for post- construction flows especially in periods of high flow;
- Lining steep channel and slopes (e.g. use jute matting) and removal of all the excess spoil to a designated place is advisable (Plate 29)

Plate 29: Jute matting to reduce soil erosion

- Transport all the soil excavated away from the slopes and dump in areas designated for spoil in the park (temporarily) and outside the park (permanently);
- Any spoils (Boulders) in the Weir area will be used for the backfilling of the weir
- Formulate construction planning on demarcation to suit exact places for slopes to be excavated to avoid over excavation and overproduction of spoil. Surveying the sites, installation of pegs and batter boards which are standard construction practices should be strictly adopted. (gGabions will be built in order to stabilize slopes and stop any earth sliding and thus control soil erosion and the subsequent siltation of the river.

6) Contamination of surface waters

Baseline parameters measured from the rivers Chobe, Bulaaya and Nile were within limits (National standards for portable water) and are currently able to support aquatic life, indicating good water quality. Accidental spills from vehicles and equipment with diesel engines may contaminate the water, lowering the quality and leading to suffocation of fish, and death of other aquatic organisms. Erosion leading to deposition of sediments in aquatic resources also introduced contamination into the water, increasing turbidity, suspended solids and lowering the overall water quality. Poor construction and domestic waste management may also release contaminants into the water ways. The impact intensity will be medium, because much as the main river has highly sensitive fish species like the tilapines and Nile perch, all activities will be a distance from the water course, except at the intake and end of tail race of the plant. The receptor sensitivity is high, because the Nile is an internationally shared system therefore any negative impact will affect not only a regional area, but may travel across international boundaries.

Water pollution sources during the construction include: wastewater from rinse of the sand/stone processing system, oily wastewater from maintenance of mechanical equipment, alkali wastewater, sewage from the construction staff, foundation pit discharge and wastewater from tunnel construction etc. For the Project, a sand/stone processing system is planned to be located at about 350 m upstream the exit of the access tunnel. The system will have a capacity of 725 T/h, and the estimated sand/stone wastewater discharge is about 580 T/h. Main contaminant in the waste rinse water is suspended solids with concentration as high as 30,000 to 50,000 mg/L, which will increase suspended solid concentration in local water area near the bank and will impact water quality of the river reach under construction.

Oily wastewater - Construction of the Ayago Hydropower Station is primarily mechanical construction powered by oil. Regular maintenance and rinsing of the machinery will produce a certain amount of oily wastewater in which the main pollutants are oil and suspended solids. In the discharged wastewater, suspended solids account for about 500 to 1000 mg/l and oil about 40 to 100 mg/l. Main construction machinery that need regular cleaning at peak time of the Project are about 300. Suppose that each piece of machinery need 0.6 m^3 for cleaning and 70% of the machinery powered by fuel need rinsing every day, wastewater generated will be about 126 m^3/d. Careless discharge of oily wastewater will reduce soil fertility and change soil structure, which is unfavorable to the recovery of the construction slash; if the wastewater is discharged to the Nile River, a layer of oil film will form on the water surface making the dissolved oxygen difficult to be complemented, which will adversely affect water quality of the river reach under construction.

Alkali wastewater - Three concrete production systems were planned for the Project. Rinsing water for concrete processing is Alkaline with pH up to 11 to 12, and has suspended solids of higher concentration, which can be up to about 5000 mg/L. Careless discharge of alkali wastewater will adversely affect the surrounding oil environment and water quality of the river reach under construction.

Influence of project implementation on water quality of the reservoir - In accordance with preliminary analysis on sectional pollution sources, total pollutant discharge of the Ayago Hydropower Station reservoir is very small. During operation of the Station, total pollutant discharge of the reservoir increased moderately compared to the status quo. After the Station is completed, residuary organics in the bottom of the reservoir decompose, then nitrogen, phosphorus and organic matters etc. in the soil get in the water. Accumulation of various types of pollutants will, over time, increase water pollutants content in the reservoir. However, concentrations have increased, the Nile run-off a large, however, runoff volume of the Nile is large, so pollution load of the reservoir is very small, and compared to that before completion of the Station, change of the water pollutants content in the river reaches of the reservoir is very small and it is unlikely to cause eutrophication in the reservoir.

Influence of project implementation on downstream water environment - Completion of the Ayago Station changed the let-down flow rate of water from the reservoir, thus changed space-time distribution of natural water in the downstream water courses. This section will determine min. flow rate to maintain basic habitats of existing aquatic organisms in water courses. Depending on the availability of environmental characteristics and information, the analysis selected hydrological method - Tenmant to calculate ecological flow rate. For Tennant, there are following rules: mini. environmental flow of normal rivers should be no less than 10% of average flow; but for large flow rivers (average annual flow is greater than 80 m^3/s), it can be adjusted and re-regulated, but should be no less than 5% of average annual flow. Current dam site of the Nile has an average annual runoff of 994 m^3/s, far larger than 80 m^3/s, the resulting ecological flow is 50 m^3/s. Therefore, the Project selected 50 m^3 /s as the min. ecological flow of watercourse downstream the dam site.

After the Ayago Hydropower Station is completed, flow rate and water flow of river reaches downstream the dam have been decreased substantially, which will impose influence on water dilution and degradability of the river reaches. However, the Station is located in Murchison Falls National Park with no source of industrial pollution, no village on both sides of the strait no villages, small amount of pollutants flowing into the river, low water pollution load and the Nile water environmental quality is rather high; moreover, project planning has taken into account the ecological flow of 50m^3/s at the Ayago dam site, and after convergence of sectional Ayago River, water flow in the river reach will be increased further. So reduce of water flow downstream the dam imposes little influence on the water quality.

Mitigation

- Activities that may destabilize soils/sediments should be done in as far as practicable in the dry season (ie when the seasonal rivers like Chobe are dry) to reduce sediment/contaminant delivery to the Nile;
- Application of appropriate construction practices and creating awareness among the construction crew of the need to maintain high water quality;
- All project vehicles scheduled to work near water resources will be cleaned prior to use (during the dredging activities);
- Surface runoff from process areas or potential sources of contamination will be prevented to prevent rain water contamination;
- When water quality criteria allow, storm water should be managed as a resource in holing lagoons, either for groundwater recharge or for meeting water needs at the site;
- Oil water separators and grease traps should be installed at sites for re-fueling equipment and vehicles and maintained as appropriate;
- Sludge from storm water catchment areas or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of wildlife, aquatic ecology and public health;
- Maintenance of vegetative buffer between the water and construction works to help trap loose sediments and or materials;
- Provision of automatic fill shutoff valves on construction fuel storage tanks to prevent overfilling and eventual spills
- Use of a catch basin or absorbent material to soak around the fill pipe to collect spills.
- In the key works areas, the items mainly include the overflow structures, water retaining structures, fishway, water diversion and power generation structures, etc. In order to ensure the engineering safety, for the excavated slope, the anchor pile, shotcrete and water interception/ drainage and other measures are taken in the main works design, all of which will contribute to the conservation of soil and water. During construction, the conservation of soil and water measures mainly refer to the temporary fencing and protection measures in regard to the temporary stack and storage of the excavated material. Upon completion of the construction, for the excavated slope of the buildings, appropriate greening measures should be taken; and for the exposed aboveground vegetation within the land acquisition boundary line, corresponding restoration measures should be adopted.

7) Contamination of ground waters

Waste storage areas for the construction crew may leak nutrients and biological pollutants into ground water resources. Other sources of pollution maybe spoil storage areas on site for contaminated soils. Storage areas for fuels may also lead to leaching of vast amounts of toxic heavy metals to below ground water resources. The impact magnitude in this case is low, because construction crew camps are expected to be short term, therefore any leachates will not have reached ground aquifers before the camps are removed and restoration commences. The Receptor sensitivity is low because there are not many ground water users in the park save for a few Park hotels that substitute with surface waters therefore presenting a minor impact before mitigation.

Mitigation

- Waste collection points for workers at the construction site will be located out of the high water table sections of the area;

- All waste areas will be banded during temporary storage to prevent pollutant leaching to below ground water resources
- For the waste water produced from sandstone processing and washing, the flocculant is applied for precipitation. After treatment, the waste water could be reused for production and processing, so as to maximize the utilization rate of water resource. The filter residue precipitated is placed in the spoil disposal area after water removal.
- All effluent and waste waster shall be assessed to comply with national discharge standards before discharge into the environment.
- A simple waste water collection system is established where the machinery are placed. The waste water containing oil will be collected in the catch pit and treated in the oil separator as required before discharge.
- For the alkali waste water produced during construction, the sand which is easily precipitated will be removed by means of intermittent natural precipitation. Due to a high pH value of the waste water, appropriate amount of acid may be added to the sedimentation tank to adjust the pH value to a neutral figure before the sedimentation process.
- The camp buildings will be equipped with a domestic sewage purification device.
- In view of the large discharge amount of waste water from the foundation pit and tunnel construction and the high pH value and high content of suspended substance, it is proposed to apply the neutralizer before static settlement for over 2h for discharge.

8) Loss of vegetation

Sections scheduled for the construction of the Head and tail race, the power house and the waterway will inevitably be stripped of vegetation. The areas identified for these facilities are within the grassland cover of the MFNP and therefore the impact magnitude is rated as medium, and the receptor is medium because grasses easily re-vegetate after disturbance as compared to woody plant species.

Mitigation

- The developer will select appropriate low- impact extraction (e.g. excavation, quarrying and dredging) methods that should result in final site contours supportive of habitat restoration principles and grasses re-establishment;
- Native species especially those preferred by native/migratory birds will be left intact as far as practical and in the event this is not possible, they will be relocated within the same corridor;
- Establishment of buffer zones from the edge of extraction areas, considering the characteristics of the natural habitats and the type of extraction activities;
- Vegetation translocation and relocation techniques will be used as necessary. Vegetation cover, such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement;
- During extraction, ecological niches should be preserved and protected as far as possible;
- Smaller, short-lived extraction sites will be reclaimed immediately, and larger sites with a useful lifespan beyond 3–5 years be subject to ongoing rehabilitation.
- The contractor shall be required to develop and implement tree planting and greening innitiatives to offset the lost vegetation

9) Construction traffic

The construction phase will entail material haulage that will put varying number of heavy trucks on the main roads to the park and roads within the park. The current heavy traffic observed during the baseline development was at the Junction in Kiyanja TC and Masindi-Kigumba road. The Chobe route had less traffic except for that associated with recreational activities to the lodge. With an introduction of heavy vehicle traffic to the area, the Masindi-Kigumba road will not be heavily impacted since already there is heavy vehicle flow. Chobe route will be heavily impacted because currently there is low vehicle flow and an increase will disrupt normal traffic movement to the lodge. The impact intensity is medium, because the construction is to take place in phases, which will necessitate the usage of only a small number of vehicles at a particular time. The receptor sensitivity is low on the Masindi-Kigumba road and high on the Chobe route producing a combined receptor sensitivity of medium ranking, since either routes are likely to be used. The impact severity is moderate before mitigations

Mitigation

- The developer will plan vehicle routes to target low traffic hours on Masindi-Kigumba road and will establish high vehicle access on the Chobe route during low tourist seasons to avoid interference with lodge activities;
- In the case that there is an overlap of public and project vehicles, the developer will be charged with controlling vehicle traffic through the use of one -way traffic routes if needed, and on- site trained flag-people wearing high- visibility vests or outer clothing covering to direct traffic;
- Ensuring the visibility of personnel through their use of high visibility vests when working in or walking through heavy equipment operating areas, and training of workers to verify eye contact with equipment operators before approaching the operating vehicle;
- Ensuring moving equipment is outfitted with audible back-up alarms;
- Using inspected and well-maintained lifting devices that are appropriate for the load, such that there are no breakdowns in the middle of the road;
- Contractor shall provide temporary road signage during construction and ensure drivers observe speed limits and for safety of other road users.
- In view of the geographic and geomorphic conditions of the Project area, the construction roads are basically built along the contour line, and considerable damage is caused to the mountain during road construction (upside: excavated slope; downside, backfilled slope). For the excavated slope, the water interception/ drainage measures are taken in the main works design and the protection measures (such as interception) are taken for the downside of the backfilled slope, all of which will contribute to the conservation of soil and water. During road construction, it is proposed to clear the excavated and scattered scruff and intercept the scruff on the lower slope. Upon completion of the construction, for permanent roads, the greening measures should be taken for the excavated upper slope, backfilled slope and buried lower slope; for temporary roads, the land reclamation measures, including the removal of hardened land surface and ground leveling, should be taken, and the vegetation should be restored.

10) Noise

The construction duration for the hydropower project is expected to last for about five years and it is anticipated that noisy equipment (Heavy Vehicles with potential emissions of Rock drill- 99 Portable air compressor- 80, Power saw- 110 Concrete mixer- 82, Bull dozer- 87, Dump truck- 90, Pneumatic tools- 85 measured 15m away among others) will be used in the construction process. The limits according to the National environment Noise Standards and Control regulations, 2003 for construction sites are 85 db and 65 db during day and night respectively. Noise impact from one vehicle will be low, given the vegetative barriers and remoteness of the construction site from receptors, however because of the magnitude of activities, more vehicles will be involved at any given time of day and these will elevate the overall noise emissions from the construction process. The impact magnitude will therefore be high, and the receptor sensitivity is high given that this is a wildlife area, producing an overall impact severity of major ranking before mitigations.

Mitigation

- The developer will erect noise barriers such as temporary walls or piles of excavated material, between noisy activities and sensitive receptors (animal breeding grounds);
- The traffic will be re-routed to roads with few vehicles (Chobe route) to reduce the cumulative impact from additional traffic to already congested roads like the Masindi-Kigumba junction;
- Speed limit of 40kph shall be adhered to within the national park;
- In order to limit noise due to haulage traffic, the construction fleet will be kept in good condition, well serviced, well fitted with efficient silencers;
- Because the operation of the generator will introduce unacceptable noise levels it is recommended that the generator will be housed within a sound proof structure;
- Use few generators with higher capacity instead of so many small generators. This minuses the footprint
- Signages and where possible speed bumps will be installed so that tracks ferrying the construction materials do not move at high speeds which enable high noise generation;
- Speed guns, speed governors and trackers shall be used to monitor compliance to speed limits.
- Drivers and operators of heavy equipment shall be sensitized to adhere to standard operating procedures and ensure the equipment and macheinery are efficiently serviced.
- It will be mandatory for the workers to use earmuffs and the supervisor will ensure compliance to this requirement. Disciplinary measures should be taken against any worker who do not comply with safety requirements.
- There will be a periodic monitoring programme (weekly) for noise to check if measures put in place are having the desired effect. These measures include the housing of the generator in sound proof casing, proper maintenance of vehicles. Upon realization of high noise levels and receipt of compliants from stakeholders, the Owners Engineer shall give instructions to the contractor to comply with the existing national standards.
- A calibrated sound meter will be used to record Measurements or readings will be taken at distances from the noise producing equipment e.g. generator.

11) Waste

There will be over 1000 workers at the site at any one time who will require accommodation, washing, sanitation and cooking facilities, Worker camps will produce solid and liquid wastes which will require treatment and safe disposal to prevent soil and water pollution. The impacts arising from these wastes have been addressed separately in the worker's camp ESIA. However, the construction itself will produce wastes in the form of domestic wastes from workers onsite, including waste food materials, plastic waste containers and human refuse on site. There will also be hazardous waste generation from re-fuelling areas, workshops and that from waste oil containers. The impact intensity in this case is medium, because the majority of waste anticipated for production on site will be organic since the workshops are to be located considerably far from any sensitive areas. The receptor sensitivity is low for the organic pollution, while that arising from workshops would be high, producing an impact magnitude of medium rank. The receptor sensitivity is high because any reduction in water or soil quality will be significantly negative. This therefore implies major negative impact before mitigation.

Sewage from the construction staff - From excreta, food residues and detergents etc., major pollutants in sewage water include COD, BOD 5 and so on, with concentration up to 400 mg/L and 250 mg/L respectively. The number of people at peak time of the construction will be 4800. Suppose that sewage water from each person is 150L/person·d and the discharge coefficient is 0.8, it is primarily estimated that the max. Sewage discharge will be 576m 3 /d. If sewage water is discharged directly without treatment, it will affect water quality of the river reach under construction.

Foundation pit discharge water and wastewater from tunnel construction - Project foundation pit discharge includes initial discharge and regular discharge. Regular foundation pit discharge is composed of cofferdam water seepage, rain and water for construction. Due to excavation of the foundation pit and maintenance of placed concrete, suspended solids content and pH value of the foundation pit value is rather high. For regular discharge, the pH value is up to 11~12 and suspended solids content is about 2000mg/L. Direct discharge of foundation pit wastewater without treatment will adversely affect water quality of the Nile River. Wastewater produced by excavation of diversion tunnels, construction adits and underground cavities usually have rather high suspended solids content and pH value. Direct discharge from tunnel construction without treatment will adversely affect water quality of the river reach under construction. All waste water and effluent from the project site shall be metered and discharged into the environment after treatment (e.g sedimentation) and must comply with national discharge standards.

Mitigation

- The contractor shall be required to develop a a modern waste handling and disposal facility outside the MFNP
- Composting should be done for organic waste
- The contractor should aquire All permits relating to waste disposal, transportation etc should be aquired
- The contractor should ensure that the complaince status of sub-contractors involved in the project is ascertained with NEMA
- The developer and or contractor shall be required to develop and implement a waster management plan for the Ayago HPP.
- Because of the construction site is in the national park, any human fecal material waste produced will be contained in temporary sealed septic tanks before collection by licensed waste collection agency and disposed at NEMA approved facilities;
- There is need to consider set-up of a waste treatment plant for the project human fecal material treatment before discharge to the environment outside the park;
- The contractor will be procured to be responsible for the handling and transporting of hazardous waste.
- Transportation of all waste from the project area to areas of disposal and recycling shall be done by licenced contractors
- All domestic solid waste (i.e. trash and garbage) will be source separated into organic, paper and non-biodegradable fractions.
- Biodegradable, and Non-toxic non-biodegradable waste, including glass, plastic and metal cans, bottle tops, foil wraps, etc. will be bundled and transported to the nearest designated District/Sub county Solid Waste dump site by a licensed handler.

- Toxic, non-biodegradable waste such as spent machine oil and batteries will be stored in sealed drums, which in turn will be stored within a bund having 110% storage capacity volume, until they can be removed for safe long term disposal at the nearest designated District/Sub county solid waste storage site or improve the facility to take up the wastes from the project;
- Hazardous wastes such as: torch batteries, motor vehicle batteries and any other waste classified as hazardous will be disposed off in accordance with the manufacturer's specifications. Initially it will be contained in sealed drums before it can be transported to designated points by a licensed handler;
- Packaging materials: It is not anticipated that there will be a lot of packaging materials at the power plant construction site. Invariably this may consist of paper boxes, plastic containers in the form of bags, bottles and drums, and metallic containers. Those packaging materials that were not used for hazardous materials can be disposed of normally as described above. If there should be packaging materials used which are hazardous, then they will be disposed of in accordance with manufacturers instruction or containerized and sealed.
- Plastics: Plastics arising from the construction activities are non biodegradable and will persist in the environment. They may be carried by storm water into the rivers Chobe, Ayago, or the Nile causing aesthetic problems, as well as suffocation of wildlife like fish, crocodiles and hippos. Broken plastic pieces can be a safety risk to employees and wildlife. Careful attention needs to be paid to their disposal.
- Metal scrap: metal scrap will be collected and when in suitable quantities sold off for recycling. Alternatively it will be containerized for future use or recycling.
- All waste water and effluent released to environment must be first treated to meet the required standards (National Environment (Standards for discharge of effluent into water or land) (regulations).

12) Occupational Health and Safety Risks

Construction and operation activities at the hydro power project that involve handling of heavy equipment, working at height, working near waters that habour dangerous wildlife, working with fuels and other hazardous material, may cause injuries to project workers, leading to loss of limbs, and in the worst case scenario, death. Workers will be exposed to diseases arising from sanitation inefficiency which may lead to a loss of valuable work-days due to ill health. The probability of occurrence is high, due to the nature of the activities, which may present a number of occupational health and safety challenges. The overall significance is major, therefore necessitating stringent mitigations as proposed below.

Mitigation

- Contractor shall develop and implement Occupational health and safety management plans. Supplimentally environmental and social management plans have also been developed under Volume II.
- Carry out risk assessments and prepare a risk management plan of all activities at work site and purchase fit for purpose PPE for use by the workers.
- Ensure certification of the equipment by Ministry of Gender, Labour and Social Development and registration of work place.
- The contractor should carry out baseline health screening of workers before employment and bi-annual health check-ups for workers.
- Surfaces, structures and installations should be easy to clean and maintain, and not allow for accumulation of hazardous microorganisms. Therefore surfaces in food preparation areas will be maintained with a highest level of cleanliness to prevent food poisoning due to ingestion of contaminated food stuffs;

- Structures housing workers will be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise conditions;
- Passages to emergency exits should be unobstructed at all times. Exits should be clearly marked especially with reflective tapes. The number and capacity of emergency exits should be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum of two exits from any work area;
- Only highly skilled and experienced workers with valid permits will be allowed to operate heavy machinery (cranes, excavators, graders) and heavy trucks (Tipper trucks) and the conditions of the permits should be enforced;
- Equipping the fuel storage areas/re-fuelling places with fire detectors, alarm systems, and fire -fighting equipment. The equipment will be maintained in good working order and be readily accessible;
- Provision of manual fire-fighting equipment (fire extinguishers) that is easily accessible and simple to use. Trainings where necessary will be undertaken to ensure adequacy in the usage of the equipment
- Contractor should develop and implement an emergency preparedness and response plan.
- Fire and emergency alarm systems that are both audible and visible will be installed in areas with a high likelihood of fire (enclosed spaces, near generator, fuel storage) and purchase of emergency and first aid equipment in accordance with the Occupational Health and Safety Act, 2006 and designate fire assembly points;
- Carry out period emergency response drills to assess workers response to emergency and adequancy of the emergency equipment
- Conduct daily tool box meetings before start of each work shift.
- Recruit qualified and experienced personel to manage the health and safety work.
- Establish health and safety management committees with representation of the workers in accordance with the Occupational Health and Safety Act, 2006;
- Ensure placement of adequate sanitary facilities around the work site in accordance with Public Health Act,1964 and ensure they are cleaned all the time and the design plans are approved.
- Any excavated pits will be guarded (with tape or mesh) to prevent wildlife falling into the pit and or community members/tourists;
- Worksites especially those posing a greater danger to humans/animals will have limited access (i.e. excavation areas, worksites with heavy vehicular movement);
- Training of workers in lifting and materials handling techniques in construction and decommissioning of projects, including the placement of weight limits above which mechanical assistants or two-person lifts are necessary;
- Planning work site layout to minimize the need for manual transfer of heavy loads. This reduces over exhaustion of project workers;
- Job rotations and rest or stretch breaks;
- Implementing good house-keeping practices, such as the sorting and placing loose construction materials or demolition debris in established areas away from foot paths/;
- The sanitation and hygiene management of the reservoir area focuses on the insect and mouse killing and disinfection of each epidemic spot within the submerged areas to reduce the vector density of pathogenic organism and mosquito and mouse, so as to control the prevalence of infectious disease and natural focal disease within the reservoir area during construction and after water storage.
- The drinking water protection and food hygiene management should be enhanced. Wider publicity should be given to health-care knowledge and relevant knowledge on the commonly seen infectious disease should be popularized, so as to raise the people’s awareness of health care and disease prevention.

- Establishment of a functional and well equipped health facility on site and recruit qualified and registered doctors in Uganda to ensure registration and supervision of the clinic.
- Orientation of new workers on the likely occupational health and safety risks and hazards at the work place and possible mitigation measures.

8.6.2 Faunal Impacts

1) Animal behavior alteration

Many mammal, reptile and bird species may alter their behaviour patterns if disturbance becomes severe. For instance, the duiker may avoid areas frequented by people during the day and tend to feed at night, which is not their norm. This destabilizes the natural flow of ecosystem functions, and interrupts the predator-prey relationship. For instance predators that are unable to find prey will tend to attack neighbouring communities because the disturbance has made it impossible for the prey to appear during day. Disturbance can arise from mere human presence, noise, vibration and light intensity. Night (intense lighting) activities may disrupt feeding habits of organisms like copepods, plankivorous fish that feed on plankton at night. If the area is illuminated continuously (24hrs), these organisms may fail to feed and an alternation of behaviour indicates an overall change in ecosystem trophic levels. This may destabilize normal ecosystem function, which may lead to a low fish yield from the river and eventual loss of income for many downstream community members that depend primarily on fishing. The impact intensity on aquatic species will be medium, because most activities will be a distance from the main river, therefore the aquatic organisms will have the riverine wetland plant shielding most of the nightlights out however hippos that are night grazers may be considerably negatively affected, making the impact magnitude high and the receptor sensitivity is High, because there are a variety of wild animals that the project is likely to impact on. The impact intensity is therefore major, however with mitigations; this is anticipated to become minor severity.

Mitigation

- The constractor should implement a biodiversity monitoring plan for the project area as presented under Volume II.
- Areas scheduled for night activities will be located away from the edges of the river, so that minimal interaction between workers, machines, and the river edge, especially the wetlands, where fish are known to spawn and are also a habitat for juvenile fish;
- Any night activites will prevent illumunation in as far as is practible to prevent interference with normal activities in River Nile of the aquatic organisms;
- Barriers between sensitive habitats and worksites will be erected to enable the separation of project activities from habitats within the park;
- Lights at the worksite during night time will be directed at the activity, rather than illuminating the entire area. This is aimed to reduce the ‘trespass’ of lighting into areas that are not intended to be lit (including the night sky). Reducing the trespass of lighting will maintain heterogeneity even in otherwise well-lit areas, providing dark refuges that mobile animals (hippos, and other nocturnal predators) can exploit;
- The developer will take advantage of vertical shading offered by natural landscape (hills) and horizontal shades, offered by vegetation canopies;
- Lights will only be used as and when needed, so that continuous/unnecessary lighting is limited;
- The construction areas shall be fenced off. The fence should be that which blends perfectly with nature and prevents wildlife injury as they move to foraging areas;

- All support infrastructure and facilities will be located away from known/established animal corridors, breeding grounds to prevent animal disorientation; Hippo trails should be mapped and avoided during the construction and operation.
- Known animal foraging areas should not be illuminated.
- Create poundage areas within the areas of reduced flow between the intake and the outfall (cutoff area) to mimic the original habitat for the High population of Hippos observed along this stretch.

2) Injury to fauna

Construction of the intake structures, weirs and power house would significantly alter the river that would provide the water supply for the hydropower facility. Fish could be injured or killed during construction of the intake or dam through human or mechanical means or due to increased sedimentation downstream. The impact magnitude is low, since the construction will be phased that any structures nearest the river will be constructed last, to prevent water inflow into incomplete structures and associated consequences. The receptor sensitivity is low, since the areas proposed for the weir, intake and powerhouse have lowest diversity of fishes and or other animals.

Mitigation

- The construction areas shall be fenced off. The fence should be that which blends perfectly with nature and prevents wildlife injury as they move to foraging areas;
- Incase any fish and other aquatics are caught in the excavated sections for the water intake facilities; they will be removed and placed in the main river to prevent injury.
- Put in place evacuation mechanism for any trapped wildlife during the construction period.
- All injuired or trapped wildlife encountered should be reported to UWA for appropriate action.
- In liaison with UWA, all project workers shall be sensitized about the park rules so as to sustainably co-exist with wildlife

3) Animal Migration

Encroachment on faunal habitats especially areas used for grazing and or breeding may lead to attacks on humans by wildlife. The diversion of waters to the waterway and eventual evacuation to the powerhouse may displace animals such as the hippos, from the shores of the Nile, leading to their migration towards the new-waterway. Elephants may be forced to water at sections further downstream of the river, or away from the left bank (southern bank) of the river. This may push elephants into already established niches belonging to other wildlife (hippos, warthogs). The impact intensity in this case is medium, since most of the large mammals already graze in areas occupied by smaller mammal (warthogs) so no clash is anticipated, especially since the two big mammals (hippo and elephant) feed at different times of day. The receptor sensitivity is low, since the most preferred feeding/watering grounds for large mammals is the northern bank, and the power plant and associated activities will be the southern bank. The impact severity before mitigation is therefore moderate before mitigation.

Mitigation

- All activities likely to lead to large migrations should be minimized;
- Vegetation clearance will be minimal to ensure that after construction, animals originally grazing on the southern bank can re-establish after the construction activity;
- All activities unavoidably located in breeding grounds will be halted during the breeding season to prevent animal attacks on workers.
- Design a still basin at the outfall to mitigate the high velocity of water flow into the river and tunnels.

- Identify and map out migration routes and where possible protect them. Discourage establishement of support infrastructure or facilities in such routes

4) Hydrology

Construction of the weir, installation of the headrace and tail race will alter water flow (hydrology) by the diversion and temporal storage of water, affecting the speed at which water travels through the catchment (retention time). As a result flood patterns and seasonal flows may change; the flood level which was expected during the wet-period will be lower and the dry period may present shallower situations in the Nile section between the intake and the tailrace. Hippos require atleast 1.5m depth at the banks to submerge and keep cool during the daytime. An alteration of the bank flood regime will move the animals deeper into the river, which may lead to high turbidity since hippos movement in and out of the river highly destabilizes sediments, which may in turn lead to suffocation of fishes and other aquatic organisms. The impact intensity is low, because the water will be returned to the main flow channel a distance downstream of the plant; however the receptor sensitivity is high because there are a variety of animals directly dependant on the waters of the Nile associated streams.

Mitigation

- To avoid impacting on the ecology and to keep the sytem in a health state, it is recommended that instead of EFR of 10%, a fixed discharge of 100cumecs bemaintained all the time.
- Discharge from the tailrace will be maintained as a percentage of the normal flow to reduce alterations especially when the river floods;
- Protective barriers/screens will be offered at the weir to ensure that fish and other aquatic organisms do not meander into the water way, because they may be injured at the powerhouse;
- Construction of the weir will prevent a significant loss of water from the main river channel during the dry season because this will act as a very temporary water storage area before the water is directed into the intake and power house;
- Normal hydrological functions like transportation of sediments downstream will be maintained to sustain the downstream ecological functions like siltation in the wetlands, that are areas for breeding/feeding for various birds and wildlife; this is so because the water will not be dammed at anytime during plant operation;
- The stretch of reduced flow between the intake and the outflow should be modified to provide a natural habitat for hippos through creation of small weirs and ponds to cater for the aquactic life.
- The contractor shall carry out additional studies and river surveys and develop mitigation measures that will be undertaken on the river between the intake and outfall after the diversion of the water through the tunnels.
- Update the baseline before diversion.

8.6.3 Terrestrial and Aquatic Ecology

1) Influence on terrestrial plants

The project mainly covers grass, shrub land and woodland. So it will cause certain damages to regional vegetation. Reservoir filling will inundate a small amount of vegetation below normal storage level at both sides of the River. Key project construction, road construction and other construction activities, etc. will also damage local vegetation, reducing areas covered by various kinds of vegetation and amount of plant resources in the construction areas. On the other hand, however, inundation of the reservoir will have some potential and long-term beneficial effects on terrestrial ecological environment at borderland to both sides of the reservoir. If the surface becomes larger as water store, small local change of weather will promote growth of plants, recovery and development of vegetation at a certain scope around the reservoir.

2) *Influence on terrestrial animals*

Terrestrial animals in the project area are mainly composed of mammals, amphibians, reptiles and birds. Water storage in the Reservoir will force mammal populations to migrate to above the reservoir flooded line; will reduce habitat areas of amphibians and reptiles, change the living environment they've already been adapted to and thereby forcing them out of the environment to higher places for survival. On the other hand, local climatic effect of the reservoir is beneficial for the growth of plants and recovery of vegetation, providing suitable living and breeding environment for herbivorous insects. Increase of insects provides more food for some animals creating better conditions for their living and breeding, which is beneficial for the recovery of the population. In general, there are both beneficial and adverse influence on amphibians and reptiles and negative impacts are limited.

Enlargement of water area, especially reservoir area will enlarge the habitat of wetland birds, resulting in the increase of species and numbers. In general, water storing in the reservoir will, to a certain extent, have certain influence on habitats terrestrial animals. For terrestrial animals existing in the submerged area, except that animals with weak migration ability and reptiles in hibernation will be reduced, species and numbers of most animals will not be affected substantially. After the reservoir stores water, marginal effect of the reservoir may also provide some animals with new habitats of higher quality, which is favorable for habitation of these animals.

3) *Influence on aquatic habitats*

After completion of the Ayago Hyrdropower Station, water in the reservoir increases, water level upstream of the dam rises, water flow rate slows, sediment deposition becomes obvious and water transparency becomes higher, so the reservoir will convert from typical torrent to subcritical watercourse habitat. After implementation of the Project, a water reduced river reach will be formed at about 9.4km downstream of the dam. However, the Project has taken a let-down base flow of 50m3/s, so it is unlikely for the water reduced river reach to run dry. But reduction of water flow at the water course from the gate of the dam to the plant still have a certain degree of influence on living environment of aquatic organisms, forcing aquatic organisms to migrate to the upstream or tributaries and leading to decrease of species and numbers of aquatic organisms in the river reach.

There is the Murchison Falls downstream of the water reduced river reach of Ayago Hydropower Station, so fish migration in the river reaches in the project area has natural barriers, and therefore the construction and operation of the Station have little impact on fish migration activities. In addition, for the purpose of the coherence of upstream and downstream fishway arrangement, fishways are designed for the Project, so as to reduce impact of dam barriers on aquatic organisms and to impose little influence on continuity and integrity of aquatic habitats.

4) *Influence on food organisms*

After completion of the Ayago Hyrdropower Station, water surface in the reservoir is enlarged, water flow rate slows, nutritious substances are retained and transparency becomes higher, which is beneficial for the breeding of plankton, leading to increase of species and numbers of phytoplankton and zooplankton. Food organisms in the Reservoir were mainly composed of zoobenthos and periphytic algae, then evolving into food mainly containing phytoplankton and zooplankton; community structure of food organism resources in the Reservoir which is favorable for growth and breeding of fish feeding on plankton.

5) Influence on fish

Barrier of the dam will cause fragmentation of fish habitats, hindering genetic exchange of fishes upstream and downstream of the dam, which may lead to decrease of genetic diversity. Change of hydrological regime will reduce the number of fishes adapted to torrent environment or force them to migrate to the upstream or tributary areas, while number of fishes adapted to subcritical flow will increase. Fishways of the Project are located at the central bar with a total length of about 620 m. In addition, at tail of the Reservoir and in riverine area around the Reservoir, rich nutritious substances are suitable for the growth and breeding of fishes, so that there are more fishes. But for areas upstream of the dam and mainstream water courses, maybe oxygen deficient due to deep water and few nutritious substances which will lead to small amount of fishes.

Mitigation

- Establishment of fishways (fish ladders) will not only provide passages for some migratory fishes, but also create conditions for fishes loving running water to take fishways as habitats, so as to reduce influence of the dam barrier on fishes.
- Identifty the breeding grounds for aquactic life and gazette them
- Before construction, the preliminary work concerning construction planning should be done as required; during construction, the protection of the spoil disposal area should be enhanced and the construction of waste water & sewage should only be discharged after meeting applicable standards to minimize the adverse impacts on the aquatic organism;
- the environmental flow of 50 m^3/s should be ensured during the operation of the Hydropower Station, the discharge regulation should be optimized at an appropriate time and the ecological regulation should be adopted according to the ecological protection of the river channel; the fishway is set up in the river island, reducing the impacts of the dam on the fish. It is recommended that the fishery administrative management should be enhanced and the aquatic organism should be monitored and investigated to alleviate the adverse impacts.

6) Influence on Aquatic Ecology

Construction phase will mainly involve riverbank vegetation clearance, topsoil stripping, riverbed excavations and blasting, earth movements and development of embankment. All these activities increase sediment transported to downstream reaches. Increased suspended and dissolved solutes (turbidity) are likely to cause visual impairment reducing escape ability and hunting efficiency of organisms. Subsequent silting would modify habitats, feeding and breeding environments thus shift to pollution tolerant flora and fauna communities in the downstream reaches.

These impacts are **negative** and **significant**, **local**, **reversible** and **short-term** in nature; anticipated to occur throughout the construction phase.

Mitigation

- Avoid damping waste and excess construction and excavated materials into the river;
- limit clearance of vegetation and stripping of subsoil only to critical areas of river bank;

- Minimise riverbed and riverbank disturbance (e.g. restricting access of construction activities and workers to susceptible areas that could contribute to sediment loading);
- Develop " environmental rules" and protocols to reduce effects on vegetation, noise management, avoidance of spills, maintenance of pollution control measures such as oil separators, and a dust management plan;

8.6.4 Landscape Alterations

Construction of the Project will cause certain changes to characteristic of the river reaches in the project area. Muck disposal areas, Adit portals, camps and other support infrastructure within MFNP are also potentially going to change the land scape of MFNP. Water level of the Reservoir keeps stable in general, so the Reservoir water still has river landscape features. In addition, the Murchison Falls is located outside the water reduced river reach of the Station to be constructed, the project construction have little influence on the fall landscape.

Mitigation

- The contractor shall develop a greening and landscaping plan for the project area.
- The developer shall develop and implement a decommissioning and restoration for the whole site
- The riverfront landscape showing harmony between man and nature should be created.

8.6.5 Environmentally Sensitive Area

Construction of the Ayago Hydropower Station Project, water storage and project construction will cause damages to vegetation in the Murchison Falls National Park, leading to reduction of areas covered by various kinds of vegetation and amount of plant resources in the National Park. Widening of the water surface in the Reservoir will narrow habitat areas for amphibians and reptiles, which will impose certain influence on animals in the National Park. In addition, the Station is located in a medium tourism area in the Murchison Falls NP, which will have certain influence on the tourism in the National Park.

Mitigation

- Liase with UWA to identify key areas that are sentive in the project area and to enable development of suitable mitigation measures.
- Enhance the publicity, education and management of the construction personnel and local residents, formulate applicable rules and regulations and strictly prohibit the catching for pet use,poaching and killing of wild animals within the construction area.
- In each work area, the warning signs should be set up to protect the terrestrial animals and plants. In case of any rare animal wounded, effective first aid measures should be taken and contacts with UWA should be made; and the rare plants and ancient trees, if any, should be immediately transplanted.
- Carryout an economic valuation to determine the value of the biodiversity and ecosystem that will be lost to enable come up with the biodiversity offset
- With guidance from stakeholders, develop and implement a decommissioning and restoration plan.
- All pollutants should not be discharged unless the applicable standards are met or with an obtained waste discharge permit, so as to reduce the impacts on the environmental quality of Murchison Falls National Park.
- Sensitise all workers about park rules and guidelines for sustainable operation in the national park
- Implement project activities by strictly adhering to design requirements.

8.6.6 Social Impacts

1) Increase in employment and household income

Direct impacts would include the temporary creation of jobs for construction workers and the associated income and taxes generated by the hydropower project. Indirect impacts would occur as a result of the new economic development, and would include new jobs and businesses that support the expanded workforce or provide project materials, and associated income and taxes. Hydropower development activities could also potentially affect property values, positively, from increased employment. The project will employ people from Kiryandongo and Nwoya districts. The employment of labourers, both technical and casual will increase overall household income through salaries offered during construction. The impact magnitude will not be discussed in this case because employment is beneficial to communities and therefore no mitigations are required, rather some recommendations will be suggested.

Recommendations

- Priority should be given to residents of the communities within close proximity to the project site;
- Equal treatment of men and women should be emphaised during the employment process, with due consideration to community structures and norms;
- No children will be hired on the project for any work in keeping with the International Labor Organization, (ILO) Convention No. 138, (1973), that defines the minimum age of employmentand the Labour Act.
- Workers should be employed depending on their qualifications
- Wage structures should be harmonized for the different categories of workers and professions employed on site.
- A clear grievance/complaints handling mechanism should be established
- The Contractor should ensure fair treatment of all workers on site irrespective of race and gender
- The contractor shall establish an ethical code of conduct to be followed by all workers on site
- Sexual harassment of workers should be avoided at all costs and penalized where it occurs

2) Influx of migrants

The establishment of temporary construction camps for the project workforce will increase the influx of migrants into the Kiryandongo, Nwoya and other areas. It is also anticipated that the promise of employment will draw residents from the neighbouring areas in search of work. The influx could result in secondary effects such as increased spread of diseases like HIV/AIDS and other STDs. The impact magnitude is high, because a large number of people is expected to be engaged in the construction process. Along with the expected workforce, associated developments complementary to the project will be set up, like airtime booths, along the route to the worksite, restaurants, among others.

Mitigation

- The contractor shall develop an HIV/AIDS prevention and awareness plan
- In line with the developed plan,the Contractor will continuously sensitize workers and community members on HIV/AIDS and STDs prevention and the dangers of unsafe sexual relations;
- Workers housing will be planned and located strategically so that access by community members is limited to official reasons only, like delivery of goods/services. This will prevent social visits by residents to workers camp and potential engagement in disagreeable behavior.

- Deliberate effort shall be made by the contractor to curb defilement and sexual abuse of school going children and minors.
- Workers will be encouraged to abide by the set out company code of conduct while on duty to prevent risky interactions with community members.
- The contractor shall provide facilities for co-curricular activities for workers when off duty.
- Workers will be transported to and fro the construction site to limit unnecessary encounters with community members.
- The contractor will provide a communication forum with the local leaders, with women and youth groups to monitor any changes in social structure and population.
- The contractor shall engage in social co-operate responsibility activities to mitigate the effects of influx of immigrants in the project area.
- Project should set up internal controls and security systems for its materials and worker's personal items.
    - Issues of security should be handled hand in hand with the local Council administration to ensure that suspicious elements are delt with lawfully to avoid disrupting project activities .

3) Disruption of cultural norms and practices

There is also a possibility of disruption of cultural norms of the residents in Kiryandongo and Nwoya districts. The impact intensity is low, because priority is to be given to residents in the communities within Kiryandongo and any neighboring districts. The receptor sensitivity is medium because the residents are moderately modernized and positively responsive to development changes.

Mitigation

- The contractor shall undertake a baseline study on the social economic and cultural aspects of the communities of the project area.
- Any foreign project workers will be informed on cultural norms of the local communities before encounter, to avoid conflicts with communities;
- Capacity building of Local Authorities shall be done to strengthen in order to deal with the their ability to deal with the social impacts that will result from the population influx;
- Cultural norms relating to gender will be considered in all aspects of project implementation.

4) Loss of Aesthetic Quality/Landuse

Changes in aesthetics (landscape/visual beauty) are another potential direct effect from the hydropower development. There is growing evidence that people increasingly value aesthetics in their daily life and environment (Postrel, 2003). The current landuse practice is recreation, however with the HPP construction; the landuse will change to commercial hydropower generation. Ground disturbance and vegetation removal may produce contrasts of water color, form and soil texture. Such disturbances could occur as a result of excavation for foundations and ancillary structures; trenching to bury pipes; grading and surfacing of the roads; clearing and leveling staging areas; stockpiling soil and spoils (if not removed); and soil scars and exposed slope faces resulting from excavation, leveling, and equipment movement. It is anticipated that the project will change the visual quality of the left bank of the Nile in the proposed area significantly by introducing structures, cables, power-substations, lights, moorings, or barges. The most preferred views in the area are nature-like, by virtue of the tourists visiting the place per year. The alteration will therefore have a negative impact on the tourism in the area. The receptor sensitivity is high since maintenance of the park is partly due to the funds sourced from tourist visits and activities.

Mitigation

- The contractor in consultation with UWA and other stakeholders will follow the developed restoration plan to restore the landscape to as near as possible to its natural environment prior to project implementation.
- Maintenance of native tall trees around newly excavated areas shall be done to maintain the visual aspect of the area and to prevent visual intrusion;
- All construction of infrastructure in the park such as houses and electric poles should be painted green to blend with the aesthetics.
- Excavation areas will be properly condoned off to limit access to all none- construction crew to prevent accidents and exposure to construction site conditions within the park;
- All cleared areas and pits will be backfilled and trees, grass planted at the end of construction of the power plant and associated facilities to avoid further land degradation and rugged terrain;
- The waterway will be a perpendicular distance away from the river edge to avoid views of recreation activities on on the river. Erosion control measures shall be implemented by the contractor to prevent siltation of the river which could affect its visual beauty.
- The contractor shall ensure that tourism activities close to construction sites are not interfered with.

5) Health of the workers

During the construction period, increasing number of workers population influx mobility, will affect environmental health and drinking water quality. This poses a risk of exposure to intestinal and respiratory infections. It is important to ensure that health and sanitation issues are properly addressed by the contractor.

Mitigations

- Health screening and profiling of workers before recruitment and periodical checks/screening shall be conducted to monitor occurance and prevalence of diseases.
- The contractor shall provide a safe, accessible and clean drinking water source to all workers
- The contractor shall develop and implement an HIV/AIDS and STDs prevention and awareness plan for the workers and surrounding communities to the project area.
- The contractor shall construct usable and accessible sanitary facilities and changing room for workers and ensure proper maintenance.
- The contractor shall support and participate in health and sanitation campaigns conducted within the project area and the surrounding communities.
- The contractor shall construct and maintain a functional health facility/clinic registered and manned under the laws of Uganda.

6) Influence on historical relics

There are historical relics such as earthenware relics, stoneware relics and graveyards, which may be affected by construction of the Project to some extent. In-depth investigation and analysis on relics existing in the project area, as well as detailed assessment of their importance shall be performed before construction, in order to determine the influence of project construction on relics.

Mitigations

- The contractor shall carry out an archeological and physical cultural resources survey in the project area prior to project implementation.
- The contractor shall prepare a physical cultural resources management plan

- In the event of any chance findings the contractor shall ensure recovery, protection and delivery of the items to the relevant authorities for preservation

8.7 Operation Phase Impacts

These are impacts anticipated during the operation of the Ayago hydropower plant, including impacts on aquatic flora and fauna, river ecology, and hydrology.

8.7.1 Aquatic fauna

The Operation phase will involve diverting of river channel through spillways, impoundment of water in reservoir, and controlled release of water to suit operational requirements. The damming of the river water at the weir section will change flow characteristics from free-flow to static waters. At the weir, it is anticipated that stratification will occur, resulting in formation of oxygen limited hypolimnion. This reduces the vertical space available for fisheries habitation, which may lead to incidences of over predation (by resident fish predators like African Fish eagle, Kingfisher, Crocodiles and some sport fishers) if the fish are limited to living only in the Epi & Metalimnion. Fish such as catfish and some tilapine eggs which are buried in sediment may be pulled into the intakes and get killed. Fish food organisms will be highly affected by reduced flow rates and new species will invade areas with a slow current. The impact intensity is medium, because the planned weir will have an overhead flow, and the water will only be temporarily held back. The receptor sensitivity will be low, since the Nile has for over along time been turbid, providing adequate algal cover for most fishes from predators. This has for a long time reduced over predation from wild animals.

As a result of water impounding sediment and nutrient feeding to downstream reaches is prevented causing river bank morphology change due to corrosion to re-establish sediment requirement and deprivation of nourishment to downstream communities. Corrosion of riverbed and banks destroys the egg lying zone and microhabitat of some organisms making living in the river ecosystem restricted. Normal passage of migratory species is hindered by dam barrier preventing upstream movement aiming ovulation and feeding and thus significant species population decrease and discrepancy between up- and down-stream communities. In the upstream reaches, water temperature, salt, nutrient and oxygen distribution may change vertically as a consequence of reservoir formation. This may cause the generation of new living species and algal blooms in the reservoir.

River channel diversion dewaters organisms in the main channel exposing them to predators and entrains organisms through the floodgates, turbines and pumps where they can be damaged even result in their death. While controlled water release from reservoir causes water fluctuations in the reservoir that would undoubtedly affect the composition and diversity of aquatic vegetation, having an additive effect on the wider ecological food web within the area. When the reservoir is at its lowest level, the smaller residual volume of reservoir water will reduce habitat availability for fish and other aquatic organisms and form mud flat areas that encourage growth of terrestrial and semi-aquatic vegetation tolerant of temporary inundation (including nuisance species).

These impacts are **negative** and **significant**, **local** and **long-term** in nature**;** anticipated to occur throughout the operational phase.

Mitigation

- The weir will have an overhead flow, allowing for continuous flow of water, except at a reduced speed, though not slow enough to induce stratification;

- The intake will have fine screens to prevent suction of mature fishes into the headrace, as this prevents the fish kills at the turbines in the powerhouse;
- The water intake will be placed in the hypolimnetic strata of the water at the weir. This zone will be devoid of fish, so the fish kills will have been prevented;
- The hydropower plant is designed to be a run-of-river flow type, so modifications in the hydrology from riverine to lake-like will be completely avoided;
- Should adopt methods of gradual diversion of river flow to the canal and adequate environmental flow should be provided to sustain the survival of aquatic invertebrates and river-edge organisms;
- Reduce the biomass that will be flooded by clearing most of the vegetation;
- Implement ‘nuisance’ plant monitoring programme for the reservoir;
- Design the operational plan for the Ayago hydro power plant to ensure that reservoir drawdown is managed to optimise native vegetative growth in littoral zone;
- Design to have short periods of impoundment;
- Develop a catchment management programme to prevent further sediment loading from upstream reach; and
- Design to maintain/ mimic the pre-project flow regimes and cycle to maintain breeding and cycles for aquatic species at depend on them.

Table 101: Impact Mitigation, Net Effects Analysis, and Effects Monitoring Activities

Issue	Location	Mitigation measure	Net effect	Monitoring/ follow-up
Detrimental effect on aquatic flora and fauna populations	Upstream and downstream	Maintain water flow regimes	Expected maintain similar flora and fauna communities upstream and downstream of the reservoir.	Conduct aquatic flora and fauna surveys post-construction; upstream and downstream
Damage to aquatic organisms through entrainment and passage through the turbines	Reservoir	Installation of organism screens before water intake to reduce rate of entrainment by fish and other organisms.	Deaths caused by entrainment will be reduced.	During initial operation, inspection of materials removed from fish screens will be done to determine the success of the management measure.
Change in available habitats for some species	Reservoir	Mimic pre-project water flow regimes	The project will result in minor changes to the balance between flora and fauna species populations of upstream and downstream of the dam.	Conduct aquatic flora and fauna surveys post-construction; upstream and downstream

The hydropower station has been placed to avoid high species rich areas like the River Bulaya. During the baseline, these were the areas with the most diverse fish species. The HPP has been scheduled to be placed in an area near River Ayago with the lowest fish species diversity.

1) *Sediment flush from the powerhouse*

During operation, water drawn from the hypolimnion at the intake may become de-oxygenated, and discharge of such water downstream may negatively impact the aquatic fauna in the river. The impact may be felt more on the macro-invertebrates at the river banks downstream of the powerhouse. The weir will accumulate sediments as a result of reduced water flow. The discharged deoxygenated water from the power house may also contain sediments sucked in at the intake. Sediments released will lower the water quality of the river downstream and may corrode fish gills as fish try to pull in water to obtain dissolved oxygen. The impact intensity is low, because the HPP will make use of the natural flow regime of the river, therefore the intake will suck in only the sediment that is naturally carried by the river, giving no room for accumulation. The receptor sensitivity is high, because any sediment flush out of the natural transport of the Nile will be highly harzadous not only to fisheries in the Victoria Nile, but also that in Lake Albert. Therefore the impact magnitude is moderate before mitigation.

Mitigation

To reduce the negative impact on macro-benthos and fish will involve;

- Develop and implement a shedule for flushing the sediment during Operation and maintenance.
- Enhancing the habitat by tree planting to increase shelter cover, shade and drift food;
- Maintaining sediment transport in as far as applicable a natural state to prevent sudden flushes that could shock ecosystems;
- Encouraging gravel and boulders together to create spawning riffles to attract resident fishes to small rapids

2) *Soil Contamination*

Soil contamination will not be expected at operation stage because hydropower plants donot require heavy use of fossil fuels except alittle bit during maintenance. The impact magnitude in this case is very low, and atmost negligible, so no mitigations will be proposed, rather recommendations to avoid at all costs any oil spill or drops that may escape from motor engines or other engines.

Recommendations

- Any vehicles used for maintenance activities at the intake or power house will be refueled before discharge to the site; So no refueling will take place on site or within the national park during operations;
- All vehicles to be used for the maintenance will be kept in proper working condition to prevent any leaks.

3) *Soil Erosion*

During the operation phase there will not be significant impact on soil. However, proper and continuous maintenance is called for to prevent erosion from the steep areas above the Head race Canal. The erosion will deposit sediments in the weir, or powerhouse, which may lower the efficiency and possibly damage equipment. The impact magnitude will be low and the receptor sensitivity will be low, giving a minor impact severity.

Mitigation

- The developer will continue to maintain the steep slope above the headrace to protect any sliding of earth and adhere to a regular inspection, and mitigation plan.
- All the drainage paths that have been constructed will be maintained and de-silted on a regular basis;
- Native herb and grasses species will be encouraged to re-grow in previously cleared areas to help trap loose soils and prevent their progression downstream into the waterway or the river;

4) Alteration of river flow

River diversion will reduce the water in the main river channel. This may lead to collapse of bank slopes due to decreased flow especially during the dry season. The effect is local and can be overcome to some extent by releasing compensation flow downstream.

Mitigation

- To avoid impacting on the ecology and to keep the sytem in a health state, it is recommended that instead of EFR of 10%, a fixed discharge of 100cumecs bemaintained all the time.
- During the operational phase, technical staff will continuously monitor the slopes especially those at the banks of the river;
- Compensation flow for the conservation of microflora, aquatic insects and fish in the dewatering zone should be within 10-20% of the regular flow;
- Land clearing and slope stabilization activities should be conducted in their proper sequence and disturbed areas are to be suitably protected and maintained until permanent protection is established.
- In the early storage period of the reservoir, the dry branches and fallen leaves, domestic garbage and animal remains in the reservoir will be blocked and accumulated before the dam. Therefore, appropriate facilities should be placed in the dam site to intercept the floating substance, and personnel should be specially assigned to remove it periodically. The filth could be disposed together with the domestic garbage.
- In order to avoid severe pollution to the water quality in the reservoir, it is forbidden to establish enterprises that discharge waste water containing toxic and hazardous substance within the water-collecting area; the clearance of floating substance from the water surface should be enhanced; and the water quality and bottom quality within the reservoir area should be further monitored and researched.

5) Noise & Vibration

Sound from the project operations could include the transformer hum and power line corona discharge (buzz) or above ground noise from the hydropower generator systems. The Impact intensity will be low and the receptor sensitivity is high, because there is a likely hood of wildlife directly interacting with the power station.

Mitigation

- The power station will be protected with fencing to prevent animals from wondering into the area and getting exposed to noise/vibrations;
- All facilities will be heavily muffled to prevent noise disturbance to animals/recreational tourists since this project will exist for a long time;
- No vibration is expected at this stage, therefore no mitigation has been offered.

6) Landscape Aesthetics

Operation of the hydropower plant will change the land-use from recreational to commercial power generation. The impact magnitude will be low, because the power plant is located upstream of the Murchison falls, which is the main tourist attraction in the area, so negative visual impacts will be minimal. The receptor sensitivity is medium because some boat rides have been conducted in that section of the river for hippo observations, producing a moderate impact before mitigation.

Mitigation

- The contractor shall develop and implement a landscape and greening plan for the Ayago project area.
- The height and landtake for muck disposal areas shall not exceed what has been allowed by UWA.
- Thick vegetative cover will be encouraged on the riparian strip of the Hydropower plant to conceal the intake, Headrace, tailrace and power house;
- Structures will be painted with earthen tone colours to prevent visual blight caused by highly dissimilar buildings with the back drop of a natural setting.

7) Traffic

It is not anticipated that traffic will increase or be a nuisance during the operation of the power plant. The vehicle requirement in and out of the park will reduce considerable to 1-3 cars for periodical maintenance and regular workers at the plants.

Mitigation

- Developer will reduce the required number of trips to and from the site to only necessary incidences requiring transportation of project staff and the occasional maintenance workers;
- The Project drivers will abide by the speed limits set forth by the UWA for all vehicle access to the park;
- The developer will orient all workers and visitors to the power plant so that safety park rules are followed in close coordination by project staff.
- The contructor shall ensure that all vehicles are timely and efficiently serviced

8) Occupational Health and Safety

Accidents arising from handling heavy equipment or working at heights may expose workers to various injuries at the plant. There is a high likely hood of emergence of vector borne diseases like malaria and other water related illnesses. Workers scheduled to work within the powerhouse or those engaged in maintenance on the exterior will be exposed to closed spaces and work at height situations. The impact intensity in this case will be evaluated using a probability of occurrence as accidents are a result of unplanned activities.

Mitigation

- The contractor shall develop and implement an occupational Health and safety management plan
- Project workers will be required to use protective equipment (gloves and face mask) when working with paints, solvents and diesel fuels; Workers engaged in activities likely to raise dust will have dust masks at all times during this phase;
- Earplugs will be worn at all worksites where noise levels are expected to be higher than 85dB (A) like those working in the powerhouse near the turbines; alternatively, project workers will be shifted periodically to ensure long time exposure to high noise levels by an individual is reduced;
- There will be sufficient number of first aid trained personnel to respond to emergencies at the sites (intake and powerhouse);

- Workers will be trained on the recognition and prevention of hazards specifically applicable to work in remote areas, and in areas with dangerous wild animals like hippos, lions crocodiles and elephants; Working in groups gives safety in numbers, since the area harbors known dangerous wild animals (Hippopotamus crocodiles) and snakes
- There will always be a rule for workers not to work inside the park or reserve without the presence of rangers for safety
- Swimming as a pre-requisite for working across river/stream sections will be needed and where lack of the skill is observed, training will be undertaken;
- For the case of diseases like malaria, the project will put in place strategies to control the disease through issuance of mosquito nets and education on their usage. The developer will have a clinic stationed at the worksite to address any illness. There will also be an emergency evacuation plan to remove any injured worker from the field for urgent treatment;
- Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites.
- Use of chemoprophylaxis drugs by non-immune workers and collaborating with public health officials to help eradicate disease reservoirs.

All components of the workers' camps, including accommodations, sanitation facilities, water supply and other infrastructure, recreation facilities, kitchens and dining areas, and medical facilities, will need to adhere to and be maintained at internationally accepted health and safety standards.

9) Security

There have been reports of poachers in the area, as seen in baseline of this report. Clashes between workers especially those on night duty with poachers is a high probability, since some may use the advantage of light at the facility to hunt wildlife. Some of the poachers may be armed with guns or bow and arrows. Other security risks may also arise due to the uncontrolled access of visitors on site and poor enforcement of legal requirements within the project area.

- Poaching activities will be highly discouraged within the project area
- Anti poaching awareness campaigns shall be regulary conducted on site.
- The contractor shall setup a competent security and safety management team on site to oversea issues of security.
- No worker will be allowed to move within the park without a ranger to avoid risks associated with dangerous people.
- The contractor shall develop and procedure for visitors access to site.
- The contractor shall ensure that all accesss point are well secured and ensure security personel are deployed at all project installations.

8.8 Cumulative Impacts

To avoid impacting on the ecology and to keep the sytem in a health state, it is recommended that instead of EFR of 10%, a fixed discharge of 100cumecs be maintained all the time. The Nile catchment contains multiple dams, including the Aswan high dam in Egypt, Ethiopia's proposed grand renaissance dam and Owen falls dam in Uganda. Therefore, with an increase in the number of dams over the Nile, the greater the fragmentation of the ecosystems, limiting fish migration, sediment transport, human re-settlement and archeological relocation and in some cases burial under reservoirs. Multiple dams magnify the changes to flow regimes, water quality and the productivity and species composition of rivers. Upstream dams also impact the risk profile of downstream dams. Major structure failure of upstream dams may damage structural integrity of downstream dams. The Ayago hydropower plant will not dam the river, rather, it will divert it, therefore there will not be a significant foreseeable loss of water from the main River channel, save for a periodical decline, which is replenished a short distance downstream of the powerhouse. The additive effects of land use conversion or significant changes to river hydraulics, will become significant in the long run, therefore Ayago management will work closely, sharing experiences with potential developers on the river so that impacts experienced during the construction and operation are minimized in future developments.

Cumulative effects on land use may be reduced by the sharing of access roads and transmission lines. Some risks to downstream dams may be reduced by coordinated emergency response actions to more effectively manage extreme floods. Upstream hydropower infrastructure may become unstable over time and require decommission. The decommissioning may lead to transport of large debris downstream that may damage existing dams and or other hydropower structures within the Nile. Therefore, prior assessment will be undertaken to ensure that no aspects of the decommissioning will affect other infrastructure on the Nile. It will be advisable that dams/hydropower infrastructure be placed at great distances apart so that spill off impacts from one dam can be ameliorated by the river (dilution, dispersion, entrapment in the wetlands) before delivery downstream. Wetlands along the river should be kept in as natural a state as practical to mitigate some of the impacts of upstream dam construction and hydropower development. This would include reduction of floods, sediment entrapment, and contribution of organic materials to the aquatic systems, and biomass for use by watershed communities.

Given that there already is the Owen falls dam and construction of Karuma dam upstream of the proposed Ayago hydropower station within the Nile River watershed is underway, the combination of all these can have impacts on the environment of the watershed. The management of Ayago hydropower will work in close liaison with the Nile Basin Initiative to coordinate all efforts that relate to the protection and management of the watershed. Thre is certainly a need for more detailed studies on the cumulative impact of the various projects on the ecological, environmental, socio-economic setting of the area and the general landscape associated with the Nile. This will require that all the players (developers of all the existing and planned projects and stakeholders) work together to support this study which should take a landscape approach to the analysis of the impact.

8.9 De-Commissioning Phase

On completion of construction, the powerhouse facilities, stores, equipment, intake, penstock and machinery, and worker camps will need to be safely and securely removed and the areas stabilized to minimize risks of release to the environment of toxic or polluting materials, All disturbed sites which are no longer being used will need to be rehabilitated and re-vegetated. During the removal of debris, there will be adverse impacts if the materials such as scrap iron, glass, polythene materials, planks, Electronic waste, ceramic pieces, and other corroded tin sheets etc. are not safely disposed. The concrete layers (cemented/concreted floors/areas of temporary structures and access roads) should be removed; the materials should be safely disposed off at sites previously agreed upon with NEMA. Transport of both salvaged materials and disposable materials will increase vehicular traffic, noise and disturbances to the communities along the main access roads. The impacts are very temporary in nature and precautions or mitigations suggested earlier in the impacts discussion should be enforced to minimize further disturbance. The following are the foreseeable impacts, for which management should take precautionary measures, referring to the mitigations/recommendations suggested in this section:

- Soil, erosion impacts caused by demolition of structures and debris removal.
- Noise and vibration on structure demolition
- Damages to access roads from vehicles with heavy loading.
- Aesthetic impacts on debris amassing and denudation of the structure environment

NB: The contractor shall be required to develop a detailied decommissioning and restoration plan for the entire project area. Table 103 presents an assessment of anticipated impacts from the implementation of Ayago Project and Mitigation Measures. The overall significance of the impacts before and after the implementation of the mitigation measures is also presented.

Table 102: Anticipated impacts from the Project and Mitigation Measures Pre-construction and Construction Period

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
Pre-Construction											
Vegetation	Loss of vegetation	Vegetation clearing for access road construction	Access routes and adjacent areas				• Siting of the road and support facilities (Construction Camps) to avoid critical terrestrial and aquatic habitat (e.g. thick wooded grassland the riverine forests, wetlands, and fish spawning habitat); • The developer will utilize existing transport corridors whenever possible; • Design and construction of wildlife access to avoid or minimize habitat fragmentation, taking into account motorist safety and the behavior and prevalence of existing species; • Encourage native vegetation to re-grow				Mitigation adequate to reduce impact to minor levels. Precaution is to be taken to ensure any unforeseen issues are addressed as and when they arise.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							after the construction; • Active management of invasive species particularly *Lantana camara* and, to a lesser extent, *Mimosa pigra* through allowable (by UWA) practices like periodic bush burning, • The developer will avoid/modify construction activities during the breeding season and other sensitive seasons or times of day to account for potentially negative effects; • Preventing short and long term impacts to the quality of aquatic habitats by minimizing clearing				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							and disruption of riparian vegetation, especially that nearest the river; • The developer will provide adequate protection against scour and erosion; and giving consideration to the onset of the rainy season with respect to construction schedules;				
Flora	Loss of species of conservation concern (especially the threatened, endemic, rare and restricted species) or decline in their	Vegetation clearance for construction	Access roads, weir, power house, power evacuation lines and other main features				• The developer will map the threatened and other sensitive and species and sites within the project area • Educate all the workers about threatened and other sensitive species and sites • As much as possible, avoid destruction of (especially mature)				The impact will be reduced by undertaking regular monitoring of populations of species of conservation concern

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
	abundance						individuals				
Fauna	Loss of species of conservation concern or decline in their abundance	Disturbance through noise and habitat alteration through vegetation clearance	Key breedings sites, ranging and migratory routes				• The developer will map the sensitive sites key for sensitive species especially threatened ones within the project area • Educate all the workers about threatened and other sensitive species and sites • As much as possible, avoid destruction or injury of threatened and other sensitive sites				The impact will be reduced by undertaking regular monitoring of ranging and population size of species of conservation concern. Use of game cameras will be employed in critical sites to monitor presence of game. In cases of key taxa such lions and elephants, radio telemetry techniques such as

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
											collaring will be done
Noise & Vibration	Noise of activities involving heavy machinery use during road clearing, grading	• Cutting and land excavation • Equipment mobilization	• National Park • Route communities • Recreation areas • Workers camps				• Sound-control devices on equipments should be maintained in good condition; • Appropriate and sufficient PPE for noise protection shall be provided to all workers and visitors to highly active sites; • Construction activities that may generate harmful noise should be limited only in day time, e.g. 6 am to 7 pm and only outside of breeding periods; • Reduction of speed in highly sensitive areas will be adopted to reduce the high impact noise so that shock events are reduced to manageable levels by animals;				Impact intensity is reduced to moderate ranking , therefore post-assessment monitoring as prescribed in the EMMP is essential to ensure that mitigations achieve the desired results. The developer will develop a mechanism to record and respond to complaints especially from wildlife officials and

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							• Selecting equipment with lower sound power levels and installing suitable mufflers on engine exhausts; • The developer will limit the hours of operation for specific pieces of equipment and operations, especially mobile sources operating through sensitive areas • Re-locating noise sources to less sensitive areas to take dvantage of distance and shielding will be employed in as far as applicable; • Taking advantage of the natural topography as a noise buffer during facility design;				or tourists and tour operators to check on effectiveness of the applied mitigations and to get insight on how to address these concerns in due time.
Construction Phase											
Biophysical Impacts											
Air quality	Increased	• Onsite	• Construction				• All vehicles will be				No further

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
	emissions from vehicles Storage and transfer of fuels for construction equipment	machine engines • Mobile vehicle engines (emissions)	area • Neighboring communities to access route				instructed to switch off engines on arrival at site. More pollutants are released during idling as compared to a vehicle in active movement; • All non road mobile machinery (NRMM) to use ultra low sulphur tax-exempt diesel (ULSD) where available; • Observance of speed limit within the park (≤40km/h) will be implemented, to prevent raising dust and the developer will engage in activities that preserve carbon sinks (trees and natural resources • All trucks delivering				mitigations are anticipated however regular monitoring will be undertaken.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							materials to the site will be maintained in good working order as inefficient fuel combustion is key in the release of NO2, SOx CO, and NO from vehicle exhausts; • Vehicle drivers will be encouraged switch engines off when not in use because an idling truck releases more emissions than one in active movement;				
Air quality (dust emissions)	• Increased dust particles and fugitive dust to atmosphere • Heavy	• Blasting, • Moving soils • Excavations, dumping • Road traffic on unsealed murram surface	• Materials haulage route • Recreational areas along haulage route • Immediate vicinity to Construction				• No bonfires for waste will be encouraged in the park, as this causes dust raising situations; • The developer will be encouraged to plan the site layout – machinery and				No further mitigations are anticipated however regular monitoring will be undertaken.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
	dust cover over foliage		site				dust causing activities should be located away from sensitive receptors; • Dust generating activities will be minimized especially on windy days to prevent dust raising in the park; • Water will be used as dust suppressant where applicable to subdue any dry particles from becoming airborne during windy days in the dry period; • Enclose stockpiles in temporary or keep them securely sheeted to prevent dust spreading; • All loads entering and leaving site to				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							be covered to prevent windblown dust along the route to and fro the site; • Land clearing, removal of topsoil and excess materials, tips and stock piles, will be planned with due consideration to meteorological factors (e.g. precipitation, temperature, wind direction, and speed) as well as the locations of sensitive receptors; • A simple, linear layout for materials-handling operations to reduce the need for multiple transfer points will be designed and appropriately				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							installed; • Roads around the construction site will be adequately compacted and periodically graded and maintained. This reduces dust raising events during materials haulage by the heavy trucks; • Water spraying of roadways and exposed stockpiles using a sprinkler system or will be implemented; • Foot patrolling of the immediate surrounding of the area by rangers and project workers prior to blasting to ensure no observable animals may be injured or				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							killed				
Archeology	Destruction of archeological/ cultural sites	• Excavations • Construction of weir • Temporary damming of diversion	• Excavation sites around the headrace, penstock and tail race • Temporary storage at the weir • Powerhouse excavations				• Where the developer/contractor has encountered tangible cultural heritage that is replicable and not critical, the personnel will apply mitigation measures that favor avoidance; • Minimize adverse impacts and implement restoration measures, in situ, that ensure maintenance of the value and functionality of the cultural heritage, including maintaining or restoring any ecosystem processes needed				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							to support it; • Where restoration in situ is not possible, restore the functionality of the cultural heritage, in a different location, including the ecosystem processes needed to support it; • Where the project site contains cultural heritage or prevents access to previously accessible cultural heritage sites being used by, or that have been used by, Affected Communities within living memory for long-standing cultural purposes, the developer will,				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							based on consultations allow continued access to the cultural site or will provide an alternative access route, subject to overriding health, safety, and security considerations; • Where an encounter has been made with artefacts, the developer will ensure that the project personnel doesnot disturb any chance find until further assessment by competent professionals has been made and the find has been rendered replicable in another area or be preserved in its current state;				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							• The developer/contractor will work in close collaboration with the UWA officials on any find and develop a procedure for addressing chance finds especially during excavations				
Soil	Erosion	• Excavations for the facilities • Runoff from spoil, materials storage area	• River banks, • Excavated sections of water way • Seasonal streams within the vicinity				• Project activities will be scheduled to avoid heavy rainfall periods (i.e. more activities during the dry season) to the extent practical; • The developer will encourage contouring and minimizing length and steepness of slopes to reduce erodibility; • Mulching using vegetation				No further mitigations are anticipated however regular monitoring will be undertaken.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							previously cleared from the areas will be used to stabilize exposed places; • Re-vegetating areas promptly after activities. This helps to stabilize soils after excavation activities; • Spoil and stock piling areas should have properly designed channels to direct runoff away from the areas to prevent material erosion; • Designing channels and ditches for post- construction flows especially in periods of high flow; • Lining steep channel and slopes (e.g. use jute				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							matting) and removal of all the excess spoil to a designated place is advisable • Transport all the soil excavated away from the slopes and dump in areas designated for spoil in the park (temporarily) and outside the park (permanently); • Any spoils (Boulders) in the Weir area will be used for the backfilling of the weir • Formulate construction planning on demarcation to suit exact places for slopes to be excavated to avoid				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							over excavation and overproduction of spoil. Surveying the sites, installation of pegs and batter boards which are standard construction practices should be strictly adopted. (gabions to be adopted to stop any earth sliding).				
Water	Surface Water contamination	• Accidental petrol/diesel spills • Soil erosion • Domestic waste from camps	River Nile Streams Neighboring the construction or transit site				• A fixed discharge of 100cumecs be maintained all the time • Activities that may destabilize soils/sediments should be done in as far as practicable in the dry season (ie when the seasonal rivers like Chobe are dry) to reduce				Impact intensity is reduced to moderate ranking , therefore post-assessment monitoring as prescribed in the EMMP is essential to ensure that mitigations achieve the

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							sediment/contaminant delivery to the Nile; • Application of appropriate construction practices and creating awareness among the construction crew of the need to maintain high water quality; • All project vehicles scheduled to work near water resources will be cleaned prior to use (during the dredging activities); • Surface runoff from process areas or potential sources of contamination will be prevented to prevent rain water contamination;				desired results. The developer will develop a mechanism to record and respond to complaints especially from wildlife officials and or tourists and tour operators to check on effectiveness of the applied mitigations and to get insight on how to address these concerns in due time.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							• When water quality criteria allow, storm water should be managed as a resource in holing lagoons, either for groundwater recharge or for meeting water needs at the site; • Oil water separators and grease traps should be installed at sites for re-fueling equipment and vehicles and maintained as appropriate; • Sludge from storm water catchment areas or collection and treatment systems may contain elevated levels of pollutants and should be				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of wildlife, aquatic ecology and public health; • Maintenance of vegetative buffer between the water and construction works to help trap loose sediments and or materials; • Provision of automatic fill shutoff valves on construction fuel storage tanks to prevent overfilling and eventual spills • Use of a catch basin or absorbent				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							material to soak around the fill pipe to collect spills				
	Groundwater contamination	• Leaching from waste storage areas • Leakage from Re-fuelling areas	Below ground aquifers				• Waste collection points for workers at the construction site will be located out of the high water table sections of the area; • All waste areas will be banded during temporary storage to prevent pollutant leaching to below ground water resources	-	-	-	-
Vegetation	Loss of vegetation	Clearing for • the powerhouse • Penstock, head and tail race • weir	• River banks, • Riparian vegetation				• The developer will select appropriate low- impact extraction (e.g. excavation, quarrying and dredging) methods that should result in final site contours supportive of				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							habitat restoration principles and grasses re-establishment; • Native species especially those preferred by native/migratory birds will be left intact as far as practical and in the event this is not possible, they will be relocated within the same corridor; • Establishment of buffer zones from the edge of extraction areas, considering the characteristics of the natural habitats and the type of extraction activities; • Vegetation translocation and relocation				of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							techniques will be used as necessary. Vegetation cover, such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be removed in separate operations and segregated for later use during site reinstatement; • During extraction, ecological niches should be preserved and protected as far as possible; • Smaller, short-lived extraction sites will be reclaimed immediately, and larger sites with a useful lifespan beyond 3–5 years				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							be subject to ongoing rehabilitation				
Traffic	Increased vehicular traffic enroute to site	• Material, equipment haulage, • Workers transportation	Chobe route, existing roads within the Murchison park				• The developer will plan vehicle routes to target low traffic hours on Masindi-Kigumba road and will establish high vehicle access on the Chobe route during low tourist seasons to avoid interference with lodge activities; • In the case that there is an overlap of public and project vehicles, the developer will be charged with controlling vehicle traffic through the use of one -way traffic routes if needed, and on-site trained flag-				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							people wearing high- visibility vests or outer clothing covering to direct traffic; • Ensuring the visibility of personnel through their use of high visibility vests when working in or walking through heavy equipment operating areas, and training of workers to verify eye contact with equipment operators before approaching the operating vehicle; • Ensuring moving equipment is outfitted with audible back-up alarms; • Using inspected				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							and well-maintained lifting devices that are appropriate for the load, such that there are no breakdowns in the middle of the road; • Contractor shall provide temporary road signage during construction and ensure drivers observe speed limits and for safety of other road users				
Noise	Noise from construction activities, Equipment,	Construction activities, drilling, excavation, concrete mixing	• Animal habitats around river banks, • Camps within the vicinity, • Recreational areas on the river				• The developer will erect noise barriers such as temporary walls or piles of excavated material, between noisy activities and sensitive receptors (animal breeding grounds); • The traffic will be re-routed to roads				Regular monitoring to assess the efficiency of the mitigations will need to be undertaken

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							with few vehicles (Chobe route) to reduce the cumulative impact from additional traffic to already congested roads like the Masindi-Kigumba junction; • Night time activities will be avoided at all costs in as far as is practical, because sound travels further during night than during the day; • In order to limit noise due to haulage traffic, the construction fleet will be kept in good condition well fitted with efficient silencers; • Because the operation of the				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							generator will introduce unacceptable noise levels it is recommended that the generator will be housed within a sound proof structure; • Speed bumps will be installed so that tracks ferrying the construction materials do not move at high speeds which enable high noise generation; • It will be mandatory for the workers to use earmuffs and the supervisor will ensure compliance to this requirement. Disciplinary measures should be taken against				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							any worker who does not comply with safety requirements. • There will be a periodic monitoring programme for noise to check if measures put in place are having the desired effect. These measures include the housing of the generator in sound proof casing, proper maintenance of vehicles. In particular at the discretion of the Resident Engineer upon receipt of complaints, noise measurements will be made to monitor the noise levels. Measurements or readings will be taken at distances				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							from the noise producing equipment e.g. generator. A calibrated sound meter will be used. It is recommended that noise measurements be done only as indicated.				
Waste	Waste littering	• Poor solid and liquid waste disposal, • Construction waste like debris, scrap items	• River banks, • Workers camps • Access routes to site				• Because of the remoteness of the site location, any human fecal material waste produced will be contained in temporary sealed septic tanks before collection by licensed waste collection agency and disposed at NEMA approved facilities; • There is need to				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							consider set-up of a waste treatment plant for the project human fecal material treatment before discharge to the environment; • The proposed development will be responsible for the handling and transporting of its entire production of solid waste. • All domestic solid waste (i.e. trash and garbage) will be source separated into organic, paper and non-biodegradable fractions. • Biodegradable, and Non-toxic non-biodegradable waste, including glass, plastic and				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							metal cans, bottle tops, foil wraps, etc. will be bundled and transported to the nearest designated District/Sub county Solid Waste dump site. • Toxic, non-biodegradable waste such as spent machine oil and batteries will be stored in sealed drums, which in turn will be stored within a bund having 110% storage capacity volume, until they can be removed for safe long term disposal at the nearest designated District/Sub county solid waste storage site;				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							• Hazardous wastes such as torch batteries, motor vehicle batteries and any other waste classified as hazardous will be disposed off in accordance with the manufacturer's specifications. Initially it will be contained in sealed drums before it can be transported at designated points; • Packaging materials: It is not anticipated that there will be a lot of packaging materials at the power plant construction site. Invariably this may consist of paper boxes, plastic containers in the				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							form of bags, bottles and drums, and metallic containers. Those packaging materials that were not used for hazardous materials can be disposed of normally as described above. If there should be packaging materials used which are hazardous, then they will be disposed of in accordance with manufacturers instruction or containerized and sealed. • Plastics: Plastics arising from the construction activities are non biodegradable and will persist in the				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							environment. They may be carried by storm water into the rivers Chobe, Ayago, or the Nile causing aesthetic problems, as well as suffocation of wildlife like fish, crocodiles and hippos. Broken plastic pieces can be a safety risk to employees. Careful attention needs to be paid to their disposal. • Metal scrap: metal scrap will be collected and when in suitable quantities sold off for recycling. Alternatively it will be containerized for future use or recycling.				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
Occupational Health and Safety	Injuries from accidents	• Heavy machinery handling • Slips and falls • Accidental fires • Enclosed spaces • Work at heights • Drowning, • Hazardous materials	• Workers • Community members				• Surfaces, structures and installations should be easy to clean and maintain, and not allow for accumulation of hazardous microorganisms. Therefore surfaces in food preparation areas will be maintained with a highest level of cleanliness to prevent food poisoning due to ingestion of contaminated food stuffs; • Structures housing workers will be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							conditions; • Passages to emergency exits should be unobstructed at all times. Exits should be clearly marked to be visible in total darkness. The number and capacity of emergency exits should be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum two exits from any work area; • Only highly skilled workers will be allowed to operate heavy machinery (cranes, excavators,				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							graders) and heavy trucks (Tipper trucks); • Equipping the fuel storage areas/re-fuelling places with fire detectors, alarm systems, and fire - fighting equipment. The equipment will be maintained in good working order and be readily accessible; • Provision of manual firefighting equipment that is easily accessible and simple to use. Trainings where necessary will be undertaken to ensure adequacy in the usage of the equipment • Fire and emergency alarm systems that				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							are both audible and visible will be installed in areas with a high likely hood of fire (enclosed spaces, near generator, fuel storage); • Any excavated pits will be guarded to prevent wildlife falling into the pit and or community members/tourists; • Worksites especially those posing a greater danger to humans/animals will have limited access (i.e. excavation areas, worksites with heavy vehicular movement); • Training of workers in lifting and				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							materials handling techniques in construction and decommissioning projects, including the placement of weight limits above which mechanical assists or two-person lifts are necessary; • Planning work site layout to minimize the need for manual transfer of heavy loads. This reduces over exertion of project workers; • Job rotations and rest or stretch breaks; • Implementing good house-keeping practices, such as the sorting and placing loose construction				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
						■	materials or demolition debris in established areas away from foot paths/;	■			
Wildlife	Behaviour alteration	Disturbance from noise, human presence,	Neighboring habitats to construction site			■	• Areas scheduled for night activities will be located away from the edges of the river, so that minimal interaction between workers, machines, and the river edge, especially the wetlands, where fish are known to spawn and are also a habitat for juvenile fish; • Any night activites will prevent illumunation in as far as is practible to prevent interference with normal activities in River		■		Regular surveys need to be undertaken to detect any change in behavior patterns of wildlife.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							Nile of the aquatic organisms; • Barriers between sensitive habitats and worksites will be erected to enable the separation of project activities from habitats within the park; • Lights at the worksite during night time will be directed at the activity, rather than illuminating the entire area. This is aimed to reduce the 'trespass' of lighting into areas that are not intended to be lit (including the night sky). Reducing the trespass of lighting will maintain				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							heterogeneity even in otherwise well-lit areas, providing dark refuges that mobile animals (hippos, and other nocturnal predators) can exploit; • The developer will take advantage of vertical shading offered by natural landscape (hills) and horizontal shades, offered by vegetation canopies; • Lights will only be used as and when needed, so that continuous/unnecessary lighting is limited; • Highly visible fencing will be used, to prevent				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							wildlife injury as they move to foraging areas; • All facilities will be located outside of known/established animal corridors to prevent animal disorientation; • Known animal foraging areas should not be illuminated;				
Terrestrial ecology/wildlife	Injuries from Human encounters	Construction activities like excavations,	• Left/south bank of the Nile • Construction site • Haulage route				• The construction will be timed during the dry period so that runoff doesnot flood the excavated sections to transport sediments downstream into the main river; • Incase any fish are caught in the excavated sections for the water intake facilities, they will				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							be removed and placed in the main river to prevent injury;				
	Faunal migration	Land take for power house, intake, weir, noise, vibration, water diversion					• All activities likely to lead to large migrations should be minimized; • Vegetation clearance will be minimal to ensure that after construction, animals originally grazing on the southern bank can re-establish after the construction activity; • All activities unavoidably located in breeding grounds will be halted during the breeding season to prevent animal attacks on workers				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
Hydrology	Flow alteration	• Weir construction • Diversion	• Southern bank of the Nile, • Neighboring streams pouring into the Nile				• A fixed discharge of 100cumecs be maintained all the time • The distance between weir/intake and powerhouse/tailrace should be limited to areas of low animal interaction in as far as is practical, without compromising the integrity of the environment or project effort; • Discharge from the tailrace will be maintained as a percentage of the normal flow to reduce alterations especially when the river floods; • Protective barriers/screens will				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							be offered at the weir to ensure that fish and other aquatic organisms do not meander into the water way, because they may be injured at the powerhouse; • Construction of the weir will prevent a significant loss of water from the main river channel during the dry season because this will act as a very temporary water storage area before the water is directed into the intake and power house; • Normal hydrological functions like transportation of sediments downstream will be				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							maintained to sustain the downstream ecological functions like siltation in the wetlands, that are areas for breeding/feeding for various birds and wildlife; this is so because the water will not be dammed at anytime during plant operation;				
Social Impacts											
Income	Employment opportunities	Construction and material sourcing	Construction and business premises				• Priority should be given to residents of the communities within close proximity of the development; • Women should be considered equally as men during the employment process, with due consideration to				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							community structures and norms; • No children will be hired on the project for any work in keeping with the International Labor Organization, (ILO) Convention No. 138, (1973), that defines the minimum age of employment;				
Migration	Influx of migrants	Increase in project workforce, Migrations from neighboring areas	Project area - Kiryandongo				• The developer will continuously sensitize workers and community members alike on HIV/AIDS and the dangers of unsafe relations; • Workers housing will be planned and located strategically so that access by community				Regular screening and monitoring of communicable diseases amongst the workforce and regular treatment for ill workers.

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							members is limited to official reasons only, like delivery of goods/services. This will prevent social visits by residents in Kiryandongo to workers camp and potential engagement in disagreeable behavior. • Workers will be encouraged to be disciplined when on company assignments in the villages and prevent risky interactions with community members. • Workers will be transported to and fro the construction site to limit				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							unnecessary encounters with community members. • The developer will keep in close communication with women and youth groups to monitor any changes in social structure and communication with local leaders to monitor any changes in population. • Project should set up internal controls and security systems for its materials and worker's personal items. ○ Issues of security should be handled				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							hand in hand with the local Council administration to ensure that suspicious non-known members of the area who are also not part of the project are rounded up to avoid disrupting the activities of the area				
Culture	Disruption of cultural norms and practice	Disrespecting cultural practices, Disregard of cultural norms by project	Project area (Kiryanongo)				• Any foreign project workers will be informed on cultural norms of the local communities before encounter, to avoid				Awareness raising amongst project staff of cultural events and participation is

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							conflicts with communities; • Local authorities shall need to be strengthened in order to deal with the increased cases of indiscipline brought about by the increased population influx, and any disputes that are likely to ensue; • Gender issues will be considered during the hiring process to ensure equality in income provisions;				encouraged
Aesthetics	Loss of aesthetic quality	Change in landuse from recreational to hydropower generation Ground disturbance and	Southern bank of River Nile				• Strategic placement of screening material should be employed (maintenance of native tall trees around newly				No further mitigations are anticipated however regular monitoring will

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
		vegetation removal					excavated areas) to maintain the visual aspect of the area and to prevent visual intrusion; • The entire process will take into consideration the preferred land-use proposed by UWA and tour operators after excavations; • Access to excavation areas will be closed off to all but construction crew to prevent accidents like falls, or exposure to unsightly conditions within the park; • All cleared areas and pits will be backfilled and trees and grass planted at the end of construction of the				be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							power plant and associated facilities. This should clear the problem of further land degradation and rugged terrain created by the construction activities and will avoid the presence of unsightly stagnant water pools; • The waterway will be a perpendicular distance away from the river edge so that any views from the river like boating activities are not disrupted by the sight of construction activities.				

Table 98: Summary of Potential impacts and mitigations arising from Operation of the HEPP

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
Operations											
Aquatic fauna	Impact on fisheries	Temporary damming of the river at the weir	Project site, South bank of river Nile Neighbouring streams discharging into River Nile				• A fixed discharge of 100cumecs be maintained all the time • The weir will have an overhead flow, allowing for continuous flow of water, except at a reduced speed, though not slow enough to induce stratification; • The intake will have fine screens to prevent suction of mature fishes into the headrace, as this prevents the fish kills at the turbines in the powerhouse; • The water intake will be placed in the				Periodic monitoring of species diversity

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							hypolimnetic strata of the water at the weir. This zone will be devoid of fish, so the fish kills will have been prevented; • The hydropower plant is designed to be a run-of-river flow type, so modifications in the hydrology from riverine to lake-like will be completely avoided; • Should adopt methods of gradual diversion of river flow to the canal and adequate environmental flow should be provided to sustain the survival of aquatic invertebrates and river-edge				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							organisms; • The hydropower station has been placed to avoid high species rich areas like the Karuma Bridge and River Bulaya. During the baseline, these were the areas with the most diverse fish species. The HEPP has been scheduled to be placed in an area near River Ayago with the lowest fish species diversity;				
Sediments	Negative impacts on aquatic organisms	Sediment release from the powerhouse	Downstream of the powerhouse				• Enhancing the habitat by tree planting to increase shelter cover, shade and drift food; • Maintaining sediment transport in as far as applicable a natural				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							state to prevent sudden flushes that could shock ecosystems; • Encouraging gravel and boulders together to create spawning riffles to attract resident fishes to small rapids				mitigations
Soil	Contamination	Leaks from faulty vehicles	Access routes				• The developer will continue to maintain the steep slope above the headrace to protect any sliding of earth and adhere to a regular inspection, and mitigation plan. • All the drainage paths that have been constructed will be maintained and de-silted on a regular basis; • Native herb and				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							grasses species will be encouraged to re-grow in previously cleared areas to help trap loose soils and prevent their progression downstream into the waterway or the river;				
Hydrology	Alteration of river flow	River diversion	Upstream and midstream from the intake				• A fixed discharge of 100cumecs be maintained all the time • During the operational phase, technical staff will continuously monitor the slopes especially those at the banks of the river; • Compensation flow for the conservation of microflora, aquatic insects and				A fixed discharge of 100cumecs be maintained all the time

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							fish in the dewatering zone should be within 10-20% of the regular flow; • Land clearing and slope stabilization activities should be conducted in their proper sequence and disturbed areas are to be suitably protected and maintained until permanent protection is established;				
Noise & Vibration	Noise from powerhouse equipment	• Noise from operation of generator, and power line	• Immediat e vicinity of the facility				• The power station will be protected with fencing to prevent animals from wondering into the area and getting exposed to noise/vibrations; • All facilities will be heavily muffled to				No further mitigations are anticipated however regular monitoring will be undertaken to assess the effectiveness of mitigations

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							prevent noise disturbance to animals/recreational tourists since this project will exist for a long time; • No vibration is expected at this stage, therefore no mitigation has been offered,				
Aesthetics	Landuse change	• Placement of hydropower plant in place of recreational use	Southern bank of Nile in project area				• Thick vegetative cover will be encouraged on the riparian strip of the Hydropower plant to conceal the intake, Headrace, tailrace and power house; • Structures will be painted with earthen tone colours to prevent visual blight caused by highly dissimilar buildings with the back drop of a natural setting;				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
Traffic	Vehicle access within the park	• Maintenance activities at the plant	Southern bank of Nile in project area				• Developer will reduce the required number of trips to and fro the site to only necessary incidences requiring transportation of project staff and the occasional maintenance workers; • The Project drivers will abide by the speed limits set forth by the UWA for all vehicle access to the park; • The developer will orient visitors to the power plant so that safety park rules are followed in close coordination by project staff;				
Occupational health and safety	Injuries from accidents on site, exposure	• Maintenance works on the intake, power	At project site				• Project workers will be required to use protective				Periodic monitoring to check on

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
	to high noise levels	house					equipment (gloves and face mask) when working with paints, solvents and diesel fuels; Workers engaged in activities likely to raise dust will have dust masks at all times during this phase; • Earplugs will be worn at all worksites where noise levels are expected to be higher than 85dB (A) like those working in the powerhouse near the turbines; alternatively, project workers will be shifted periodically to ensure long time exposure to high noise levels by an individual is reduced;				health and safety issues at the plant is required to ensure worker safety measures are implemented

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							• There will be sufficient number of first aid trained personnel to respond to emergencies at the sites (intake and powerhouse); • Workers will be trained on the recognition and prevention of hazards specifically applicable to work in remote areas, and in areas with dangerous wild animals like hippos, lions crocodiles and elephants; Working in groups gives safety in numbers, since the area harbors known dangerous wild animals (Hippopotamus				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							crocodiles) and snakes • Swimming as a pre-requisite for working across river/stream sections will be needed and where lack of the skill is observed, training will be undertaken; • For the case of diseases like malaria, the project will put in place strategies to control the disease through issuance of mosquito nets and education on their usage. The developer will have a clinic stationed at the worksite to address any illness. There will also be an emergency evacuation plan to				

Environmental Component	Nature of Impact	Concerned Activities (that would cause impacts)	Impact Area	Impact Significance			Proposed Mitigation Measures	Impact Significance			Further Mitigation requirement
				Minor	Moderate	Major		Minor	Moderate	Major	
							remove any injured worker from the field for urgent treatment; • Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites. • Use of chemoprophylaxis drugs by non-immune workers and collaborating with public health officials to help eradicate disease reservoirs.				

9. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

9.1 Environmental Management and Follow-Up Programs

The primary objective of this Environmental and Social Management Plan (ESMP) is to safeguard the environment, site staff and the local population from site activity which may cause harm or nuisance. This ESMP for Ayago Hydropower Project is intended to provide a framework to ensure transparent and effective monitoring, prevention, minimization, mitigation, off-setting and enhancement measures to address the environmental and social impacts associated with the Project. The Environmental Management and Monitoring Plan (EMMP) cover all aspects of planning, construction and operation of the project, which are relevant to the environment. It is essential to implement the EMMP right from the planning stage and then continue with it throughout the construction and operation stages. It also involves the physical planning, including work programme, time schedule and allocations for putting mitigation and compensation systems in place, identifying implementing agencies, delineation of financial plan for implementing the mitigation measures in the form of budgetary estimates and demonstration of its inclusion in the project budget estimates.

The objectives of the Environmental Monitoring Management Plan are to:

i. bring the project into compliance with applicable national environmental and social legal requirements and the international legislation;
ii. outline the mitigating/enhancing, management, consultative and institutional measures required to prevent, minimise, mitigate or compensate for adverse environmental and social impacts and;
iii. address capacity building requirements to strengthen the funder's environmental and socialcapacities if necessary.
iv. Allocate responsible authorities for each monitoring requirement

The main stakeholder responsible for implementing the plan will be the EPC Contractor while, the developer i.e., The Ministry of Energy and Mineral Development (MEMD) through Uganda Electricity Generation Company Limited (UEGCL) its implementing agency will co-ordinate and monitor all the work done by the Owners Engineer and EPC Contractor (Table 104). Uganda Wildlife Authority (UWA), National Environment Management Authority (NEMA), Directorate of Water Resources Management (DWRM), Uganda National Museums (UNM), National Forest Authority (NFA), Forestry Sector Support Department, (FSSD), Chief Government Valuer (CGV), Districts (Kiryandongo and Oyam) and the Local Authorities will be the other stakeholders responsible for implementation and monitoring of the management plans.

Monitoring is recommended in the context of ensuring that ecosystem function is maintained at a level equal to or better than pre-construction conditions. UEGCL, and where required, external consultants and other Government Agencies, will undertake to monitor various components of the project. All environmental monitoring programmes shall be undertaken under the supervision of the National Environment Management Authority (NEMA), Uganda Wildlife Authority (UWA) and the respective Districts. This will ensure compliance to the environmental mitigation plans during construction, operation and maintenance of the hydro power infrastructure. The scope and responsibility of the main stakeholder responsible for implementing the plan i.e., The MEMD and EPC Contractor are presented in Table 105.

The proposed project may have minimal adverse environmental effects, provided that recommendations and mitigation measures identified in Chapter 8 are incorporated into all the contracts and followed by both the developer and the contractor. Accordingly, the management plans with specific mitigation measures to be implemented during construction and operation phase of the proposed Ayago HPP are prepared and are summarized in the Table 106.

The project's compliance with Ugandan and International lender legislation and guidelines for environmental and social performances will be the key responsibility of the project sponsor (MEMD & UEGCL). However, day-to-day responsibility for implementing environmental and social mitigation, compensation and monitoring actions will be of the Engineer, Procure, Construct (EPC) Contractor or the other governmental agencies. The governmental agencies are assigned responsibilities for implementation of the proposed mitigation measures to be implemented under the Physical environment, Biological environment, Socio-economic environment and Cultural & Archaeological Environment during the design, construction and operational phases of the project.

Table 103: Scope and Responsibility of Key Stakeholders

Main Implementation Stakeholder	Scope and Responsibility
Role of EPC Contractor	▪ Review the approved ESIA document, particularly the required mitigation measures and the environmental management and monitoring plans, and the owners environmental and social management framework; ▪ Review approval conditions provided by NEMA (approval certificate), and permits from lead agencies including DWRM (Water Abstraction Permit), DWD (Construction Permit), UWA (Construction Permit), Department of Occupational Health and Safety, Department of Petroleum Supplies (Construction permit, operating license for storage and dispensing facilities of petroleum products), Ministry of Internal Affairs (handling of explosives), Ministry of Water and Environment (River Dredging permit); NEMA (River Bank Use Permit). ▪ The Contractor should then prepare a Contractor's Environmental, Social, Health and Safety Action Plans to comply with the above requirements. This should include an implementation framework, including staffing and budget. ▪ The EPC Contractor will also consult general public and disclose information in relation to construction scheduling, traffic management, public health and safety, and the results of Environmental monitoring. ▪ All expenditure and costs related to complying with Environmental safeguards as applicable to construction and development of Ayago HPP would be met by the EPC Contractor.
Developer (MEMD)	The Developer coordinate all project activities and monitor compliance of the Contractor through its implementation

	agency (UEGCL), and a stakeholder wide monitoring group comprising technical staff from government institutions (NEMA, MEMD, UEGCL, UETCL, ERA, MWE, DWRM, DWD, MoWT, MoGLSD, UWA, MTTI, NFA, FSSD, The National Fisheries Resources Research Institute (NaFIRRI), Ministry of Lands, Housing and Urban Development etc) and Civil Society.

Table 107 address project construction and operational activities identifying specific mitigation and monitoring measures associated with environmental and social aspects where relevant and as required. ESMP is structured under the following management plans (Volume II).

a) Muck Management Plan
b) Landscaping, Visual Amenity& Restoration Plan
c) Materials and Waste Management Plan
d) Air Quality Management
e) Noise and Vibration Management
f) Water Resources and Water Quality Management
g) Dam Safety and Emergency Response Plan
h) Wildlife and Biodiversity Management Plan
i) Health and Safety Management Plan
j) Emergency Preparedness and Response Plan
k) Traffic and Transport Management
l) Labour Force Management Plan
m) Management Plan for Resettlement
n) Management Plan for Human Aspects
o) Management Plan for Cultural Heritage including a chance find procedure
p) Climate Change Management
q) Community Developemnt Action Plan
r) Livelihood restoration Plan

Table 104: Proposed Environmental Management Plan for the Ayago HPP

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
1	All environmental components	Environmental and social management	The EPC Contractor in collaboration with the Project Management	EPC Contractor Developer (MEMD/UEGCL),	To be implemented and completed within	Records of specialized Training

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			Team and the relevant authorities shall be responsible for the following: • Supervision of all employees and sub-contractors • Enhance environmental protection through training of employees in good professional and environmental practices. • Sharing of information on bio-physical and socio-economic aspects of the environment to prevent misunderstanding. • Thorough acquaintance with the environmental protection requirements. • Awareness of archaeological artifacts. • Awareness of any other environmental	UWA	the first 18 months of construction	Submission of reports on status of project area bio-physical and socio-economic aspects – (quarterly)

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			matters which are deemed necessary by the Project Management Team (e.g. appropriate behaviour or community relations.			
Muck Management Plan						
2	Land environment	Disposal and rehabilitation of the muck	Substantial amount of muck shall be utilized in construction material. The excess muck shall be dumped at the pre-identified muck disposal sites. These muck disposal sites shall be stabilized by using various engineering and biological measures **Engineering measures:** Retaining wall is proposed to hold the disposed muck. **Biological measures:** Vegetation cover controls the hydrological and mechanical effects on soil and slopes. Therefore, biological measures are proposed to stabilize the loose slopes which	EPC Contractor, MEMD/UEGCL	During construction	Monitor measures being implemented

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			includes plantation with plant species. The selection of the plant species should be based on the climatic, soil and drainage condition of site. - Muck disposal sites shall be identified in consultation with UWA - Height and landtake for muck disposal sites shall not exceed what has been allowed by stakeholders (UWA) - Contractor shall develop and implement decommissioning and restoration plan for muck dsposal areas			
3	Land and Water	Minimization and safe disposal of spoil generated as a result of tunnel blasting	• Where possible, spoil material will be used as a construction material and for concrete batching; and • Other spoil will be disposed off in spoil disposal sites which have been identified at	EPC Contractor, MEMD/UEGCL	During construction	• Maintain records of amount of material disposed of to each spoil disposal site; and • Monitor spoil disposal sites for erosion

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			a number of locations within the Project area. • The contractor shall ensure that wastes are properly disposed in an environmentally sound manner • Waste water and effluent shall be discharge after meeting national discharge standards.			
Landscaping, Visual Amenity& Restoration Plan						
4	Land Environment	Sediment load into the river as a result of various excavation activities in the project area	• Reservoir rim treatment work should be carried out by providing the treatment to the drains directly draining into the reservoir with the series of gabion check dams, retaining walls coupled with vegetative measures of sufficient dimensions. • Construction of sediment traps structures on tributary stream and slope stabilization	EPC Contractor MEMD/UEGCL	Start during construction and continue into operation	• No contamination of any surface waters; • Regular visual water monitoring

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			• For restoration of quarry areas and slope Environmentally friendly stabilization shall be undertaken using suitable engineering and biological structures			
5	All environment components	Reduce visual intrusion of Construction activities and Areas due site clearance, Road construction and quarrying	• Construction sites to be kept tidy; • Clearing of vegetation around construction sites to be minimized; and • Landscape planting strategy to identify appropriate re-vegetation .	EPC Contractor, MEMD	During construction	MEMD Environmental personnel to undertake bi-weekly visual checks of construction areas.
6		Reduced visual Footprint due to Dams, powerhouses, roads etc.	Landscape planting strategy with appropriate re-vegetation .	EPC Contractor	Start during construction and continue into operation	Annual survey of re-forestation and re-vegetation.
7	Geology and Soils	Prevent soil erosion	All earthworks for site preparation and leveling shall be carried out during the dry season of each implementation phase and the permanent storm water, road and site drainage system will be in	EPC Contractor, MEMD	During construction	MEMD Environmental personnel to undertake bi-weekly visual checks of construction areas.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			place before the onset of the following rains. All earth work and tunnel operations shall be done according to the designs			
8	Project footprint	Management of Biodiversity issues Habitat conservation And management	• Develop and implement a Biodiversity management and montoring plan (BMMP) • Stakeholder consultation, suggest a series of one to one meetings and local communities stakeholder workshops; and • Production of the final BMMP • Appointment of Community Liaison Officer (CLO). • The contractor shall implement all project activities according to the approved project layout	EPC Contractor, MEMD/UEGCL	From start of construction to end of the Project life.	• BMMPcompleted and circulated to all stakeholders and contractors; • Sign off of the BAP • Approved layout plans
9	Land Environment	Land degradation and soil erosion	Restoration of the quarry sites and other vulnerable	EPC Contractor, MEMD	During construction	MEMD Environmental

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			areas should be done using suitable bio-engineering measures.			personnel to undertake bi-weekly visual checks of construction areas.
10	Land Environment	Illegal encroachment of land for setup of labour camps, for quarry or for project component	As much as possible, the workers should be recruited from the locals residing in the area based on their skills during before/at the commencement of the construction. Land for quarry area and other project component establishment is already identified hence no encroachment is foreseen.	EPC Contractor, MEMD	During construction	MEMD Environmental personnel to undertake bi-weekly visual checks of construction areas.
11	Geology and Land	Prevent land degradation	All raw materials and construction inputs shall be procured from approved sources and NEMA authorized quarries and existing approved gravel pits. In such a case as it may be deemed necessary to open up an alternative source of material (e.g. for gravel or laterite), a separate environmental	EPC Contractor, MEMD, NEMA	During construction	MEMD Environmental personnel to undertake bi-weekly visual checks of construction areas.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			project brief shall be elaborated for each separate material extraction site for consideration and approval by NEMA in accordance with the Ugandan Environmental Legislation.			
Materials and Waste Management						
12	All environmental components	Minimization and safe disposal of waste due to Spoil generated as a result of tunnel blasting	• Where possible, spoil material will be used as a construction material and for concrete batching; and • Other spoil will be disposed of in spoil disposal sites which have been identified at a number of locations within the Project area.	EPC Contractor, MEMD/UEGCL	During construction	• Maintain records of amount of material disposed of to each spoil disposal site; and • Monitor spoil disposal sites for erosion
13	All environmental components	Waste generated as a result of general construction & operational activities	• Develop and implement Construction phase waste management plan (Appendix 1 Materials Use and Site Waste Management Plan (WMP) Framework) • Operational phase	EPC Contractor	During Construction and operation	• Waste inventory including: − waste stream − volume; − disposal route; − competent waste contractor; and − date of uplift; • Audit of waste

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			WMP; and • Materials Use and Site WMP Framework.			management including: − storage and disposal facilities; − waste contractors; and − waste documentation.
14	All environmental components	Sustainable use of raw materials	• Re-using materials on site wherever possible; • Good housekeeping and operating practices, including inventory control to • reduce amount of out-of date, off-specification, contaminated, damaged material or excess to plant needs; • Procurement measures to match material requirements with construction programme; and • Substituting raw materials or inputs with less hazardous or toxic materials wherever economically and	EPC Contractor, MEMD	Construction and operation	Monitor materials use.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			technically feasible.			
15	All environmental components	Minimize Pollution Materials through handling and storage	• Appropriately covered and banded storage located away from sensitive receptors; • Appropriate spill kits nearby (as necessary for hazardous liquids); • Secure and protected from risk of theft or vandalism; • Easily accessible in a safe manner; and • Located next to any required PPE (as necessary for irritants and hazardous materials)		Construction and operation	• Audit of Contractor's materials storage facilities • Number of pollution incidents.
16	Land & Public Health and safety	Prevent contamination of land and, surface and ground water To ensure healthy environment in project site	Adequate facilities for collection, segregation and transportation of waste and refuse such as rejected off-cuts and packaging, workers garbage, waste from workers canteen etc to the approved disposal sites on a regular basis shall be provided.	EPC Contractor, MEMD, NEMA, DWRM	Construction and operation	• Audit of Contractor's materials storage facilities • Number of pollution incidents.
17	Water Quality	Prevent contamination of surface and ground	• Adequate sanitary facilities shall be	EPC Contractor, MEMD, NEMA,	Construction and operation	• Audit of Contractor's

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		water	provided for workers in the form of portable communal toilets • On establishment of the project camps and hostels, water supply and sewage system, permanent ablution/sanitation facilities connecting into this system shall be constructed and provided for construction workers. • Sewerage water shall be treated before its disposal in the river stream	DWRM		materials storage facilities • Number of pollution incidents.
18	Water flow	Minimise disruption to surface drainage	Temporary drains should be constructed and directed in such a manner as to reduce the risk of water logging or erosion and siltation of downstream drainage system	EPC Contractor, MEMD, DWRM, NEMA	Construction and operation	• Audit of Contractor's materials storage facilities • Number of pollution incidents.
Air Quality Management						
19	Air Quality	Minimize dust Emissions due to tunneling, land clearing, quarrying, road	• Minimizing dust from material handling and storage sources by using covers and/or	EPC Contractor	During construction	• Environmental Manager to undertake daily visual checks;

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		construction, spoil deposition and general construction activities.	control equipment (water suppression); and • Dust suppression techniques should be implemented, such as applying water or non-toxic chemicals to minimize dust from vehicle movements.			• Number of dust complaints.
20	Air Quality	Minimise dust Emissions due to Traffic and vehicle movements on site roads	• Restrict traffic to tarmac roads as far as possible. • Speed limit for all off road traffic to be <40 kph within MFNP to minimize dust; • All vehicles should be tarped to prevent dust generation from the loads. • All work areas and access roads on site shall be regularly watered by water sprinkler in order to reduce dust levels.	EPC Contractor	During construction	• Environmental Manager to undertake bi-weekly visual checks of construction vehicles. (violation to be reported only); • Contractor to maintain servicing records for all vehicles; and • MEMD review Contractors Servicing records at beginning of contract and thereafter on six monthly basis for

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
						those longer term contracts lasting more than six months.
21	Air Quality	Minimise construction machinery / vehicle emissions	• Manage emissions from mobile sources as per IFC EHS guidelines for Air Emissions and Ambient Air Quality; and • Locate generators away from receptors (workers' camps and residents). • Equipment engine, fuel and emission systems of construction machinery and vehicles shall be well maintained and calibrated in accordance with manufacturers' recommendation to minimise exhaust smoke, fuel and oil leaks.	EPC Contractor	During construction	• Environmental Manager to undertake bi-weekly visual checks of construction vehicles. • Contractor to maintain servicing records for all machinery. and • MEMD review Contractors servicing records at beginning of contract and thereafter on six monthly basis for those longer term contracts lasting more than six months.
22	Air Quality	Minimize air pollution	The burning of any kinds of waste or construction materials shall not be	EPC Contractor, MEMD, NEMA	During construction	Environmental Manager to undertake bi-weekly

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			permitted			visual checks of construction workstations.
Noise and Vibration Management						
23	All environmental components	Avoid noise nuisance generated by on-site plant and construction activities due to site preparation excavation and foundations, construction and blasting / tunneling	• Establish noise emtting facilities (e.g Generators) away from known sensitive areas e.g breeding grounds. • Positioning of temporary site compounds as far as reasonably practicable from sensitive receptors; • Undertaking construction activities in accordance with good practice; • Maintaining equipment in good working order and fitting with appropriate noise control at all times; • Use of site terrain, material stockpiles and suitable work locations so as to screen work locations and maximise the distance between work activities	EPC Contractor, MEMD, NEMA	During construction	• Requirement for contractors to implement mitigation as part of the contracts; • Monitor noise levels using sound level meter at the nearest residential properties to construction activities for comparison against standards; • Record noise complaints and investigate using sound level meter via the community grievance mechanism.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			and receptors; • Consider acoustic enclosures for compressors/generators if located near sensitive receptors; • Ensure deliveries arrive and depart so as not to disturb residents at inconvenient times; • Follow NEMA set noise limits; • A regime of noise monitoring where appropriate; and • Providing the public with advance notice of planned noise-generating activities. • Provide workers with appropriate PPE			
24	All environmental components	Avoid noise nuisance generated by construction traffic	• Maintaining equipment in good working order and fitting with appropriate noise control at all times; • Keep haulage routes well maintained; • Ensure deliveries arrive and depart so as not to disturb residents	EPC Contractor, MEMD, NEMA	During construction	• Requirement for contractors to implement mitigation as part of the contracts; • Monitor noise levels using sound level meter for comparison against

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			at inconvenient times; • Setting noise limits; and • A regime of noise monitoring where appropriate.			standards; • Record noise complaints and investigate using sound level meter.
25	Noise and vibration Level	Minimise noise and vibration nuisance from construction activity.	• The Contractor shall restrict any of the operations, which result in undue noise disturbance to nearby communities, dwellings, animals (e.g. blasting activities and operation of heavy machinery and construction traffic) between 18:00 to 06:00 hours. • Standard of nuisance as per country rules and acts shall be maintained all the times at construction sites. • To minimize the noise silencers shall be used and buffer shall be created under green belt development. • Blasting shall be	EPC Contractor, MEMD, NEMA	During construction	• Requirement for contractors to implement mitigation as part of the contracts; • Monitor noise levels using sound level meter for comparison against standards; • Record noise complaints.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			carried out safely as indicated in requirements for public health and safety.			
Water Resources and Water Quality Management						
26	Water Quality	Protection of surface water quality for the environment due to in river construction works	Good practice construction measures. Contractor shall be required to obtain a riverbank use permit Adhere to conditions within the riverbank use permit	EPC Contractor, MEMD, NEMA, DWRM	During construction	• No contamination of any surface waters; • Regular visual water monitoring; • Regular review of contractor activities
27	Water Quality	Protection of Groundwater due to tunnel boring	• Water feature survey to determine tunnel lining requirements; and • Compensation through alternative drinking water source Stick to approved drilling and tunneling methodologies	EPC Contractor	During construction	Annual monitoring of water flows
28	Water Quality	Prevent contamination of surface and ground water	Immediate soil remediation will be carried out for any major oil or fuel spillages that may occur by mopping up with an appropriate	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			material and disposal off site by a registered contractor in an approved manner. - All effluent and waste water discharge into the environment should comply to national discharge standards			quality. • Regular visual water monitoring
29	Fisheries/Aquatic Resources	Prevent chemical contamination of water which lead to the poisoning of biota and loss of aesthetic appeal	• All hazardous wastes, material soiled with hazardous wastes and empty containers of hazardous materials shall be stored on site in an approved manner, and be removed at regular intervals to offsite waste disposal facilities designed to handle such hazardous waste as required by law. • Contingency measures/procedure for accidental spills has been proposed and should be followed in the event of such an	EPC Contractor, MEMD, NEMA, MWE	During Construction and Operation	Weekly water quality tests

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			occurrence.			
30	Water Quality	Prevent contamination of surface and ground water	Drip pans will be available on hand for the capture of any substance leaking from machinery.	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water quality. • Regular visual water monitoring
30	Water Quality	Prevent contamination of surface and ground water	Liquid fuel storage and dispensing on site shall be provided in accordance with relevant standards set by the energy regulations and NEMA	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water quality. • Regular visual water monitoring
31	Water Quality	Prevent contamination of surface and ground water	All bunds of the fuel storage facility will have a drainage sump with a piped drain to a common oil interceptor (shared with the workshop / maintenance area)	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water quality. • Regular visual water monitoring
32	Water Quality	Prevent contamination of surface and ground water	• The oil interceptor shall be	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			cleaned/emptied as per regulations • Used oil and lubricants will be stored in approved containers on a concrete hard standing surface with retention bund as per standards and disposed of in accordance with NEMA regulations.			management procedures; • No spills affecting surface water quality. • Regular visual water monitoring
33	Water Quality	Prevent contamination of surface and ground water	All routine maintenance of construction machinery and vehicles, if carried out on site, shall be carried out in a designated workshop / maintenance area with concrete hard standing surface and drainage to an oil interceptor.	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water quality. • Regular visual water monitoring
34	Water Quality	Prevent contamination of surface and ground water	The concrete batching plant / mixing area will be surrounded by a retention bund and all excess and wash water will be retained and recycled.	EPC Contractor, MEMD, NEMA, DWRM	During construction	• Agreed and implemented management procedures; • No spills affecting surface water quality. • Regular visual water monitoring

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
35	Water Quantity	Minimise competition for water supply for use for construction /operational workforce	If creating a temporary water supply for the Project, ensure no adverse impact on other water users. The contractor shall obtain water abstraction permit for all water used on site	EPC Contractor, MEMD, NEMA, DWRM	During construction and during project life	Annual monitoring of water flows. Water abstraction permits
36	Water Quantity	Maintain sufficient water flow for socioeconomic uses	• Operate in with minimum flow requirements • Install and monitor environmental flows using gauge • Comply with conditions spelt out in water abstraction permits	EPC Contractor, MEMD, NEMA, DWRM	During operation	Regular flow monitoring in line with that set out in the ESIA. A fixed discharge of 100cumecs be maintained all the time
37	Water Quantity	Maintain sufficient water flow for ecological uses	Operate in with minimum flow requirements and maintain a fixed discharge of 100cumecs all the time	EPC Contractor, MEMD, NEMA, DWRM	During operation	• Annual fisheries surveys; • Regular flow monitoring in line with that set out in the ESIA.
Dam Safety and Emergency Response Plan						
38	Human environment	To reduce the ill impact resulting from the disasters caused due to dam failure and to reduce risk of drowning	• Putting restriction to restrain the locals from unguarded contact with the reservoir and by installing warning	MEMD, EPC Contractor,	During construction and during project life	Periodic inspection reports on dam safety

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			signs near dam reservoir. • An effective dam safety surveillance, monitoring and observation along with periodic inspection, safety reviews and evaluation must be installed. • Emergency Action Plan shall be prepared and include all the potential indicators of likely failures of the dam, since the primary concern is for timely and reliable identification and evaluation of potential emergency. • The plan should provide warning and notification procedures to be followed in case of potential failure of the dam. The purpose of the plan is to provide timely warning to nearby residents and alert key			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			personnel responsibility for taking actions in case of an emergency. • A Dam Safety review panel will be formed to address safety issues. The Panel will consist of up to three technical experts who will provide advice through final design, construction, and initial filling and start-up phases of the dam. Safety risks will be addressed as part of the Panel's terms of reference. • An efficient communication system and a downstream warning system are absolutely essential for the success of an emergency plan especially in the present case because of inadequacy of time.			
Wildlife and Biodiversity Management Plan						
39	Wildlife	Minimise hunting and	• Code of Conduct for	EPC Contractor,	From start of	• No recorded

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		Poaching	construction workers banning hunting; and • Signage highlighting hunting ban in all Project areas.	MEMD, UWA	construction to end of the Project life.	hunting and poaching activities; and • Hunting prevention measures to be included within Contractor's scope through acceptance of MEMD EHS requirements.
40	Wildlife	• To promote conservation of biodiversity • Control the likely increase in poaching and habitat destruction. • Minimise/Reduce disturbance to the wild animals near construction sites • To reduce disturbance to the wildlife due to noise pollution • Minimise noise nuisance due to construction activities	• Biodiversity offset should be provided by considering the following measures: ➢ Acquiring an equivalent amount of land near the boundary of the Reserve or Park for protection. ➢ Buy land elsewhere of equal or bigger acreage and plant indigenous trees to serve as an offset to the vegetation loss	EPC Contractor, MEMD, NEMA, UWA	From start of construction to end of the Project life.	• Monthly audit of construction areas; • All laydown and working areas restricted to predetermined areas; and • MEMD approval of the Ecological Management Plan developed by the contractor.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			as a result of the project activities and; ➢ Provide financial support to UWA for enhanced ranger patrol operations and Park/Reserve boundary monitoring. ➢ Replanting of characteristic indigenous species of conservation significance and economic importance shall be undertaken. • Awareness programs about the continued survival and the importance of wildlife. These programs should be coordinated through local NGOs. • Awareness campaigns to be carried out for all construction workers to protect and avoid			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			killing such animals unnecessarily. • The Contractor shall restrict any of his operations, which result in undue noise disturbance to nearby communities, dwellings, animals (e.g. blasting activities and operation of heavy machinery and construction traffic) between hours of 18:00 and 06:00. • Standard of nuisance as per country rules and acts will be maintained at construction sites. • Excessive nighttime lighting be avoided by utilizing low-glare lighting fixtures with light beams directed downward to work sites rather than skyward. • Creation of veterinary facilities and rescue camps for healthcare of wild animals and for			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			controlling diseases.			
41	Protected area	Minimise the Influx of project vehicles, equipment transportation and construction dam site that could alter the normal visual impressions in MFNP and KWR	• Only agreed number of vehicles should be allowed into the construction sites that fall within the wildlife reserve. A vehicle quota should be kept for in-coming and out-going vehicles. • To guard against all illegal activities; frequency and the number of people including construction work-force entering the protected area should be monitored and a patrolling programme should be established and implemented in collaboration with UWA and the local authorities. • Time limits for workers to move out of the KWR part of the project area should be set and strictly observed. • The Project falls in the Ayago wildlife reserve	EPC Contractor, MEMD, NEMA, UWA	From start of construction to end of the Project life.	• Monthly audit of construction areas; • All laydown and working areas restricted to predetermined areas • Record the number of reported incidents of bird or mammal kills.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			area and is rich in floral and faunal diversity. Therefore, the wildlife management plan should be proposed with respect to the conservation and should emphasize on the following measures in the protected areas: ➢ All conservation aspects for both physical and biological environment shall be enhanced and habitat restoration shall be enhanced ➢ Awareness, education and sensitizing of fringe population ➢ Recruitment of field staff ➢ Anti-poaching and hunting operational measures ➢ Rehabilitation of a small wildlife			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			health cum ex-situ conservation centre. ➢ Infrastructure development ➢ Enforcement of law ➢ Proper regulation of movement of floating population and settlement of camps near wildlife habitat			
Forest and other vegetation Protection Plan						
42	Forest and other vegetation types	Avoid Vegetation clearance	• No other tree felling other than required for the project components should be allowed and where ever possible tree plantation should be taken up. • Necessary facilities would be provided to the forest/wildlife officials for the improvement of vigilance. • Organizing public awareness programmes,	EPC Contractor, MEMD, NEMA, UWA, NFA	Prior to and during site preparation works (Construction)	Daily monitoring and monthly audit of site preparation /construction activities.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			conducting training camps, hoardings etc.			
43	Forest and other vegetation types	Control of invasive plant and animal species due to vegetation clearance, earthworks, and spoil disposal during construction	Monitoring of alien species and treatment of materials contaminated by invasive plant material e.g. seeds, roots etc.	EPC Contractor, MEMD, NEMA, UWA, NFA	Prior to and during construction	Results of invasive species survey to determine distribution at project site.
Fisheries Management Plan						
44	Fisheries	Contamination of river water with suspended solids, sewage disposal and chemical from the equipments which leads to ➢ Destruction of fish breeding and feeding sites ➢ Enhance light attenuation and degrade primary and secondary productivity as well as fish production ➢ Clogging of breathing organs of the fishes	• Strict adoption and enforcement of environmental friendly management strategy and practice of waste disposal • Safe procedures for storage/handling oil and oil products; standby contingency measures for accidental spills. • Treatment of water before disposing into main river	EPC Contractor, MEMD, NEMA, UWA, NaFIRRI	From start of construction to end of the Project life.	Monthly water and aquatic life monitoring.
45	Aquatic ecology	Reduced flow along river stretch from dam to tailrace outlet will affect	Maintenance of proposed 100 cumecs environmental flow all the	EPC Contractor, MEMD, DWRM, NEMA, NaFIRRI	From start of construction to end of the	Monthly water and aquatic life monitoring.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		the aquatic biodiversity and other aquatic animals	time into the river for the sustenance of fisheries and other aquatic life.		Project life.	
46	Fishes	At operation stage dam will lead to interruption in fish migration. Creation of new fishing grounds	• To explore provision of fish ladder or fish pass to allow continuous upstream and downstream movement of fish during the operation phase. • Stocking of the reservoir with commercial and environmentally viable fish species should be explored in conjunction with the Department of Fisheries. Additionally the possibilities for promoting fish farming in the area shall be explored with support from the District Fisheries Officers.	EPC Contractor, MEMD, NEMA, UWA. NaFIRRI	From start of construction to end of the Project life.	Monthly water and aquatic life monitoring.
Health and Safety Management Plan						
47	Occupational health and Safety	Ensure occupational health and safety on the construction site	• The EPC Contractor will design an occupational health and safety programme (OHSP), which addresses all aspects	EPC Contractor, MEMD, Local Leadership, MoL, Districts	From start of construction to end of the Project life.	Occupational health and safety programme (OHSP)

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			of worker health and safety relevant to the operation of the hydro facilities. • This plan shall comply with the Health and Safety Regulations of MEMD as well as with all applicable Ugandan construction Health and Safety Standards as required by the Occupational Safety and Health Act of 2006 with specific reference to part VIII that relates to Health and Welfare at the workplace. • The Contractor shall ensure that all employees are made aware of and comply with safety rules and measures that will apply on site. • Personal Protective Equipment (e.g. hard hats, gloves, overalls, boots, respiratory protection, hearing and eye protection, high			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			visibility waist coats, fall protection harnesses) shall be issued as required to the various categories of the workforce and replaced when necessary. • The Contractor will install temporary lighting for roads, pathways and work areas according to applicable local standards.			
48	Occupational health and Safety	Hazardous materials handling and storage: fire prevention systems	• Fire prevention systems and secondary containment should be provided for storage facilities, electrical equipment should be grounded, well insulated and conform to applicable codes. Electrical installations must be designed, constructed and maintained to eliminate fire or explosion hazards and risks to	EPC Contractor, MEMD	From start of construction to end of the Project life.	Hazardous materials handling and storage and fire prevention systems

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			employees. • A fire prevention and fire safety programme should be implemented and include regular drills. • Fire alarm should be installed in the project construction area.			
49	Wildlife	Noise and light pollution from construction activities	• Minimize where possible noisy night time working; • Use low light directional lighting to minimize light pollution; • Regular inspection and maintenance of plant and equipment; and • Maintain compliance with national noise standards.	EPC Contractor, MEMD	During construction	• Daily monitoring and monthly audit of construction activities; • Report on number of incidents where noise levels exceed international requirements; and • Complaints log and corrective action plan.
50	Occupational health and Safety	Safety – General: prevention of electrocution by electrical equipment	• Electrical equipment should be grounded, well insulated and conform to applicable codes. • Electrical installations must be designed,	EPC Contractor, MEMD	From start of construction to end of the Project life.	Emergency Preparedness and Response Plan

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			constructed and maintained to eliminate fire or explosion hazards and risks to employees			
51	Public Health and safety	Reduce risk of HIV and communicable disease transmission	• Where practicable the Contractor's other contractual obligations, preferential employment shall be given to members of local communities to reduce the risk of communicable diseases associated with migrant labour. • Project authority should follow proper quarantine and screening procedure and ensure that all migrant workers leave the area after finishing the project work. Therefore, workforce should be medically screened before taking them into the work contract • An intensive STD/HIV/AIDS	EPC Contractor, MEMD, Local Leadership, MoH, District Administration	From start of construction to end of the Project life.	• Established health center with trained medical personnel • intensive STD/HIV/AIDS awareness and prevention programme • Social facilities for both men and women • Members of staff to receive brochure which raises HIV/AIDS awareness; • Staff to sign acknowledging receipt and understanding of brochure.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			awareness and prevention programme should be put in place in consultation and association with the Kiryandongo Hospital, District Aids Coordinators and Uganda AIDS Commission. This programme shall be geared towards the staff employed by the project as well as the communities surrounding the area. • Provision of condoms, ARTs and other material for employees and families will be considered as part of a more extensive approach towards combating and mitigating HIV and other STDs. • Project authorities should also develop proper medical and health facilities in the project area as			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			suggested in Health and Safety Management Plan proposed above covering the detailed mitigation measures for combating the risk of contagious diseases and sexually transmitted diseases (STD), HIV/AIDS etc.			
52	Public health	To provide health care facilities at construction site	• Key personnel shall receive training in basic First Aid • The Contractor shall provide atleast 4-5 first aid kits First Aid which should have all the necessary items for providing medical help at the construction site so that workers are immediately attended to in case • of an injury or accident. • These First Aid post on site, should be appropriately equipped and staffed	EPC Contractor, MEMD, District Administration	From start of construction to end of the Project life.	First Aid facilities

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			by fully trained First Aid personnel. • Contractor shall formulate a plan to deal with serious injuries on site, e.g. accidents with the heavy machinery prior to possession of the site.			
53	Public Health and safety	Reduce risk of malarial infection	• Malaria protection should be made available in the form of screening of accommodation, spraying the inside of houses with residual insecticide and provide bed nets impregnated with insecticide. • To ensure detection and control of water related diseases, a regular screening programme and a treatment programme, should be introduced especially for Bilharzia, worms and malaria and in	Contractor MEMD, Local Leadership, MoH, District Administration	From start of construction to end of the Project life.	Records on screening of accommodation, spraying the inside of houses with residual insecticide and provide bed nets impregnated with insecticide

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			collaboration with the Ministry of Health provision and supply of adequate personnel, equipment and medication should be ensured. • Awareness/Health campaigns on waterborne diseases should also be conducted in and around project area. • The Contractor should ensure adequate drainage at site as indicated in Landscaping and Restoration Plan to prevent stagnant water that can provide a breeding habitat for mosquitoes. • Construction techniques should include measures to avoid the creation of pools of standing water.			
Traffic and Transport Management						
54	Vehicle Traffic	Traffic	• The Contractor will	EPC Contractor,		• MEMD to review

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		movement/management plans for both the safety of personnel and to avoid/reduce risk of accident due to increased traffic and over speeding traffic	prepare and implement a Traffic Management Plan (TMP) that should contains appropriate strategies for moving materials and persons into, from and within construction areas, including abnormal loads. • The Plan should also specify the procedures for monitoring construction-generated traffic movements, and associated environmental problems. • At any point of time, construction vehicles should not be parked in a manner which affects movement of traffic on public roads. • The re-designing of the road should also cater or include the creation of pedestrian	MEMD, Local Leadership, MoW/UNRA, District Administration		Contractors TMP to ensure continuity with commitment in this ESMP; • Review / audit of contractors TMP as part of audit programme; • Number of complaints relating to traffic and transport; • Reporting of accidents and statistics by Contractor • Traffic signage

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			walk ways and pavements on the road sides especially on the residential side (right side of the highway). • Speed limit humps: Speed limit humps will be installed at the entrance into Ayago site from either Direction. • Plans to be followed while moving special loads, such as hazardous material, or heavy loads. • Details regarding maximum controlling site access, permissible vehicular speed on each section of roads, establishment of safe sight distance including within the construction areas and construction camp site. • Necessary training/ orientation to the			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			traffic operators/ drivers to make them aware of the environmental aspects of the traffic movement in the forest/wildlife areas. Sounding of loud horns, etc. in the forested areas should be banned. • Detailed plans for signage in both English and local language around the construction area to facilitate traffic movement. • Detailed plans for signage in both English and local language around the construction area to facilitate traffic movement.			
Labour Force Management Plan						
55	Protecting the workforce	Labour management	• Provide appropriate PPE (as identified through risk assessment); • Emergency	EPC Contractor, MEMD / Implementing agency	Contractor – Prior to and during construction	MEMD to review Contractors Hazard and Operability (HAZOPS) and EHS

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			Response Teams; • Emergency Preparedness and Response Plan (EPRP) to be developed covering health and safety risks to workers in emergencies; • Incident and accident logs to be maintained; and • Review of primary supply chain for occupational health and safety (OHS) issues, use of child or forced labour.		MEMD – Prior to and during operation.	Plan to ensure continuity with MEMD EHS requirements (including commitment to this ESMP). Contractor Montthly HSE progrees Reporting on provision of PPE. Emergency Response teams training reports. Contractor ERPP in place with attached budget. Accident and grievance logs updated as and when incidents or grievances are reported.
56	Labour management	Maintain the well-being of workers living in camps	Workers' Accommodation Plan.	EPC Contractor, MEMD	Contractor - Prior to and during construction	• Worker camp audit reports, Corrective measures and

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
						action plan, photographs demonstrating corrective measures implemented • monitored / audited by MEMD
57	Labour management	Inform workers of HIV/AIDS and sexually transmitted disease (STD) risks and protection to minimize risk of infection to workers and communities	HIV/AIDS and STDs awareness and prevention briefings Organise Voluntary Counselling and testing among workers and the community hosting the workers' camps.	EPC Contractor	At start of construction and updated for new workers. Quarterly re-sentizations of workers and community in the vicinity of the camps.	• Members of staff to receive brochure which raises HIV/AIDS awareness; • Staff to sign acknowledging receipt and understanding of brochure. • Quarterly HIV /AIDS training reports submitted.
58	Population	To manage the influx in population during construction	Awareness campaigns shall be undertaken for both the current residents and the new construction workers.	EPC Contractor, MEMD	Prior to and during construction	Awareness campaigns plans and reports
59	Labour management	Labour Grievance Mechanism	• Staff grievance mechanism; • Tool box talks on	EPC Contractor, MEMD, and Local Council Officials /	Contractor – Prior to and during	• Documented grievance mechanism

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			labour law and the grievance mechanism; and • Worker grievance log to be maintained. • Strict screening for construction workers shall be undertaken to ensure exclusion of social misfits and security shall be enhanced to ensure social order. • Labour disputes will be resolved according to the Labour Disputes (Arbitration and Settlement) Act 2006. • A grievance management committee will be constituted with membership from MEMD, UEGCL, workers' representatives and contractor's representatives.	implementing agency	construction MEMD – Prior to and during operation. Monthly grievance resolution meetings	established; and • Maintenance of complaints log and resolution process • Monthly grievance resolution committee meeting minutes
60	Employment conditions	Project commitment on workers' rights	• Develop and implement a Human Resources Policy;	EPC Contractor, MEMD/ UEGCL	Contractor – Prior to and during	• Payment of wages and bonuses on

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			• Issue each member of staff with an individual contract of employment; • Insert clauses in contractors' agreements to ensure compliance with all policies, plans, procedures and identified mitigation measures. Also include clauses to monitor and • enforce safety plans and report accidents and incidents; and • Provide all workers with a summary of their service and training activities.		construction MEMD – Prior to and during operation.	time; • Hours worked during period and hours lost; and • Fully described job descriptions for all roles. • Contractor human resource Policy in place.
61	Use of equipment, procedures and training	Code of Conduct for the labour force	• Worker Code of Conduct; • Training Program particularly covering health and safety; And • Worker Health and Safety Plan including road safety element with penalties for	EPC Contractor, MEMD	Contractor – Prior to and during construction MEMD – Prior to and during operation.	• Number of community complaints; • Audits of Personal Protective • Equipment (PPE) use; and • Maintenance of disciplinary

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			violation of rules and speed limits and Permit to Work system for hazardous tasks.			records.
62	Safeguarding community health, safety and security	Community Grievance Plan	• Project performance grievance mechanism; • EPRP to be developed in collaboration with and disclosed to local communities; • Record water use baseline prior to tunneling; • Provide temporary and permanent community water solutions if ground water and wells are affected; • Advance warning that flooding will occur. • Community health and safety campaign.	EPC Contractor, MEMD	Contractor – Prior to and during construction MEMD – Prior to and during operation.	• Maintenance of complaints log and resolution process; and • Contact details on MEMD website.
63	Safeguarding community health, safety and security	Restrict access to sites, especially hazardous areas	Site security measures including: • Appropriate fencing; and • Signage around site	EPC Contractor	Prior to and during construction	Provision / review of the following documentation: • Description / photographs of

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			perimeter and where identified through risk assessment process. • Contracting a licensed harzadous waste handler to dispose of the waste.			fencing / signage around site perimeter; • company licenses and individual training records of security personnel proposed as per contract requirements; and • Site registry identification system. • Monthly harzadous waste disposal certificates.
64	Infrastructure works (roads and bridges).	Improved road condition and transport	Road maintenance to leave a useful asset for communities after the construction phase.	EPC Contractor, MEMD	Following Construction phase	Monitoring of road conditions
65	Project closure	Redundancy of personnel	Develop Retrenchment Plan	EPC Contractor, MEMD	Prior to decommissioning	Implement Retrenchment Plan.
Management Plan for Resettlement						
66	Human environment	To ensure implementation of the Resettlement Action	Assistance should be provided to various agencies for the	EPC Contractor, MEMD, CGV Local Council and District	Prior to and during construction	Implementation of RAP

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		Plan (RAP)	successful implementation and monitoring of the RAP. Compensation would be paid for the loss of land, houses and all other immovable properties for which a comprehensive resettlement action plan should be prepared for directly affected people and the host community. The rehabilitation grant has already being calculated and evaluated by Chief Govt. Valuer (CGV) and is presented in Volume III Resettlement Action Plan (RAP) of ESIA.	officials		
67	Human environment	Community development plan	Assistance should be given to affected families in regaining their economic status in such a way they can sustain on their own and do not have to depend on the project authorities for long. This plan will be part of the Resettlement Action Plan which will be elaborated	EPC Contractor, MEMD, Local Council and District officials / UEGCL	Prior to and during construction	Implementation of CDP Monthly activity reports.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			in consultation with all stakeholders involved. The main objectives of the CDP will be: • Implement a consultative relationship with the local communities and administrative authorities through regular meetings, information events and media interactions, throughout the lifetime of the project; • Explain Company policies on environmental and social issues to the community and wider public, via public consultation processes during construction and operation phase. • Wherever possible and economically feasible, maximise the use of local and regional			

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			employment and business opportunities (sub contracting); • Encourage the development of a diverse range of local businesses/activities related to the agricultural sector and non-agricultural sector; • Encourage involvement of government, NGOs and other institutions in the development of the Local Area Development Plan • Undertake the conduct of compensation and relocation activities in a fair and transparent manner through active consultation with the local communities and affected populations.			
Management Plan for Human Aspects						
68	Human environment	Strengthening education facilities	• Existing education facilities in the project area should be	EPC Contractor, MEMD	Prior to and during construction	Construction / improvement of existing education

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			strengthened and if needed new schools shall be opened up in consultation with the Ministry of Education. The Project authority should provide all the infrastructure, salaries and maintenance grant for the school for at least five years • Scholarships and other skill development opportunities for the eligible persons of the affected population should be provided.			facilities. No of scholarships or no of PAPs trained in specialized skills.
69	Human environment	Opportunities associated with local employment benefits	The project authorities directly as well as through their contractors shall: • Ensure jobs for local population. • Disclosure of Recruitment Policy. • Training in vocational skill for unskilled youth of the project affected area. • Income generation schemes	EPC Contractor, MEMD	Prior to and during construction	Local population Recruitment records Vocational skills training reports.
70	Human	Strengthening of health	• The project authority	EPC Contractor,	To be	Availability of health

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
	environment	services Properly manage the increasing population and the likely public health issues such as STIs that are likely to come along with such interaction.	shall establish 2No. healthcare facilities in terms of health care centers at a few affected villages. These centers shall also extend their services to the local people. • Mobile vans for emergency services shall be provided and HIV/AIDS, centre shall be established in collaboration with Kiryandongo Hospital (Health and safety management plan).	MEMD MoH District Leadership	implemented and completed within the first 18 months of construction	services. Constructed health care facilities. Presence of Mobile vans.
71	Human environment	Properly manage the increasing population; during construction	Social amenities such as schools, water and health facility etc shall be expanded to allow for increased population.	EPC Contractor, MEMD and Local Administration	Ongoing	Social amenities availability
72	Public Infrastructure	Avoid or compensate damage to public access roads due to heavy traffic	Damage arising to public access roads which is directly attributable to construction activities or to the Contractors negligence, the Contractor shall be liable for its repair to the original	EPC Contractor, MEMD, Local Leadership, CGV, District Administration	As required	Records on roads repairs. Or costs of repair incurred.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			specifications or the cost of repair.			
73	Human environment	Local skills development / promote development	Skills training programme for local residents.	EPC Contractor, and MEMD	To be implemented and completed within the first 18 months of construction	Records of specialized training for local residents
74	Human Environment	To restore the livelihood of the vulnerable groups (elderly, widows, orphans and the disabled)	Special programmes aimed at livelihood restoration activity development shall be conducted taking each vulnerable group by its own nature and form of vulnerability	EPC Contractor, and MEMD / Implementing agency.	Continuous	Records of livelihood restoration activity/ assistance provided.
Best Management Practices in agriculture						
75	Agriculture	To increase agriculture production and self sustainability in the project affected area	• Financial Grant shall be made for providing high yielding variety of seed, fertilizers and equipments to the project affected families and for improving the veterinary health services • Agricultural Extension Centre should be opened to liaise with other stakeholders to	MEMD / UEGCL	Construction and Operation phases	Increased agricultural production – Records of change in agricultural production. Agricultural training reports.

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			give training and other extension services to the farmers. • Training programmes should be organized for the farmers on best practices of agriculture. They should be made aware about the new techniques, instruments and etc.			
Management Plan for Cultural Heritage						
76	Archaeological Sites	Avoid damage to unrecorded archaeological heritage features	At construction/operational stage, the identified sites shall be enhanced and preserved.	EPC Contractor, MEMD, Uganda National Museums, UWA	Prior to and during construction	• Reporting / notification of finds • Chance Finds Procedure • Cultural Management plan in place.
77	Cultural Resources	Properly handle the sensitive issue of likelihood that dead bodies have to be exhumed or run over during construction phase	The burial sites' owners/ clans should be consulted on the way forward. Develop and implement a Cultural management Plan.	EPC Contractor, MEMD, Uganda National Museums, UWA	Prior to and during construction	• Reporting / notification of finds • Chance Finds Procedure • Cultural management plan in place.
78	Archaeological Resources	Proper management of any archaeological	The Uganda National Museum should be	EPC Contractor, MEMD, Uganda	Prior to and during	• Reporting / notification of

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
		artifacts and sites that might be discovered during construction	informed of such discoveries and laid down procedures followed to either preserve or transfer these findings.	National Museums, UWA	construction	finds • Chance Finds Procedure • Cultural Management Plan in place.
Management Plan for Tourism						
79	Tourism	To enhance the tourism industries	• Project proponent in collaboration with UWA should explore and promote the potential tourism activities in the project area • Dam construction creates panoramic sceneries which attract tourism. This option should also be explored. • Cultural programs can also be organized for tourism enhancement.	MEMD, Local Authorities, District Administration	Construction and Operation phases	Number of tourists and sites visited
Climate Change Management						
80	All environmental components	Reduce Greenhouse Gas (GHG) emissions due to Material sourcing	• Sourcing materials from local suppliers wherever possible to avoid potentially long distance travel for materials; and	EPC Contractor, MEMD	During construction	• Inventory of materials to include source; • Procurement policy to include requirement for

Ref. No.	Affected Environment	Objective to Address Impact	Measures to be taken	Responsibility	Timescales	Monitoring / KPI
			• Use of materials recovered at site (rock and aggregates) in preference to remote suppliers.			sourcing most geographically local materials whenever possible.
81		Use of vehicles, construction plant and generators with emissions.	Using well maintained diesel generators and other plant to ensure the maximum efficiency and lowest fuel/ energy consumption	EPC Contractor, MEMD	During construction	• Record evidence of new plant being employed; • Monitor and record of plant maintenance; • Monitor and record fuel consumption.
82		Staff vehicle movements	• Controlling exhaust emissions from vehicles operating within the site, including trucks, excavators, diesel generators or other plant equipment through regular servicing; and • Transportation scheme for workers and operation staff.	EPC Contractor, MEMD	Construction and operation	• Provision of transportation from local pick up points; • Monitor use of transportation provided; • Incentives for car sharing.
83		Climate change Mitigation due to Forestry regeneration	Plant new forestry to replace forestry removed for construction or lost through inundation.	EPC Contractor, MEMD, UWA	Construction and operation	Number of trees planted

9.2 Waste Management Protocols

Waste and by-products are expected to be generated during the construction and operational phases of the project and therefore, measures to be put in place for the management of this waste have been discussed under the relevant headings in Mitigation Measures above. For ease of reference, waste management protocols for the construction and operational phases of the project are summarized in full in Table 106.

Table 105: Waste Management Protocols during Construction and Operational Phase

Ref. No.	Type of waste / By-product	Waste Management Measures
Construction Phase		
WM1.	Vegetative Material	All woody species will be harvested and cleared from the submergence area to be inundated prior to dam construction in consultation with UWA for area that falls within the national park.
WM2.	Topsoil	Topsoil generated by scarifying of work areas will be stockpiled in designated areas and will be re-used on the site for re-vegetation of the quarry area and landscaping of other green areas.
WM3.	Overburden / Tunnelling Spoil	Overburden material from the excavation, rock quarry, underground powerhouse works and tunnelling spoil, depending on the quality, will be used as gravel for construction purposes like internal access roads connecting the various elements of the scheme with the surrounding district roads. Any remaining material will be deposited as landfill under rehabilitation of the rock quarry site.
WM4.	Construction Rubble (Clean Rubble)	Material such as concrete spoil / broken blocks and excess sub-soil from trench excavations will be stockpiled in a designated area on site and recycled as: • Backfill and hardcore for new slabs / substructures • Aggregate for road construction and/or maintenance / erosion control • Filling of gabion baskets to prevent erosion of the river bank.
WM5.	Other Solid Waste	• Skips shall be provided on site for the disposal of construction waste and refuse such as rejected off-cuts and packaging, workers garbage, etc. • Waste from the skips shall be collected on a regular basis by for disposal in accordance with NEMA Waste Management Regulations. • Provision should be made for the separation and composting of organic waste from workers canteen. • Materials such as scrap timber and cement bags should be recycled as far as possible on the site.
WM6.	Hazardous Waste	• All hazardous wastes including material soiled with hazardous wastes and empty containers of hazardous materials shall be stored in a designated area on site for regular removal and disposal by a registered contractor in accordance with the Hazardous Waste Management Regulations. • Immediate soil remediation will be carried out for any major oil or fuel spillages that may occur by mopping up with an appropriate material and

Ref. No.	Type of waste / By-product	Waste Management Measures
		disposal off site by a registered contractor in an approved manner. • Used oil and lubricants will be stored in approved containers on a concrete hard standing surface with retention bund as per UNBS standards and disposed of in accordance with the Hazardous Waste Management Regulations. • Drip pans will be available on hand for the capture of any substance leaking from machinery.
WM7.	Sanitary Waste	All workers (including casuals) shall use the toilets and ablutions provided on site
WM8.	Concrete Batching Plant Washout	All excess wash water from the concrete batching plant will be retained in a sedimentation reservoir from where it will be pumped back for reuse in the concrete manufacturing process.
WM9.	Dust	All exposed work surfaces on the site will be watered down on a regular (daily) basis
WM10.	Exhaust Emissions / Oil & Fuel Leaks (Construction Machinery)	Badly maintained construction equipment will not be allowed to operate on the construction site to avoid smoke emissions and oil leaks.
Operational Phase		
WM11.	General	Proper housekeeping will ensure that all the parts of the facility are at all times clean and tidy.
WM12.	Hazardous Waste	As per WM6.
WM13.	Solid Waste	Un-recyclable waste from refuse skips shall be collected on a regular basis for disposal in accordance with NEMA Waste Management Regulations.

9.3 Environmental and Social Action Plan

The Environmental and Social Action Plan (ESAP) describes the principles, objectives and approach to be followed in minimizing and mitigation the adverse environmental and social impacts caused as a result of the implementation of the Proposed Ayago HPP (Figure 75). The plan is comprised of several components that are to be integrated and implemented by project developer and the EPC Contractor with regard to the Project. All the relevant policies, regulations, procedures arising from government agencies, lender policies and international treaties etc as outlined in the Chapter 2 of this ESIA report form the basis of this plan. These relevant policies and guidelines will have to be observed during the construction and operation of the project to reduce environmental (including social and economic) impacts of the project. The Management Framework will include a Change Management process, whereby proposed changes to social and environmental management procedures are reviewed and assessed prior to being implemented, and a comprehensive register of such changes is kept. The UEGCL implementation team structure and proposed EPC contractor's environmental team structure is presented in Figures below.

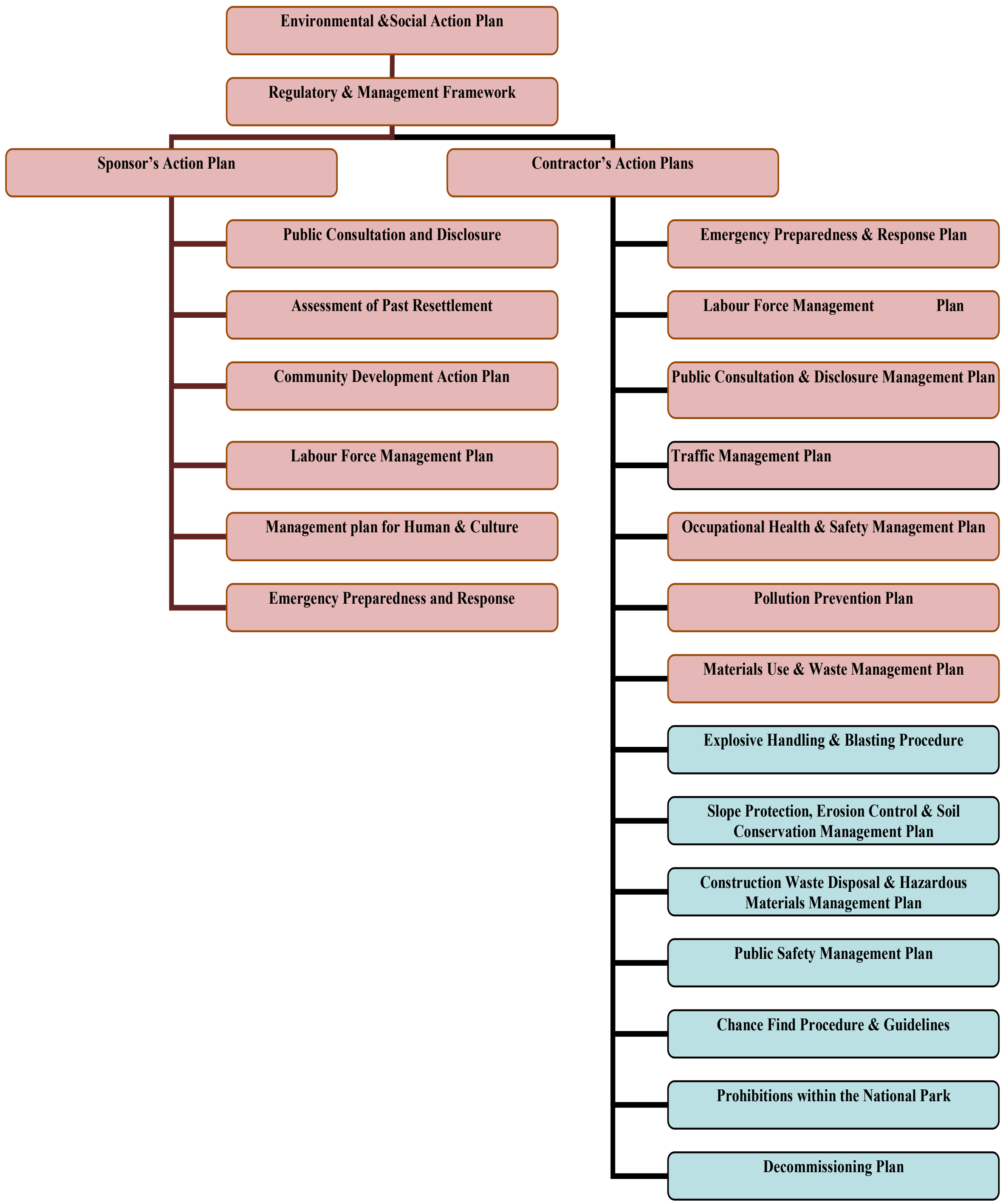


Figure 71: Environment and Social Action Plan

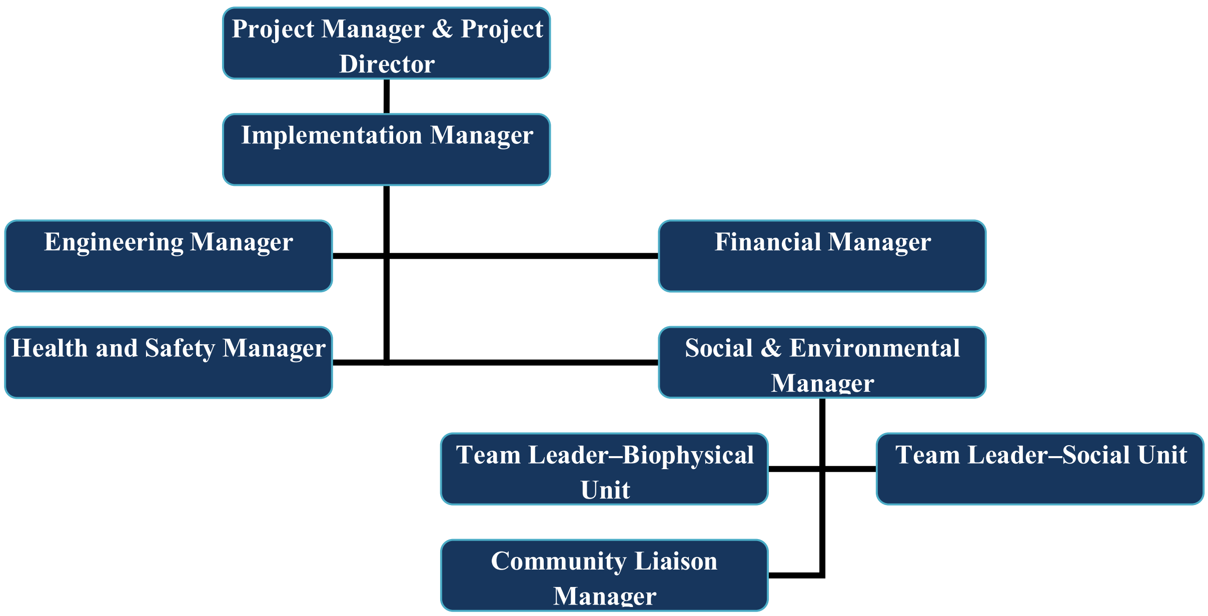


Figure 72: UEGCL implementation team structure (indicative)

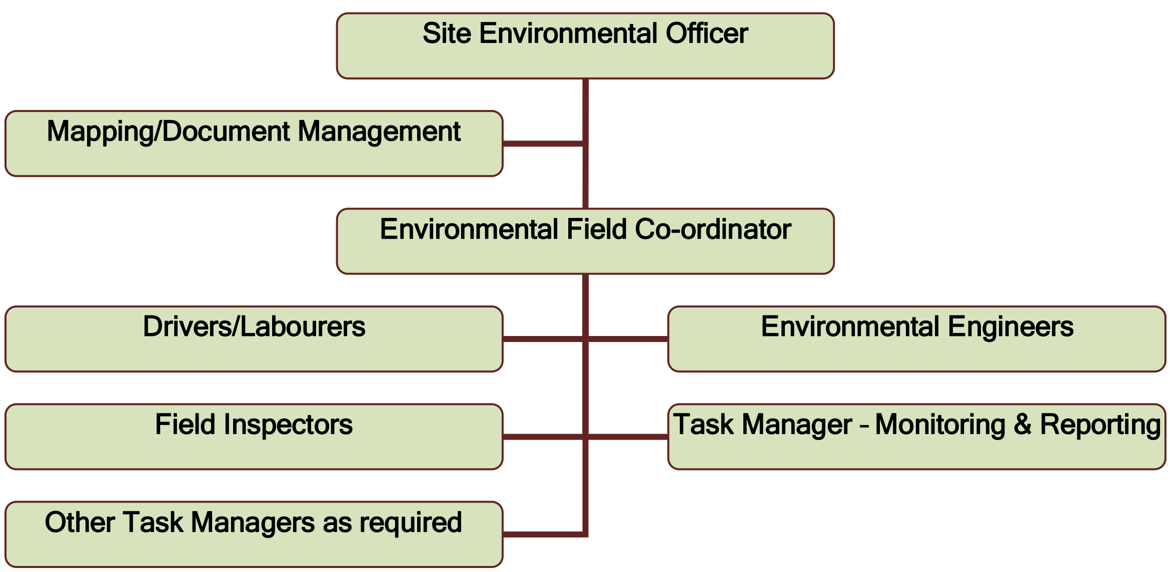
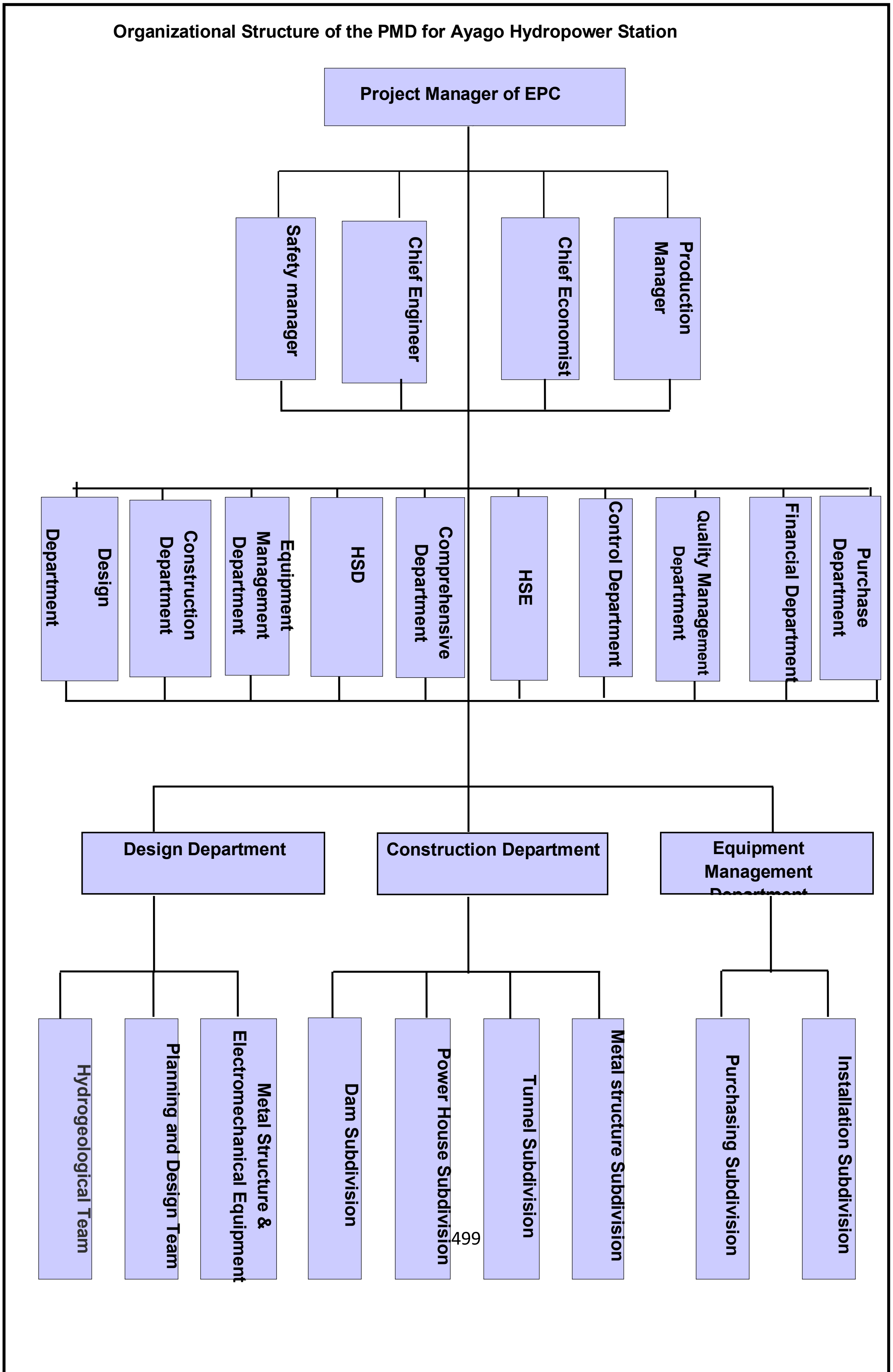
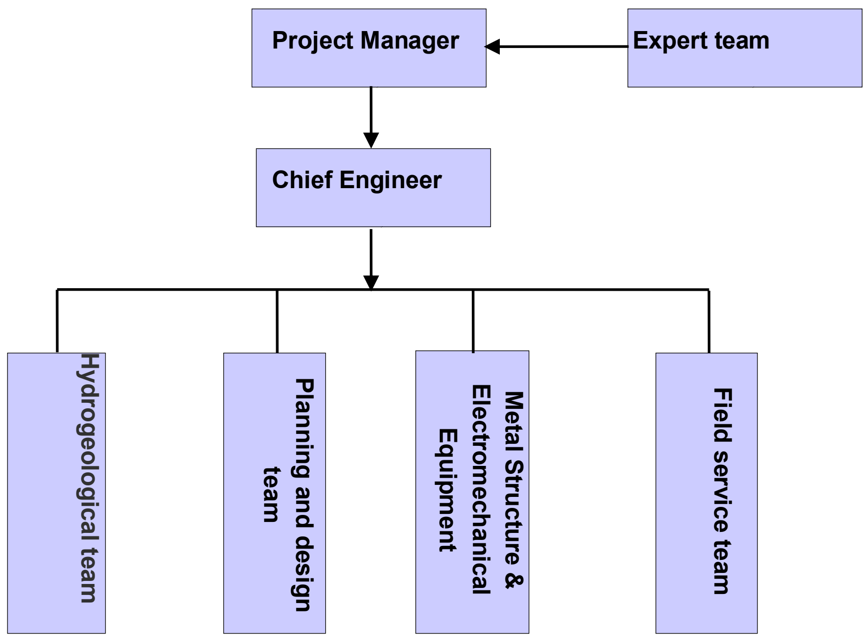


Figure 73: Proposed EPC contractor's environmental team structure

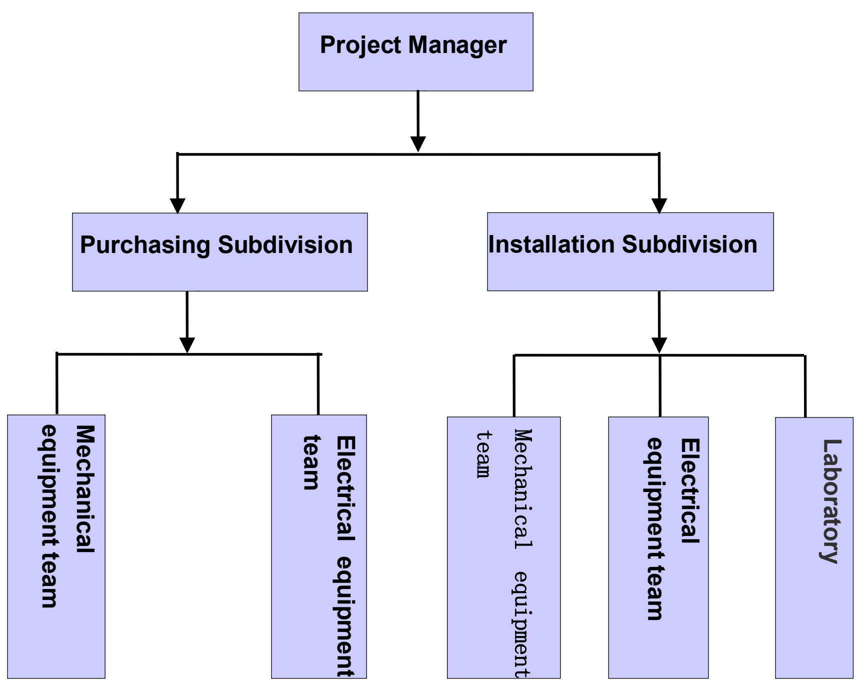
Organizational Structure of the PMD for Ayago Hydropower Station



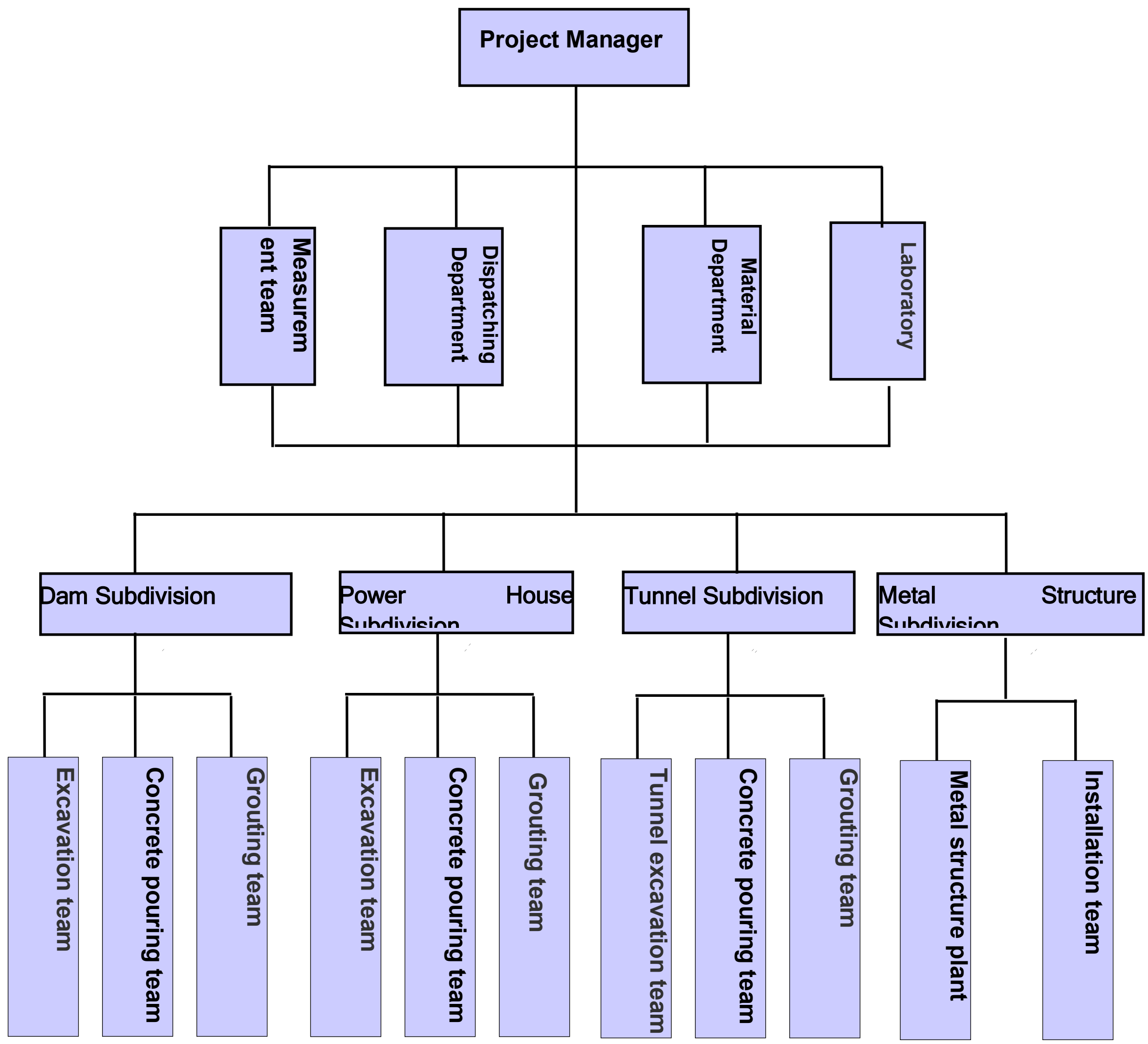
Organizational structure of the Design Department



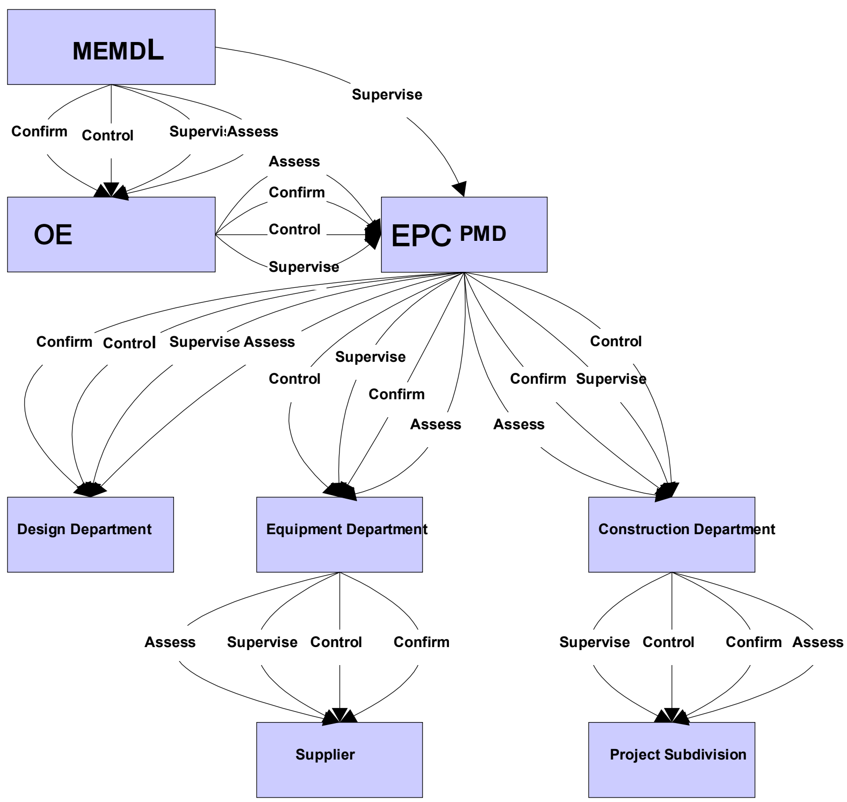
Organizational structure of the Electromechanical equipment Department



Organizational structure of the construction Department



Organization and decision-making procedures of the Project



Overall organization procedures

Responsibilities of Each Organization of the Project Department

Table 106: Responsibilities of Each Organization of the Project Department

S/N	Description	Main responsibilities
I	Decision-making level of Project	
1	EPC Project Manager	Being the authorized representative of the EPC project contract, the Project Manager entirely organizes and takes care of the work of the Project Department according to relevant regulations and authorization of the group. He undertakes the general contractor's rights and obligations stipulated in the project contract on behalf of the general contractor during the project implementation process. He is responsible for the whole process and overall management and fulfilling the contract tasks in accordance with the specified

S/N	Description	Main responsibilities
		working range and content as well as contract requirements as the agreed work cycle, quality standard and size of investment.
2	Safety Manager	To be responsible for the construction safety, public security, environmental protection, occupational health management work, and assist the EPC Project Manager in dealing with internal affairs of the Project Department as well as external coordination.
3	Chief Engineer	To be responsible for arranging project technical management, quality and occupational health safety, operation of the environmental protection system, preparing the general schedule.
4	Production Manger	To be responsible for the arrangement of the construction and production management and implementation of the scheduled plan.
5	Chief Economist	To be responsible for the contract management, fund raising and operation, expense management and purchase management of the Project.
II	Project management level	
1	Design Department	To be responsible for the approval of the project design schedule, evaluation, supervision, inspection, control and management of the design contractors, management design and assist the Project Department in completing the design, modification and change etc.
2	Construction Department	To be responsible for the examination of the construction organization design, technical scheme and measures. To be responsible for the formulation of technical scheme, examination and technical management for the construction, acceptance, test running and operation starting and quality guarantee. To be responsible for the compilation of the completion data. To be responsible for the overall dispatching and coordination for the EPC project construction; be responsible for the general plan and dynamic management of construction resources; command, coordinate and manage the construction schedule, test running and operation starting of the whole project; various mobile information (including design, equipment purchase and storage and transportation, construction schedule, engineering quality and completion data etc).
3	Equipment Department	To be responsible for the supervision, examination and implementation of the management of permanent equipment of the project, including the purchasing, installation, operation, maintenance and handover of the permanent equipment.
4	HSD	To be responsible for the HR management of the Project Department, including planning, implementation and management of human resource, team construction, personnel recruitment, training, evaluation, remuneration and labor insurance of the Project Department.
5	General Affairs Department	To be responsible for the management of internal administrative affairs, logistics support, property management, document management, promotion and external relations. There are car team, medical room and foreign affairs

S/N	Description	Main responsibilities
		office under this department.
6	HSE	Undertakes the work of project safety, management and control work of occupational health and environmental protection; establish, implement and maintain suitable HSE management system for the Project; be responsible for the security risk management of the project.
7	Control Department	Compilation of general schedule of the project, analysis, tracking and controlling of the general schedule; preparation of overall expense plan of the project and be responsible for expense management work; be responsible for the management and controlling of the planning, schedule, cost and risks of the whole implementation process of the EPC contract, subcontract and insurance contract.
8	Quality Department	Undertake the work of quality management and quality control of the project; establish, implement and maintain project quality management system; be responsible for the quality risk management work of the project; arrange the high quality, system control and management of the project to realize the quality goal of the project.
9	Finance Department	Undertakes the financial management work of the project, be responsible for the settlement of advance payment and interim payment, financial management and cost accounting for the project.
10	Purchase Department	To be responsible for the purchase, transportation, storage, issuing and quality guarantee of all the materials and construction equipment of the project, be responsible for the preparation of purchase plan for the project.
III	Project implementation level	
1	Project Design Department	To be responsible for the design, supplementary investigation and design change management of the construction drawing of the project under the leadership of the EPC Project Department.
1.1	Hydrogeology team	To be responsible for providing basic hydrologic and geologic data necessary for the dam, water release structures, powerhouse and tunnels.
1.2	Planning and design team	To be responsible for relevant work on power station planning and design of the dam, water release structures, power house and tunnels and relevant auxiliary project.
1.3	Electromechanical and metal structure team	To be responsible for the design of electromechanical and metal structure works and relevant auxiliary works.
1.4	Field service team	Be responsible for the field technical service during the construction period of the power station.
2	Construction Department	To be responsible for the construction and production of the project under the leadership of the EPC Project Department.
2.1	Dam subdivision	To be responsible for the construction of the dam and diversion facilities

S/N	Description	Main responsibilities
2.2	Powerhouse subdivision	To be responsible for the construction of the underground powerhouse.
2.3	Tunnel subdivision	To be responsible for the construction of underground tunnels.
2.4	Metal structure subdivision	To be responsible for the purchase, production and installation of all the metal structures of the project.
2.5	Housing construction subdivision	To be responsible for the construction of temporary houses and permanent camps.
3	Equipment Department	To be responsible for the purchase, transportation and installation of electromechanical equipment of the Ayago Hydropower Station under the leadership of the EPC Project Department. Formulate electromecanical equipment purchase and installation plans.
3.1	Purchase subdivision	To be responsible for the purchase, supervision, factory acceptance, transportation, custom declaration, customs clearance and site storage of electromecanical equipment.
3.2	Installation subdivision	To be responsible for the installation, commissioning, test running and acceptance of electromecanical equipment.

9.3.1 Management of Change

During the implementation of the project, change may be required to address unforeseen or unexpected conditions or situations. A change management process significant changes to project procedures, processes, design or activities. Both project proponent and the EPC Contractor will be responsible for managing changes within their respective areas of responsibility. MEMD and the EPC Contractor will incorporate into their Action Plan a change management process similar to the following:

- Identification of item/situation potentially requiring change;
- Preparation of a Change Request Document that;
    a. Outlines the nature of the item/situation requiring change;
    b. Outlines impacts of the change (e.g., cost, schedule, safety, operability); and,
    c. Identifies potential biophysical, socio-economic, or health concerns.
- Review of the Change Request for compatibility with MEMD's or the EPC Contractor's Action Plan, as applicable;
    a. At the task manager level for minor changes;
    b. By the Social and Environmental Review Panel for significant changes; and,
    c. Review by NEMA and international lenders for significant changes, to confirm it will not compromise ongoing compliance with Ugandan regulations, nor with lender policies and performance standards.
- Documentation of the approval or rejection of the change request;
- Application for, and receipt of, any approvals required to effect the change under Ugandan Law;

- Implementation of the approved change, including communication to appropriate parties concerning the nature, scope, and timing of the change; and,
- Summary of project changes and status to be included in quarterly reports to the Social and Environmental Review Panel, NEMA and lenders.

9.4 Environmental Monitoring & Auditing

During project implementation, a framework in the form of a plan is proposed to ensure efficient and effective undertaking of the mitigation measures. Environmental monitoring is used as a tool in relation to environmental management as it provides the basis for rational management decisions regarding impact control. By using the information collected through monitoring, environmental mitigation and benefit enhancement measures can be improved and the works or operation will be modified or halted when necessary. Therefore, the objectives of this environmental monitoring programme include:

- To monitor changes in the environmental conditions as a result of implementing the Ayago Hydropower Project;
- To check on whether mitigation and benefit enhancement measures have actually been adopted, and are proving effective in practice;
- To provide a means whereby any impacts which were not clearly defined/identified/evaluated or unforeseen at the time of preparation of this ESIA can be identified, and to provide a basis for developing appropriate and additional impact mitigation measures to take into account those newly evaluated impacts;
- To provide information on the actual nature and extent of key impacts and the effectiveness of mitigation and benefit enhancement measures which, through a feedback mechanism, can improve the planning and execution of other similar hydropower projects.
- To ensure that personnel exercise due diligence in carrying out activities

The proposed environmental monitoring programmes shall include:

a) Compliance monitoring

An environmental compliance monitoring programme will ensure that pre-construction commitments made to regulatory agencies, and other stakeholders are implemented. Compliance monitoring will ensure that preventive and environmental measures are in place throughout the project area. Compliance monitoring is undertaken for a project to ensure that appropriate regulations and company specifications are implemented during project development. Activities relevant to all phases of the project (i.e., construction, operation and decommissioning) are subject to the provisions of relevant regulations and guidelines.

Compliance monitoring will be performed by MEMD personnel that are familiar with the applicable regulations and will ensure that activities be planned and conducted with the knowledge and understanding of standard specifications. Monitoring will ensure that any planned activity during project development is not in contravention of the regulations or MEMD specifications. In the event of non compliance, MEMD personnel overseeing compliance monitoring will immediately report the activity to MEMD, and implement measures to achieve compliance. Monitoring during operations will be conducted during normal working hours. Compliance monitoring will follow the stipulations in the Standing Operations Procedures for the Power Station. General environmental conditions in the project area and surrounding areas will be monitored. New developments or activities near Power Station facilities will also be monitored to assess any encroachment onto the MFNP.

b) Baseline monitoring

Pre-construction (i.e. baseline) monitoring will be conducted to characterize a variety of parameters associated with environmental components, and facilitate finalization of the envisaged Power Station and conservation area. Baseline monitoring provides a basis by which changes in parameters associated with environmental components can be determined by comparing with the results obtained from the compliance and environmental effects monitoring program.

c) Environmental effects monitoring

Environmental effects will be monitored in order to assess the accuracy of any predictions made in the EIA concerning potential impacts. After project implementation, potential environmental effects of construction will be monitored. Site visual examinations of the environmental features along the Nile River and protected area (MFNP and KWR) will be conducted to identify potential problem areas. This will facilitate the assessment of recovery trends and zones that may require additional restoration activities. Soil and water sampling programmes in the project area will be developed to monitor site conditions in order to establish site specific rehabilitation programmes where need will arise. Monitoring may include documentation on the following among others:

i. Aquatic habitat,
ii. Species at risk (Fish, Wildlife and Forestry)
iii. The effect of vibrations associated with blasting and or drilling activities on the aquatic environment (especially on wild animals and fish) and surrounding areas
iv. The quality of selected surface waters draining potentially disturbed areas

Environmental monitoring ensures that the impacts have been accurately predicted and that appropriate mitigation measures are being implemented as planned and that they have the expected effects. Identification of potential environmental impacts associated with the construction of the project indicates a need to design and implement a specific environmental monitoring plan. The monitoring process begins with supervision of implementation. The bulk of the activities may take place during the implementation stage. The environmental objectives of these activities are to ensure mitigation measures outlined in the contracts are being properly implemented, that environmental contractual measures are being respected, construction is going in accordance with the agreed design standards and that no unforeseen negative impacts are occurring as a result of project execution. The comprehensive environmental monitoring programme has been proposed for Ayago HPP. This monitoring plan identifies monitoring activities that will take place, when and by whom and identifies the indicators and data collection methods, allocates the budget and institutions and persons to implement the plan. As indicated in the monitoring schedule below, monitoring will be done by MEMD, EPC Contractor, DWRM, UWA, Uganda National Museum and local authorities among others.

Table 107: The proposed Environmental Monitoring Plan for Ayago HPP

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
Pre-construction							
Loss of Vegetation	Siting of the road and support facilities (Construction Camps) to avoid critical terrestrial and aquatic habitat (e.g. thick wooded grassland the riverine forests, wetlands, and fish spawning habitat);	ESIA Document, this report Wetlands Policy, 1995, National Environmental Regulations (Wetlands, River banks and Lake shores)- 2000	Visual observation Design documentation Suspended solids in water ways/runoff	√	√		Throughout the implementation phase
	The developer will provide adequate protection against scour and erosion; and giving consideration to the onset of the rainy season with respect to construction schedules						
	Preventing short and long term impacts to the quality of aquatic habitats by minimizing clearing and disruption of riparian vegetation, especially that nearest the river;	NCORE, ESMF-NBI, March 2014	Visual observation		√	√	
	The developer will avoid/modify construction activities during the breeding season and other sensitive seasons or times of day to account for potentially negative effects;		Periodical monitoring	√			
	Active management of invasive species like the *mimosa pigra* through allowable (by UWA) practices like periodic bush burning,	Wild Life Act, CAP 200, 1996	Visual observation		√	√	

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	Encourage native vegetation to re-grow after the construction;		Number of native plants after phase				
	Design and construction of access to avoid or minimize habitat fragmentation, taking into account motorist safety and the behavior and prevalence of existing species;		Fauna Counts and observations	√	√		
	The developer will utilize existing transport corridors whenever possible;		Visual observation		√		
Noise & Vibration	Sound-control devices on equipments should be maintained in good condition;	The National Environment (Noise Standards and Control)Regulations, 2003, EMMP, this report	Visual inspection at workshop	√	√		Monthly
	Appropriate and sufficient PPE for noise protection shall be provided to all workers and visitors to highly active sites;		Visual Observation, Reports at clinic of hearing problems on work site	√	√		Monthly
	Construction activities that may generate harmful noise should be limited only in day time, e.g. 6 am to 7 pm and only outside of breeding periods;		Workers time check in and out	√		√	Weekly checks
	Reduction of speed in highly sensitive areas will be adopted to reduce the high impact noise so that shock events are reduced to manageable levels by animals;	National Park rules - UWA	Speed gauge on vehicles	√	√		Daily
	Selecting equipment with lower sound power levels and installing suitable mufflers on engine exhausts;	EMMP, this report		√			Monthly

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	The developer will limit the hours of operation for specific pieces of equipment and operations, especially mobile sources operating through sensitive areas			√	√		Weekly
	Re-locating noise sources to less sensitive areas to take advantage of distance and shielding will be employed in as far as applicable;			√			Monthly
	Taking advantage of the natural topography as a noise buffer during facility design				√		Bi-annual
Construction Phase							
Air Quality (Gaseous Emissions)	Observance of speed limit within the park (≤40km/h) will be implemented, to prevent raising dust and the developer will engage in activities that preserve carbon sinks (trees and natural resources	EMMP, this report, Park rules-UWA, Wetland management strategy- NBI, 2013	Visual observation, Speed meter gauge	√	√		Weekly reports to be audited monthly
	All vehicles will be instructed to switch off engines on arrival at site. More pollutants are released during idling as compared to a vehicle in active movement;	EMMP, this port	Observation and registration of vehicles	√	√	√	
	All non road mobile machinery (NRMM) to use ultra low sulphur tax-exempt diesel (ULSD) where available;		Regular inspections and checks on service lists	√	√		
	All trucks delivering materials to the site						

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	will be maintained in good working order as inefficient fuel combustion is key in the release of NO2, SOx CO, and NO from vehicle exhausts;			√	√		
	Vehicle drivers will be encouraged switch engines off when not in use because an idling truck releases more emissions than one in active movement;			√	√		
Air quality (dust)	No bonfires for waste will be encouraged in the park, as this causes dust raising situations;	Park rules - UWA, EMMP, this report	Daily Visual inspections, by staff EHS supervisor, Environmental Design documentation Daily visual observations by UWA gate officials	√	√	√	As required
	Land clearing, removal of topsoil and excess materials, tips and stock piles, will be planned			√		√	
	All loads entering and leaving site to be covered to prevent windblown dust along the route to and fro the site;			√	√	√	Daily throughout construction phase
	Enclose stockpiles in temporary or keep them securely sheeted to prevent dust spreading;			√	√		Monthly
	Water will be used as dust suppressant where applicable to subdue any dry particles from becoming airborne during windy days in the dry period;			√	√	√	Daily
	Dust generating activities will be minimized especially on windy days to prevent dust			√	√		Daily. As required during

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	raising in the park;						windy dry days
	The developer will be encouraged to plan the site layout – machinery and dust causing activities should be located away from sensitive receptors;				√		During Design Stage
Archeology	Where the developer/contractor has encountered tangible cultural heritage that is replicable and not critical, the personnel will apply mitigation measures that favor avoidance;	IFC, PS8, EMMP this report	Visual observation, Collection of artefacts from site	√		√	As required
	The developer/contractor will work in close collaboration with the UWA officials on any find and develop a procedure for addressing chance finds especially during excavations				√		As required
	Where an encounter has been made with artefacts, the developer will ensure that the project personnel doesnot disturb any chance find until further assessment by competent professionals has been made and the find has been rendered replicable in another area or be preserved in its current state;		Visual observation		√	√	As required
	Where the project site contains cultural heritage or prevents access to previously accessible cultural heritage sites being			√	√		As required

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	used by, or that have been used by, Affected Communities within living memory for long-standing cultural purposes, the developer will, based on consultations allow continued access to the cultural site or will provide an alternative access route, subject to overriding health, safety, and security considerations;						
	Where restoration in situ is not possible, restore the functionality of the cultural heritage, in a different location, including the ecosystem processes needed to support it;				√	√	As required
	Minimize adverse impacts and implement restoration measures, in situ, that ensure maintenance of the value and functionality of the cultural heritage, including maintaining or restoring any ecosystem processes needed to support it;				√		As required
Soil erosion	The developer will encourage contouring and minimizing length and steepness of slopes to reduce erodibility;	Wetland Management Strategy - NBI, June 2013	Visual observation, design documentation	√	√		Monthly
	Formulate construction planning on demarcation to suit exact places for slopes	Environmental and Social Policy	Design documentation		√		

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	to be excavated to avoid over excavation and overproduction of spoil. Surveying the sites, installation of pegs and batter boards which are standard construction practices should be strictly adopted. (gabions to be adopted to stop any earth sliding).	- NBI, June 2013					
	Any spoils (Boulders) in the Weir area will be used for the backfilling of the weir	NCORE - ESMF-NBI, March 2014	Visual observation		√		Weekly
	Transport all the soil excavated away from the slopes and dump in areas designated for spoil in the park (temporarily) and outside the park (permanently);	Park rules- UWA	Visual Observation	√	√		As required
	Lining steep channel and slopes (e.g. use jute matting) and removal of all the excess spoil to a designated place is advisable	EMMP, this report	Visual observation Slope measurement	√	√		As required
	Designing channels and ditches for post-construction flows especially in periods of high flow;		Design documentation	√	√		Before project commencement
	Spoil and stock piling areas should have properly designed channels to direct runoff away from the areas to prevent material erosion;		Design documentation	√	√		As required
	Project activities will be scheduled to avoid heavy rainfall periods (i.e. more activities during the dry season) to the extent practical;				√		Monthly

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	Re-vegetating areas promptly after activities. This helps to stabilize soils after excavation activities;		Visual observation, Number of trees/shrubs planted		√	√	As required
	Mulching using vegetation previously cleared from the areas will be used to stabilize exposed places;		Visual observation		√		As required
Geology	Detect any changes in the geological formation and potentially weak zones within the project area especially along the Tunnel/power channel, and tailrace channel.	EMMP, this report	Seismicity monitoring station be established		√		Continuous
	Deterministic analysis of the regional earthquake vulnerability in the area.	EMMP, this report	Making use of seismic data available at MEMD for design earthquake		√		Continuous
	Blasting of rock and mitigation of fly rock impacts to the wildlife	EMMP, this report	Ensuring controlled blasting		√		As required
	Disposal and/or utilization of waste rock	EMMP, this report	Consideration for commercial use of the waste rock as aggregate and other construction materials (a mining lease may be required).		√		As required
	Disposal of Muck	EMMP, this report	Use of retaining walls and/or waterproof				As required.

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
			membranes if potentially hazardous		√		
	Excavation of underground tunnels	EMMP, this report	Measuring radioactive counts in underground tunnels		√		As required.
Surface water contamination	Activities that may destabilize soils/sediments should be done in as far as practicable in the dry season (ie when the seasonal rivers like Chobe are dry) to reduce sediment/contaminant delivery to the Nile;	EMMP, this report	Visual check of activity schedule		√		Dry season
	Provision of automatic fill shutoff valves on construction fuel storage tanks to prevent overfilling and eventual spills	EMMP, this report	Vehicle service sheet checks	√	√		As required
	Maintenance of vegetative buffer between the water and construction works to help trap loose sediments and or materials;	EMMP, this report	Visual observation, Species used are suitable		√		As required
	Use of a catch basin or absorbent material to soak around the fill pipe to collect spills	EMMP, this report	Visual observation, photographic evidence during audits		√		Monthly
	Sludge from storm water catchment areas or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the	EMMP, this report, Waste Discharge Regulations, 1998	Absence of pollution indicators,	√	√		Rainy season, as required

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	absence of which disposal has to be consistent with protection of wildlife, aquatic ecology and public health;						
	Oil water separators and grease traps should be installed at sites for re-fueling equipment and vehicles and maintained as appropriate;	EMMP, this report	Visual observation		√		As required
	When water quality criteria allow, storm water should be managed as a resource in holing lagoons, either for groundwater recharge or for meeting water needs at the site;	EMMP, this report	Groundwater connectivity investigations, Design criteria	√	√		Rainy season
	All project vehicles scheduled to work near water resources will be cleaned prior to use (during the dredging activities);	EMMP, this report	Absence of pollution indicators in dredged areas		√		As needed
	Surface runoff from process areas or potential sources of contamination will be prevented to prevent rain water contamination;	EMMP, this report	Presence of Pollution indicators		√		Rainy season
Ground water contamination	Waste collection points for workers at the construction site will be located out of the high water table sections of the area;	EMMP, this report	Pollution indicators in monitoring wells at site	√	√	√	Monthly or during rainy season when ground water table rises
	All waste areas will be banded during temporary storage to prevent pollutant leaching to below ground water resources	EMMP, this report	Visual inspection of the bunding material	√	√		
Loss of vegetation	The developer will select appropriate low-	EMMP, this	Visual inspection of				As required

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	impact extraction (e.g. excavation, quarrying and dredging) methods that should result in final site contours supportive of habitat restoration principles and grasses re-establishment;	report, IFC guidelines for Materials Extraction	excavation sites	√	√		
	Smaller, short-lived extraction sites will be reclaimed immediately, and larger sites with a useful lifespan beyond 3–5 years be subject to ongoing rehabilitation		Visual observation		√		Weekly/Monthly
	Native species especially those preferred by native/migratory birds will be left intact as far as practical and in the event this is not possible, they will be relocated within the same corridor;	EMMP, this report	Numbers of native plants remaining on site after construction	√	√		Annually
	Establishment of buffer zones from the edge of extraction areas, considering the characteristics of the natural habitats and the type of extraction activities;	EMMP, this report, IFC guidelines for Materials Extraction	Visual observation		√		Weekly
	During extraction, ecological niches should be preserved and protected as far as possible;		Visual inspections		√		As needed
	Vegetation translocation and relocation techniques will be used as necessary. Vegetation cover, such as native local plants, topsoil, overburden, or spoils feasible for sustaining growth should be		Number of trees replanted in the area	√	√		6months/during growing season for relocated plants

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	removed in separate operations and segregated for later use during site reinstatement;						
Traffic	The developer will plan vehicle routes to target low traffic hours on Masindi-Kigumba road and will establish high vehicle access on the Chobe route during low tourist seasons to avoid interference with lodge activities;	EMMP, this report	Vehicle numbers on road during activities	√	√	√	As required during vehicle transit
	Contractor shall provide temporary road signage during construction and ensure drivers observe speed limits and for safety of other road users	EMMP, this report	Visual observation	√	√		Daily, or as required during heavy traffic requirements on site
	Using inspected and well-maintained lifting devices that are appropriate for the road, such that there are no breakdowns in the middle of the road;	EMMP, this report	Visual observation, number of project vehicles broken down along road	√	√		
	Ensuring moving equipment is outfitted with audible back-up alarms	EMMP, this report IFC EHS guidelines	Audio measurements of equipment on site	√	√		
	Ensuring the visibility of personnel through their use of high visibility vests when working in or walking through heavy equipment operating areas, and training of workers to verify eye contact with equipment operators before approaching the operating vehicle;		Visual observation	√	√	√	

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	In the case that there is an overlap of public and project vehicles, the developer will be charged with controlling vehicle traffic through the use of one -way traffic routes if needed, and on- site trained flag-people wearing high- visibility vests or outer clothing covering to direct traffic;		Number of traffic control devices on road, Road diversions evident in road	√	√		
Noise	The developer will erect noise barriers such as temporary walls or piles of excavated material, between noisy activities and sensitive receptors (animal breeding grounds);	EMMP, this report, The National Environment (Noise Standards and Control) Regulations, 2003 Occupational Health and Safety Act 2006	Audio measurements at receptors near site		√		As required
	It will be mandatory for the workers to use earmuffs and the supervisor will ensure compliance to this requirement. Disciplinary measures should be taken against any worker who does not comply with safety requirements.		Visual inspections and Observation	√	√		As needed
	There will be a periodic monitoring programme for noise to check if measures put in place are having the desired effect. These measures include the housing of the generator in sound proof casing, proper maintenance of vehicles. In particular at the discretion of the Resident Engineer upon receipt of complaints, noise		Audio measurements at sources and receptors	√		√	Annually

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	measurements will be made to monitor the noise levels. Measurements or readings will be taken at distances from the noise producing equipment e.g. generator. A calibrated sound meter will be used. It is recommended that noise measurements be done only as indicated.						
	Speed bumps will be installed so that trucks ferrying the construction materials do not move at high speeds which enable high noise generation	EMMP, this report, The National Environment (Noise Standards and Control) Regulations, 2003 Occupational Health and Safety Act 2006	Visual observation	√	√		Onset of construction activities
	Because the operation of the generator will introduce unacceptable noise levels it is recommended that the generator will be housed within a sound proof structure;		Audio measurements	√			As required
	In order to limit noise due to haulage traffic, the construction fleet will be kept in good condition well fitted with efficient silencers;		Vehicle inspections		√		As required
	Night time activities will be avoided at all costs in as far as is practical, because sound travels further during night than during the day;		Night time Audio measurements	√		√	Periodical as recommended by NEMA/UWA
	The traffic will be re-routed to roads with few vehicles (Chobe route) to reduce the cumulative impact from additional traffic to		Visual inspections with		√		

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	already congested roads like the Masindi-Kigumba junction;						
Waste	Because of the remoteness of the site location, any human fecal material waste produced will be contained in temporary sealed septic tanks before collection by licensed waste collection agency and disposed at NEMA approved facilities; There is need to consider set-up of a waste treatment plant for the project human fecal material treatment before discharge to the environment;	EMMP, this report	Presence of organic pollution indicators in surface waters	√	√		As required
	Toxic, non-biodegradable waste such as spent machine oil and batteries will be stored in sealed drums, which in turn will be stored within a bund having 110% storage capacity volume, until they can be removed for safe long term disposal at the nearest designated District/Sub county solid waste storage site	EMMP, this report, Waste transfer forms, Waste receipt forms at disposal site Waste management Regulations, 1999	Presence of empty oil cans	√	√		Weekly
	Biodegradable, and Non-toxic non-biodegradable waste, including glass, plastic and metal cans, bottle tops, foil wraps, etc. will be bundled and transported to the nearest designated District/Sub county Solid Waste dump site.		Visual observation of waste collection areas	√	√		Weekly, or as required

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	All domestic solid waste (i.e. trash and garbage) will be source separated into organic, paper and non-biodegradable fractions.		Visual observation at site	√		√	Weekly
	The proposed development will be responsible for the handling and transporting of its entire production of solid waste.		Periodic monitoring of site waste transfer notes	√		√	Annually
Occupational health and safety	Implementing good house-keeping practices, such as the sorting and placing loose construction materials or demolition debris in established areas away from foot paths/;	EMMP, this report, IFC EHS guidelines, 2007	Visual observation, absence of houseflies and other pests, incidence of disease among workers	√	√		Daily
	Provision of manual firefighting equipment that is easily accessible and simple to use. Trainings where necessary will be undertaken to ensure adequacy in the usage of the equipment	IFC, EHS guidelines 2007, EMMP of this report	Visual inspection of work place Service date for fire fighting equipment	√	√		Monthly
	Equipping the fuel storage areas/re-fuelling places with fire detectors, alarm systems, and fire -fighting equipment. The equipment will be maintained in good working order and be readily accessible;			√	√	√	Monthly
	Only highly skilled workers will be allowed to operate heavy machinery (cranes, excavators, graders) and heavy trucks	IFC EHS guidelines 2007, EMMP of this	Visual observation, checks on workers skills		√		Monthly

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	(Tipper trucks);	report					
	Passages to emergency exits should be unobstructed at all times. Exits should be clearly marked to be visible in total darkness. The number and capacity of emergency exits should be sufficient for safe and orderly evacuation of the greatest number of people present at any time, and there should be a minimum two exits from any work area;	EMMP, this report	Visual observation, Employee knowledge of where fire assemblage is located	√	√		Monthly
	Structures housing workers will be structurally safe, provide appropriate protection against the climate, and have acceptable light and noise conditions;	EMMP, of this report	Visual observation, testing for structure integrity	√	√	√	Monthly
	Training of workers in lifting and materials handling techniques in construction and decommissioning projects, including the placement of weight limits above which mechanical assists or two-person lifts are necessary;	Developer's environmental and Safety policy, EMMP of this report	Periodic auditing to gauge Worker's proficiency in techniques	√	√		As required
	Worksites especially those posing a greater danger to humans/animals will have limited access (i.e. excavation areas, worksites with heavy vehicular movement);		Visual observation of barriers to site set up by the developer		√		As required
	Any excavated pits will be guarded to prevent wildlife falling into the pit and or						

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	community members/tourists;						
	Surfaces, structures and installations should be easy to clean and maintained, and not allow for accumulation of hazardous microorganisms. Therefore surfaces in food preparation areas will be maintained with a highest level of cleanliness to prevent food poisoning due to ingestion of contaminated food stuffs;	Developer's Environmental & Safety policy, EMMP of this report IFC EHS guidelines 2007	Visual inspections of workers housing, checks at the clinic of incidence of disease in the workplace	√	√		As required
	Planning work site layout to minimize the need for manual transfer of heavy loads. This reduces over exertion of project workers;		Visual observation and design documentation		√		Throughout construction phase
	Job rotations and rest or stretch breaks;						
Alteration of wildlife behavior	Areas scheduled for night activities will be located away from the edges of the river, so that minimal interaction between workers, machines, and the river edge, especially the wetlands, where fish are known to spawn and are also a habitat for juvenile fish;	EMMP of this report	Visual observation	√	√		Throughout construction phase
	Barriers between sensitive habitats and worksites will be erected to enable the separation of project activities from habitats within the park;	EMMP of this report, Uganda Wildlife Act CAP 200, 1996	Visual observation and barrier integrity		√		
	Lights at the worksite during night time will		Night Visual				

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	be directed at the activity, rather than illuminating the entire area. This is aimed to reduce the 'trespass' of lighting into areas that are not intended to be lit (including the night sky). Reducing the trespass of lighting will maintain heterogeneity even in otherwise well-lit areas, providing dark refuges that mobile animals (hippos, and other nocturnal predators) can exploit;		observation Light intensity tests		√		
	Any night activities will prevent illumination in as far as is practical to prevent interference with normal activities in River Nile of the aquatic organisms;	EMMP, of this report, Uganda Wildlife Act CAP 200, 1996		√	√		
	The developer will take advantage of vertical shading offered by natural landscape (hills) and horizontal shades, offered by vegetation canopies;	EMMP of this report	Design documentation	√	√		Project onset
	All facilities will be located outside of known/established animal corridors to prevent animal disorientation;	EMMP of this report	Design documentation	√	√		Breeding season
	Highly visible fencing will be used, to prevent wildlife injury as they move to foraging areas;	EMMP, of this report, Uganda Wildlife Act CAP 200, 1996	Visual inspection,	√	√		Monthly
	Lights will only be used as and when needed, so that continuous/unnecessary		Inspections involving LUX	√			Weekly

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	lighting is limited;						
	Known animal foraging areas should not be illuminated;			√	√		Weekly
Injuries to wildlife from human encounters	The construction will be timed during the dry period so that runoff doesnot flood the excavated sections to transport sediments downstream into the main river;	UWA park rules, Uganda Wildlife Act, CAP 200, 1996	Reports of animal attacks or kills from workers/tourists	√	√	√	As required
	Incase any fish are caught in the excavated sections for the water intake facilities, they will be removed and placed in the main river to prevent injury;	EMMP of this report	Visual observation from workers on site	√	√	√	As required
Faunal Migration	All activities likely to lead to large migrations should be minimized;	EMMP, of this report, Uganda Wildlife Act, Cap 200, 1996	Faunal inspections within vicinity of the work site	√	√		During breeding/dry season
	All activities unavoidably located in breeding grounds will be halted during the breeding season to prevent animal attacks on workers	EMMP, this report	Fauna counts in breeding grounds	√	√		Breeding season
	Vegetation clearance will be minimal to ensure that after construction, animals originally grazing on the southern bank can re-establish after the construction activity;	EMMP of this report	Visual inspection of plant species during construction	√	√		Plant growing season
Hydrology	The distance between weir/intake and powerhouse/tailrace should be limited to	EMMP of this report	Visual inspections, design documentation	√	√		Rainy and Dry season

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	areas of low animal interaction in as far as is practical, without compromising the integrity of the environment or project effort;		and ensure a fixed discharge of 100cumecs is maintained all the time				
	Discharge from the tailrace will be maintained as a percentage of the normal flow to reduce alterations especially when the river floods;	DWRM requirement	Flow measurements up and down stream the river at the proposed site and ensure a fixed discharge of 100cumecs is maintained all the time	√	√	√	Peak and low peak flow measurements
	Protective barriers/screens will be offered at the weir to ensure that fish and other aquatic organisms do not meander into the water way, because they may be injured at the powerhouse;	EMMP of this report					
	Construction of the weir will prevent a significant loss of water from the main river channel during the dry season because this will act as a very temporary water storage area before the water is directed into the intake and power house;		Flow measurements up and down stream the river at the proposed site	√	√	√	Peak and low peak flow measurements
	Normal hydrological functions like transportation of sediments downstream will be maintained to sustain the downstream ecological functions like siltation in the wetlands, that are areas for breeding/feeding for various birds and wildlife; this is so because the water will						

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	not be dammed at anytime during plant operation;						
Topography	Landscape alterations are reduced to a minimum		Visual inspection of earth works to ensure that excessive excavation other than those agreed upon are not carried out, particularly at borrow pit sites, access roads and around the contractor's camp.	√	√	√	Weekly inspections throughout the Construction Phase
Social Impacts							
Employment opportunities	Priority should be given to residents of the communities within close proximity of the development;	EMMP of this report	Project Documentation	√	√		Project onset
	Women should be considered equally as men during the employment process, with due consideration to community structures and norms;	Environmental and Social Policy - NBI, June 2013 National Child Labour Policy, 2006/2010, Children's Act Cap 59, 2000	Employee documentation	√	√		Throughout project implementation
	No children will be hired on the project for any work in keeping with the International Labor Organization, (ILO) Convention No. 138, (1973), that defines the minimum age of employment;		Employee documentation	√	√	√	
Influx of migrants	The developer will continuously sensitize	EMMP, of this	Documentation of				Throughout

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	workers and community members alike on HIV/AIDS and the dangers of unsafe relations;	report	Minutes of awareness meetings/campaigns	√		√	project implementation
	Project should set up internal controls and security systems for its materials and worker's personal items.	EMMP, of this report	Documentation of Developers environment and safety plans	√			
	The developer will keep in close communication with women and youth groups to monitor any changes in social structure and communication with local leaders to monitor any changes in population.	EMMP, of this report	Documentation of corporate social responsibility	√		√	
	Workers will be transported to and fro the construction site to limit unnecessary encounters with community members.	EMMP, of this report	Workers check-in and out documentation	√	√		
	Workers will be encouraged to be disciplined when on company assignments in the villages and prevent risky interactions with community members.	EMMP, of this report	Documentation on discipline requirement at worksite	√	√		
	Workers housing will be planned and located strategically so that access by community members is limited to official reasons only, like delivery of goods/services. This will prevent social visits by residents in Kiryandongo to	EMMP, of this report	Documentation on discipline requirement at camp sites	√	√	√	

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	workers camp and potential engagement in disagreeable behavior.						
Disruption of Cultural norms and practice	Any foreign project workers will be informed on cultural norms of the local communities before encounter, to avoid conflicts with communities;	EMMP of this report	Documentation of minutes from awareness rising within workers	√	√	√	Project Onset
	Gender issues will be considered during the hiring process to ensure equality in income provisions;	Environmental and Social Policy, June, 2013	Number of women/men employed at the site	√	√	√	
	Local authorities shall need to be strengthened in order to deal with the increased cases of indiscipline brought about by the increased population influx, and any disputes that are likely to ensue;	EMMP of this report	Security personnel stationed at work site	√	√	√	
Loss of Aesthetic Quality	Strategic placement of screening material should be employed (maintenance of native tall trees around newly excavated areas) to maintain the visual aspect of the area and to prevent visual intrusion;	EMMP of this report,	Visual inspections of site		√		Throughout project construction
	Access to excavation areas will be closed off to all but construction crew to prevent accidents like falls, or exposure to unsightly conditions within the park;		Visual observation of barriers to site		√		
	All cleared areas and pits will be backfilled and trees and grass planted at the end of construction of the power plant and		Visual inspections on site		√		

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	associated facilities. This should clear the problem of further land degradation and rugged terrain created by the construction activities and will avoid the presence of unsightly stagnant water pools;						
	The waterway will be a perpendicular distance away from the river edge so that any views from the river like boating activities are not disrupted by the sight of construction activities		Site measurements of distance from main river to diversion	√	√		
	The entire process will take into consideration the preferred land-use proposed by UWA and tour operators after excavations;		Visual inspections		√	√	
Operation phase							
Impact on Aquatic organisms	The intake will have fine screens to prevent suction of mature fishes into the headrace, as this prevents the fish kills at the turbines in the powerhouse;	EMMP, of this report	Visual observation	√	√		At commissioning stage
	The hydropower station has been placed to avoid high species rich areas like the Karuma Bridge and River Bulaya. During the baseline, these were the areas with the most diverse fish species. The HEPP has been scheduled to be placed in an area near River Ayago with the lowest fish	This report, Feasibility study for Ayago hydropower plant	Design documentation	√			N/A

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	species diversity;						
	Should adopt methods of gradual diversion of river flow to the canal and adequate environmental flow should be provided to sustain the survival of aquatic invertebrates and river-edge organisms;	EMMP of this report	Monitoring of flows in the main channel	√		√	Dry and wet season measurements
	The hydropower plant is designed to be a run-of-river flow type, so modifications in the hydrology from riverine to lake-like will be completely avoided;	Feasibility study for Ayago	Visual observation of the weir characteristics	√		√	N/A
	The water intake will be placed in the hypolimnetic strata of the water at the weir. This zone will be devoid of fish, so the fish kills will have been prevented;	Feasibility study for Ayago		√		√	On set of operation
	The weir will have an overhead flow, allowing for continuous flow of water, except at a reduced speed, though not slow enough to induce stratification;	Feasibility study for Ayago	Visual observation of the weir characteristics	√		√	
Sediment flush	Encouraging gravel and boulders together to create spawning riffles to attract resident fishes to small rapids	EMMP, this report	Presence of spawning grounds for fish and benthos	√		√	Throughout operational period. Preferably annually
	Enhancing the habitat by tree planting to increase shelter cover, shade and drift food;		Number of trees planted in riparian strip	√	√		
	Maintaining sediment transport in as far as applicable a natural state to prevent		Absence of significant high conductivity	√		√	

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	sudden flushes that could shock ecosystems;		downstream of the HEPP				
Soil Contamination	The developer will continue to maintain the steep slope above the headrace to protect any sliding of earth and adhere to a regular inspection, and mitigation plan.	EMMP, this report	Visual observation, slope angle measurement	√		√	Operation phase, especially flood events
	All the drainage paths that have been constructed will be maintained and de-silted on a regular basis;		Visual inspections	√		√	
	Native herb and grasses species will be encouraged to re-grow in previously cleared areas to help trap loose soils and prevent their progression downstream into the waterway or the river;		Visual observation,	√		√	
Alteration of river flow	During the operational phase, technical staff will continuously monitor the slopes especially those at the banks of the river;	Feasibility study report, EMMP of this report	Visual observation	√			Seasonal flood events
	Compensation flow for the conservation of microflora, aquatic insects and fish in the dewatering zone should be within 10-20% of the regular flow;	EMMP of this report	Field monitoring activities	√			Monthly checks
	Land clearing and slope stabilization activities should be conducted in their proper sequence and disturbed areas are to be suitably protected and maintained until permanent protection is	EMMP of this report		√			As required

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	established;						
Noise from powerhouse equipment	All facilities will be heavily muffled to prevent noise disturbance to animals/recreational tourists since this project will exist for a long time;	EMMP of this report	Noise measurements at source and nearest receptor	√		√	Annually or as advised by Lead agency
	The power station will be protected with fencing to prevent animals from wondering into the area and getting exposed to noise/vibrations;	EMMP of this report	Visual observation	√		√	Before project commences
Landuse change/Aesthetics	Thick vegetative cover will be encouraged on the riparian strip of the Hydropower plant to conceal the intake, Headrace, tailrace and power house;	EMMP of this report	Visual observation,	√		√	On set of operation to decommission
	Structures will be painted with earthen tone colours to prevent visual blight caused by highly dissimilar buildings with the back drop of a natural setting;	EMMP of this report	Visual observation	√		√	Throughout project operation
Traffic	Developer will reduce the required number of trips to and fro the site to only necessary incidences requiring transportation of project staff and the occasional maintenance workers;	EMMP of this report	Vehicle check in and out of site	√		√	Throughout project life cycle
	The Project drivers will abide by the speed limits set forth by the UWA for all vehicle access to the park;	Park Rules, EMMP of this report	Visual observation	√		√	
	The developer will orient visitors to the	Visitors rule book,	Visitors record				

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	power plant so that safety park rules are followed in close coordination by project staff;	Developers Environment and Safety policy	documentation	√		√	
Occupational Health and Safety	Project workers will be required to use protective equipment (gloves and face mask) when working with paints, solvents and diesel fuels; Workers engaged in activities likely to raise dust will have dust masks at all times during this phase;	Visual observation	Number of PPE available to project workers	√	√	√	Throughout project life cycle
	Use of chemoprophylaxis drugs by non-immune workers and collaborating with public health officials to help eradicate disease reservoirs.	This report	Absence of vector breeding grounds	√	√		Throughout project life cycle
	Promoting use of repellents, clothing, netting, and other barriers to prevent insect bites.	EMMP of this report	Visual observation of netting and documentation to advise workers to use insect repellants	√	√		
	For the case of diseases like malaria, the project will put in place strategies to control the disease through issuance of mosquito nets and education on their usage. The developer will have a clinic stationed at the worksite to address any illness. There will also be an emergency	Emergency evacuation plan, EMMP of this report	Mosquito net usage in the area Emergency evacuation plan documentation	√	√		

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	evacuation plan to remove any injured worker from the field for urgent treatment;						
	Swimming as a pre-requisite for working across river/stream sections will be needed and where lack of the skill is observed, training will be undertaken;	Employee records, EMMP of this report	Training records for employees	√	√	√	
	There will be sufficient number of first aid trained personnel to respond to emergencies at the sites (intake and powerhouse);	EMMP of this report, Developer's Environmental safety policy	Visual inspection of first aid kits on site	√	√	√	
	Workers will be trained on the recognition and prevention of hazards specifically applicable to work in remote areas, and in areas with dangerous wild animals like hippos, lions crocodiles and elephants; Working in groups gives safety in numbers, since the area harbors known dangerous wild animals (Hippopotamus crocodiles) and snakes	EMMP of this report	Training documentation	√	√	√	Throughout project life cycle
	Earplugs will be worn at all worksites where noise levels are expected to be higher than 85dB (A) like those working in the powerhouse near the turbines; alternatively, project workers will be shifted	EMMP of this report, IFC EHS guidelines 2007, Noise standards and Control	Visual inspections of noisy areas	√	√	√	

Project Component or Impact	Mitigation measures / Action	Reference Document	Monitoring Criteria	Responsibility			Timing
				Developer	Contractor	External monitor	
	periodically to ensure long time exposure to high noise levels by an individual is reduced;	regulations, 2003					

Note:

- *The summary budget for the implementation of both the Environmental Management Plan and the Monitoring Plan is given in a separate table below.*
- *The NGOs/Civil Society have not been indicated in the responsibilities, but they are key stakeholders in implementation of both the management and monitoring plans and they continuously be engaged for the smooth implementation of the proposed mitigation measures.*
- *Lead Agencies will make their own arrangements on inspections on site to ensure compliance with set guidelines and standards.*

9.5 Institutional Strengthening

Several governmental agencies at both the local and national levels will be responsible for ongoing monitoring of construction and operational conditions and activities. This section outlines the framework that MEMD will make ensure that the monitoring institutions which are assigned responsibility as per the ESIA report have the capacity to discharge their responsibilities. In general, MEMD will consult with the applicable agencies to establish the extent of each agency's 'in house' capability for managing such activities, and identify any shortfalls. Wherever appropriate, institutional strengthening should be integrated with existing programmes being planned or implemented by the institutions themselves, or by national or international organisations such as NGOs.

The general process to be followed to establish institutional strengthening needs is as follows:

- Discuss the mandate and monitoring responsibilities of each agency, and develop a monitoring plan that will include details of procedures, equipment requirements and staff requirements;
- Establish the Agency's 'in house' capability for managing such activities, and identify any shortfalls;
- Develop, in consultation with the Agency, a plan for meeting these shortfalls;
- Assist the Agency to implement a specific capacity building plan, taking into account other capacity building programmes being planned or implemented by government or international organisations; and,
- Monitor the effectiveness of institutional strengthening measures, and carry out any further measures as required.

The following agencies are responsible for the monitoring of construction and operational activities of Ayago HPP. These are: UWA, EPC Contractor, DWRM, NEMA, District Health Offices, UEGCL, MoW/UNRA, District administration, DWRM, Department of Geological Surveys and Mines.

9.5.1 Permits and Approval Conditions

The environmental monitoring reports will be provided timely by the responsible agencies. These reports help in identifying if any mitigation measure is not being effective and will enable corrective action to be taken. These documents may be inspected and/or audited by NEMA and other stakeholders and project lenders from time to time, in accordance with the regulations. This will provide an opportunity for them to comment both on the impacts of the project itself and the efficacy of the ESIA. A limited number of hard copies of the quarterly reports will be made available to local stakeholders at the project developer's offices. All monitoring and reporting documents will be kept on file for the life of the project, and will not be disposed of without permission from NEMA.

9.6 Environmental Mitigation Budget

The provision under this section covers the cost for biodiversity conservation & management, catchment area management, fishery conservation & management, public health delivery system, solid waste and sewage management, fuel and energy conservation measures, muck disposal, landscaping and restoration of construction areas & quarry sites, creation of green belt , resettlement and rehabilitation, disaster and hazard management, environmental monitoring programme, compensatory afforestation, reservoir rim treatment, local area development etc. The total environmentally related costs on the proposed project are estimated at USD 28,210,000 Million. This excludes the cost of biodiversity valuation. The budget related to land acquisition shall be provided for in the Resettlement Action Plan (RAP). The various budgeted provisions for mitigation activities and related costs are outlined in Table 109. These budget estimates have been made with adequate provisions for contingencies and is an integral part of the financial requirement of the project. MEMD will be responsible for ensuring that the budgeted resources for implementing the environmental components of the project are provided. The budgeted funds are indicative and part of the overall cost for the project and should be accessible to the EPC contractor who should prepare actual budgets according to the implementation schedules of the different proposed Management and Monitoring plans, which will also have to be adjusted and put in place.

The day today (local level) management and monitoring will be done by the EPC contractor, while the National level, the MEMD will liaise with NEMA to form a joint monitoring team. The MEMD will pay to NEMA the certificate/ approval fees that form part of their monitoring budget, but in addition the MEMD will provide the budget for the facilitation of the monitoring activities of the committee. Other/individual central government and local government agencies and institutions that will not be part of the committee shall retain their monitoring roles and mandates and will cover their costs from their annual budgets.

Table 108: Summary of costs in implementing the EMMP

Project			Expenses	
	S/N	Name of expense	Ten thousand of yuans	In Ten thousand of dollars
Investment in environmental protection project			14,668.60	2095.51
Ayago	(I)	Water environment protection project	1,325.50	189.36
Hydropower	(II)	Terricolous ecological protection project	1,522.80	217.54
	(III)	Water environment protection project	1,007.50	143.93
	(IV)	Soil and water conservation project	4,495.90	642.27
	1	Engineering measures	3,283.90	469.13
	2	Plant measures	706.6	100.94
	3	Support measures	264.9	37.84
	4	Soil and water conservation monitoring project	240.5	34.36
	(V)	Atmosphere environment protection project	96.4	13.77
	(VI)	Sound environment protection project	18	2.57
	(VII)	Solid waste disposal project	536.8	76.69
	(VIII)	Population health protection project	466	66.57
	(IX)	Cultural relics protection project	1,000.00	142.86

	(X)	Environment monitoring project	220.5	31.50
	Subtotal		10,689.40	1527.06
	(I)	Ecological protection project	1,510.00	215.71
	(II)	Electromagnetic radiation and noise environment protection project	100	14.29
	(III)	Soil and water conservation project	539.2	77.03
	1	Engineering measures	200.1	28.59
	2	Plant measures	173.5	24.79
	3	Support measures	99.4	14.20
Transformer substation project				
	4	Soil and water conservation monitoring project	66.3	9.47
	(IV)	Water environment protection project	140	20.00
	(V)	Atmosphere environment protection project	40	5.71
	(VI)	Solid waste disposal project	50	7.14
	(VII)	Population health protection project	500	71.43
	(VIII)	Cultural relics protection project	1,000.00	142.86
	(IX)	Environment monitoring project	100	14.29
	Subtotal		3,980.00	568.57
Independent expenses			**3,282.40**	**468.91**
Basic reserve fund (10%)			**1,795.20**	**256.46**
Static total investment			**19,747.00**	**2,821.00**

Note: *The cost of the land acquisition and compensation (including the cost of biodiversity loss) as evaluated by Chief Government Valuer is provided separately in the Resettlement Action Plan (RAP) and Biodiversity valuation report respectively. However, the above cost estimated for Management and Monitoring may consider as tentative which may revise in future as per need*.

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ANNEX 1: NEMA APPROVAL OF TERMS OF REFERENCES FOR AYAGO PROJECT

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

NEMA House
Plot 17, 19 & 21, Jinja Road
P.O. Box 22255, Kampala, Uganda
Tel: 256-41 - 251064/251065/251068
256-41 - 342758/342759/342717
Fax: 256-41 - 257521/232680
E-mail: info @ nemaug.org
Website:www.nemaug.org

NEMA/4.5

Date: 5th July, 2012

The Managing Director,
Uganda Electricity Generation Company Ltd.,
Plot 8 – 10 Faraday Road, Amberly Estate,
P. O. Box 1101.
JINJA.

Tel: +256 (0)434 120891

RE: REVIEW OF TERMS OF REFERENCE PERTAINING TO PROPOSED AYAGO HYDROELECTRIC POWER PROJECT

This is in reference to the Terms of Reference (TOR) for carrying out an environmental and social impact assessment (ESIA) for the proposed Ayago Hydroelectric Power Project. for review and consideration for approval. This Authority has finalised the review and grants formal **APPROVAL** of the said TOR.

In addition, there are important aspects that should looked into prior to and during the conduct of the ESIA and preparation of the environmental and social impact assessment report, respectively. That is, you should be mindful of the need to:

(i) **carry out separate EIAs** for two categories/main components, namely:

(a) the hydroelectric generation;
(b) quarries/burrow pits, workers' campsites, lay-down areas/parking and storage yards, and access roads;

(ii) **carry out separate EIA** for the electricity transmission line;

(iii) carry out comprehensive consultations with all the relevant key stakeholders, and ensure that the views of the various entities consulted are well documented and appended to the ESIA report;

(iv) to ensure that matters pertaining to land ownership/acquisition (land-take) are handled in a proper manner, in close liaison with the respective District Local Government Authorities and Office of the Government Valuer, and that **authentic copies of land acquisition documents are appended to the ESIA report**;

(v) include in the ESIA report clear/legible and well-labelled location / google maps, diagrams *(preferably on A-3 or larger paper size)*, and a set photograph showing current state of parts of the project area, as well as the respective GPS coordinates;

(vi) provide full details of the location(s) *(zone, cell, village(s), parish(es), sub-county, county, district(s), etc)* for the proposed installation of the hydroelectric generation project infrastructure (dam/weir, tailrace, power house, etc);

(vii) provide detailed and relevant baseline data for the proposed project area that will accommodate the hydroelectric power generation infrastructure;

(viii) ensure that **a comprehensive hydrological report** pertaining to the River and its associated catchment areas, is appended to the ESIA report;

(ix) ensure that detailed descriptions of the project components and activities are provided, including the different types of machinery/equipment to be installed, and size/categories of the work-force that will be involved in the construction of the hydropower generation infrastructure;

(x) provide **detailed evaluation of the potential environmental impacts** associated with the proposed project components and activities;

(xi) provide **analyses of alternatives/options** to the selected options for the hydropower generation project;

(xii) provide **large, well-labelled/legible site lay-out plans for the hydropower plant,** as well as clear boundaries of the project site;

(xiii) indicate **the various sources and names of the places** (preferably presented in tabulated format) from which the different raw materials (water, construction material such as stones, murram, sand, water, wood, etc) will be obtained from for implementing the project activities;

(xiv) include in the EIA report a **comprehensive mitigation, environmental monitoring, and emergency plans**, respectively, to cater for the environmental aspects/impacts associated with the Project;

(xv) be mindful of any other **critical environmental aspects/concerns which may have not been initially foreseen** during the preparation of the TOR, and include an evaluation of such concerns/environmental aspects in the ESIA report that wil be submitted for review.

This is, therefore, to recommend that you proceed with carrying out the environmental impact study for the proposed hydroelectric generation project. We look forward to receiving copies of a comprehensive ESIA report, for our further action.

Dr. Gerald. M. Sawula
FOR: EXECUTIVE DIRECTOR

c.c The Permanent Secretary,
Ministry of Water and Environment,
KAMPALA.

c.c The Permanent Secretary,
Ministry of Energy and Mineral Development,
KAMPALA.

c.c The Executive Director,
Uganda Wildlife Authority,
KAMPALA.

c.c The Director,
Directorate of Water Resources Management
ENTEBBE.

ANNEX 2: MINUTES OF STAKEHOLDER ENGAGEMENT

Date/Time	**2nd.July 2012 4.00pm**
Venue	Wildlife Information Office in Masindi, UWA
Participants	Henry Ndege Odong, Sergeant Ranger; Riai Yamashita, JICA Study Team Anthony Begumisa, WSS
Agenda	To obtain information relating to: 1) how the Ayago hydro power project may impact on the livelihoods of the population in direct or indirect ways 2) establish the arrangement between the park management and communities in accessing and utilizing park resources without compromising the conservation of park resources
Memo	• In response to the questions of impact mentioned above, he explained that people on trucks from Tullow oil prospectors on the side of Albert Nile use traps (illegal park entrants with poaching gadgets such as wire snares). He informed us that these wire snares have increased in Tullow operational areas (Albert Nile areas which have a large concentration of animals. • He however observed that with Ayago areas, there is not much concentration of animal population. He explained that illegal poachers when caught are prosecuted and arrested but added that this calls for a lot of vigilance and this has cost implications since there has to be allowances for Rangers. • He explained that game meat is usually from vermin's such pigs, giant rats, squirrels etc. and not highly protected animals such as buffalos, Lions and elephants, hippos and giraffes. He explained these endangered but problem animals which not protected can become extinct. He informed us that when they cross out UWA is informed and they respond to push them back for example crocodiles kill domestic animals and human beings. He said lions that have tasted human blood before are usually eliminated because many times they are the aged ones. He told the team endangered species roam about 4 times a month on average and that is often in the dry season when they looking for grass and water • Still on impact he argued that there will be an influx of people with the start of the hydro power project activities and completion and these people will buy land from the poor after sensing the value of land increasing (Speculators) at the prospect of hydro power and the likely scramble for land for investment. He however hastened to add that UWA land is not at risk because UWA does not intend to sell her land • Impact on health: He reasoned that certainly where people live together HIV spread is inevitable. He said people working on the hydro power project will earn money and use it to lure both young and old females into sex that may not be protected hence risk of HIV infections. • On collaborative park use and management arrangements with community, he explained that some areas near the park were occupied by internally displaced persons IDPs following the Kony led insurgency and park management gave them access to park for such things as firewood, grass for thatching and sale, honey, dark soil for smearing houses and herbs. They would come once a

	week on Saturdays and reach the nearest park points and entrances • He added that for honey if they come as a group they ate given site where they can put bee hives as income generating ventures • Asked which communities have this limited access to the park, he said they include: people around Karuma (Mutunda sub county, pac wach, Kichumbanyogo gate and for Bugong Wild life Reserve, there is Bulisa sub county. He added that access to the park depends whether there is an MoU between groups of people and the park management • For more information such as the current Management plan for the park he referred us to: Karuma Wildlife Office-Ms Everlyn Kyomukama, Conservation Area manager Parra- Okello Cam 0772550294, Odokorwot assistant Warden Community Conservation, Wang Kwar on 0772524129 • Data received: The respondent being an acting warden and new at the station he could not find/provide us with the current management plan for park we wanted for information relating to a range issues including planned investments and current plans for further collaborative park management with the communities. This was part the reason he referred us to the persons aforementioned

Date/Time	**3rd July 2012 9.30am**
Venue	Karuma Wildlife Reserve, UWA
Participants	Everlyne Kyomukama, Warden; Riai Yamashita, JICA Study Team Anthony Begumisa, WSS
Agenda	1)To learn about the activities, infrastructure and other investments along the planned Ayago power transmission lines 2) To obtain perspectives on the anticipated impact of the hydro power project on the park and the surrounding communities who benefit from the park currently
Memo	• In view of the planned road from Nanda, she explained that this will help UWA to monitor and check poaching activities in the park especially along the river. She explained the currently the road is not developed i.e. (not motorable). She added that Tourists would use it to enter the; park because at the moment they use to exit the park. • About the impact of power she argued that power is crucial for it will attract lots of investments that will create income opportunities for the population. She however expressed about the health of project workers since there are no health facilities in the national park where the project will be installed. She asked what would be done in case of an emergency say an accident befalling the workers, there should be emergence response plans. • She also raised the question of the security of the security of the project workers since they will be working a jungle surrounded by wild game and an area where Kony used to wreak havoc on the civilian and tourists to the park. She suggested need for a mini UPDF army detach around the area to give a sense of security to the people and the structures being put up • She also raised the issue of keeping/observing park regulations such as entry time and speed limit for the good of the animals. She wondered whether there will be insurance in case of wild game eating up some of the workers on the

	project, capsizing boats and other use of the risks • Interaction between workers and the local population and the health consequences on the local population: She said HIV/AIDS in the country is a reality and therefore there will be need for sensitization of the population of the about the disease spread and control and prevention measures • She also emphasized the need to keep the project area clean and hygienic by setting up toilets • She cautioned about interfering with the wild game feeding practices • Development wise, she hopes that people will set up businesses that rely on energy and agro processing enterprises that will boost agriculture and income levels for the population. She thinks the dependence syndrome of the population may change since they were in the IDPs for a long time and surviving from hand outs from government and Civil society organisations • She pointed out there will be employment opportunities for the local population on the project at least as casual laborers. She also hopes this employment may divert the people from poaching activities since poaching is usually at its peak during the dry season when there is not much farm work to be done • She also advised that there may be need to re-orient the population on how they can tap on the opportunities that come with hydro project investment. She noted that poverty levels in the area are unacceptably high • On Collaborative arrangements with the Karuma Wild Life Reserve, she said there are permits for the some groups to access firewood and do fishing. However she said this allowed between Karuma and Kyobe lodge. Other permits include bee keeping which is encouraged for keeping straying animals at bay especially buffalos and Elephants. She said around 1000 beehives have already been installed in some sites- spread between Karuma Bridge up to Nyamahasa parish. Both local and modern types are used. This she said deters animals • In addition to bee keeping the other strategy for stopping problem animals from straying is digging up of trenches along the boundary as has been done Nwoya and also fencing the area • On revenue sharing of park entry fees, she said some proportion is given to the community for their priority development plans • Again park access rights, she informed the team that while some people apply as a group such as bee keepers some ask to access the park in their individual capacity for such things as herbs, hand craft materials, ants, cultural sites and rituals etc. She said apart from these few, the rest of the activities we hear about are illegal. They include: hunting, charcoal burning, tree cutting for timber and building materials • She told the team that in Koch goma Sub County, there is already a trench of 36Kms along the park area to stop straying animals from damaging crops in the adjacent park communities. This was funded by CARE and again ministry of Tourism improved the trench with an additional 100M.She observed that the trench is the most effective method for preventing large mammals i.e. elephants, buffalos, hippos. Noted that the Karuma hydro power is planning to put up a trench /wall on the Kiryandongo side to prevent the said large

	mammals. She explained that small animals called vermin's are left to the left vermin guards to deal with • **Question** by respondent: She asked the study team if there will be an electrical fence after putting up the power like they have done in Kenya although it is expensive • **Tourism Plans:** She explained there is more tourism activity in the northern section of the park than the southern because the southern is woody while the northern is grassland hence makes viewing easier **Communities/parishes neighbouring the park include:** • Diima and Nyamahsa parishes in Mutunda sub county Kiryandomng district; Kyankende and Kicwabugingo parishes in Kibanda sub county, Masind district; Myene and Kamdini sub counties in Oyam district; Koch goma sub county in Nwoya district • MoU for collaborative park management and access to resources was said to be 2 years initially but subject to renewal if the MoU terms were well complied with. However, proposal writing is a requirement and can be accepted or rejected • The key procedure is forming an association with an executive committee. After the formation of the association, the association charges members going to park and the revenue generated is for the association to invest or benefit members in future. Some use for aqua culture projects, tree planting etc. and still UWA gives some support young fish. • For information on the management plan she advised us to contact: community Conservation office Parra Ms Getrude Namakula 0772 643062 and Conservation area manager/Chief Warden 0772 550294 • Will need to capture details on name of community, Sub county and type of MoU entered.

Date/Time	**3rd July 2012 12.00pm**
Venue	Kiryandongo district headquarters
Participants	About 12 District officials from various departments and Chief administrative officer and the RAP evaluation team headed by Mr Ochola Bernard
Agenda	To interface with relevant district officials over the proposed Ayago power project and to seek their cooperation during the implementation of the preliminary studies including the social environment surveys To attend the RAP results dissemination meeting for Karuma hydro power project to capture issues of interest that may inform the preparation and implementation of Ayago related studies
Memo	• It was noted that the RAP evaluation report was based on data collected from communities/respondent households in Karuma, Awo and Nora villages all in Mutunda sub county • It was revealed that most of the affected families want to be resettled and that most want cash rather relocation so they can find their level • It was noted that the exercise (resettlement) was going last a minimum of

	three months
	• There were 414 households and 1009 forms of properties were identified
	• It was also noted that some households/families own property in more than one location
	• According to the presenter the purpose of the meeting was
	  o To provide information on the process of resettlement plan
	  o To garner the support of the district in the implementation activities especially the district land board and physical planner and surveyor, sub county chief, community development officer especially livelihoods section head etc.
	• Key information in the process includes: property owners, names of property and value of property
	
	Emerging questions
	• How much are you paying?
	• He explained that after disclosure of property and value, we get reactions from affected households which allows for input/comment from affected persons and consent forms filled and then payments are processed
	• He also said that people who will appeal the valuation if not contented they can appeal but should provide strong reasons for discontent and masquerades should be identified in the process
	• He added the team has land valuers, lawyers and
	• Affected should come with: valid identification, authentic land titles or transfer agreements and recently taken pass port size photos
	• Payments exceeding 200,000 will require bank account details and if people died there is need for letters of administration
	• Within the three months the management committee should be able ton resolve any disputes arising
	• For the vulnerable groups it was noted the ministry will come up with some livelihoods needs package
	
	Others issues/Qns
	• When can the support be given by the district and how soon?
	• Land title requirement too stringent given some people hold customary tenure
	• Land board not yet in place how can they help without it
	• What is the compensation for the district that has been receiving revenue from places like Karuma Tc
	• Also impact on environment degradation and how district will be compensated
	• What will be the fate of the social infrastructure like schools and health centres and then where will the children study from?
	• What is the deadline for the compensated families to vacate their current property and residence?

Date/Time	**3rd July 2012 1.00pm**
Venue	Kiryandongo district headquarters

Participants	District Planning Officer: Mr Atuha Moses 0772646504 email atuhamoses@yahoo.com Riai Yamashita, JICA Study Team Anthony Begumisa, WSS
Agenda	To collect socio-economic information about the district and communities adjacent to the park including public infrastructure population characteristics and poverty levels etc
Memo	• He gave us a soft copy of the current integrated district development plan 2012/2013 and agai another file on district priority investment areas/projects • He also promised to send to us soft copy of Mutunda sub county development for 2012/2013 • Team went to Mutunda sub county headquarters and found that the sub county chief was out of office but his contact number is 0772 347780 or 0752-647052 Ndyanabo Peter and for the sub accountant is 0774-291992/0755-291992

Date/Time	**4rd July 2012 10.30am**
Venue	Purongo sub county, Nwoya district
Participants	Sub county Chief Esther Arimu 0754-559200 Mr Francis Lakony Okumu 0777-361078 Anthony Obama, Community Development officer 0754-560211/0775-243947/0794-560211 Eunice Piloya potential RA 0777-645794 Riai Yamashita, JICA Study Team Anthony Begumisa, WSS
Agenda	To collect socio-economic information about the Purongo sub county To explore their perspectives on anticipated impact on the livelihoods of the people by the proposed hydro power project at Ayago To establish the communities that live around the park the collaborative park management arrangements
Memo	• On anticipated impact it is expected that there will be a shift from the use of solar panels and generators to more reliable hydro power which may stimulate investment in agro processing enterprises since the communities heavily depend on crop farming highlighted by sim sim, maize, ground nuts cassava etc. • It was found that the parishes/communities neighbouring the park included: Pawat Omero with 5 villages; Pabit with 3 villages; Patira with 2 villages; Latoro with 2 villages. Only one village out of the five does not share borders with the park • On MoUs between communities and park management. • It was learnt that although there is revenue sharing it is only with Purongo Sub County as a whole and not according to parishes. She explained that for instance during the last financial year 2011/2012, the value of revenue received was 45M. Most of this was spent on building a cultural centre-community tourism site

	• The cultural centre is aimed at empowering the communities to showcase their handwork that they can sell to earn income. They intend to make hand crafts such baskets, mingling sticks, forks etc.It was noted they will be working groups either as women or youths or several women groups specialized in certain products • Again on park and community relationships, she explained that it is not so bad because as neighbors to the park every year park gives us money from gate collections. She reiterated that park gave the sub county 45M .She told us that the park management was now waiting for accountability for that money so they can disburse another round of funds approximated at 100M.She added that the history of revenue sharing is as old as the park itself but for a long time people did not put the money to good use and that is why poverty in the area has persisted. They would get the money and spend on unproductive things such as funeral rites. However this is now changing and in fact they had wanted to use the recent money to buy a tractor but I advise them against it because that was not going to benefit everyone. Hence the ideas of the idea of the community tourism centre. For that reason the centre is under construction (huts and recreational centre) after land was acquired (bought 5 acres. There is right now a trip by the councillors and community member's to Mbarara to learn from them how they set up theirs. All money from UWA will go into this project until it is complete • In addition she explained that some communities are allowed to access park resources such grass, fishing, firewood except some are killed by animals in their search for those things. Again others are allowed to enter see the animals at a low cost • She also noted that despite resettlement after the Kony insurgency, some are some people still loitering around the place where IDPs existed and helpless. They include the youths and elderly who have nowhere to go due to lack of land. She however could not tell their exact number. She said the affected persons engage in informal petty trade while the elderly are supported by some CSO such NRC by building them houses, land and food • She however added that the relationship with the park is not so good because park rangers have been shooting dead Poachers e.g. this year 3 have already died. There are also problem animals i.e. elephants and antelopes etc. which destroy or eat up everything except sim sim. We noted that the communities are also stubborn because they do not heed the warnings • She added that park animals are a problem to crops everywhere except now around Koch goma where a trench of up to 36 km has been dug. It was noted that recently elephants destroyed one acre of ground nuts • Main sources of income for the population in the area It was revealed that they depend on crop farming and the key crops are sim sim maize, cassava, beans, rice etc. However most grow on a small scale
Date/Time	**4th July 2012 12.30pm**
Venue	Nwoya district head quarters
Participants	Nwoya district Planning Officer, 0772997263; Riai Yamashita, JICA Study Team; Anthony Begumisa, WSS

Agenda	To collect socio economic information about the district and also to obtain their perspectives on the likely impact of the project on the lives of the communities To establish the existing relationship between the park management and the communities
Memo	• The planner informed us that there is good relationship between the district/communities and the park management evidenced by the annual revenue the district receives from the park. • He explained that the district uses the revenue from the park to dig up trenches to stop elephants from disturbing people • He however stated that the only problem so far is the poachers who kill wild game • He said the district development plan is available and has been approved by the council • On infrastructure he said there is a health centre II inside the park which the district wanted to expand by UWA said they needed to get clearance from NEMA and this has stalled the Plan because it involves doing an EIA • He also said there is Kyobe and Parra hotels which have been given private operators • On same visit to the district we went to Anaka Sub County but could not find the sub county Chief. However, the sub county chief for Purongo promised to contact her/him so that she can also provide us with the socio-economic information requested for.

Date/Time	**5th July 2012 12.30pm**
Venue	Oyam district head quarters
Participants	Agong John Mark, Community district development officer Laker Allen Prossy 0772 662075 (lakerallen@yahoo.co.uk) Riai Yamashita, JICA Study Team Anthony Begumisa, WSS
Agenda	To collect socio economic information about the district and also to obtain their perspectives on the likely impact of the project on the lives of the communities To establish the existing relationship between the park management and the communities
Memo	• The planner was not in office. However, we were told that the development plant is ready but has not been printed and therefore still with the planner • The district physical planner promised to give us the document by email when the planner comes back. By Monday 9th.July 2012 • We also established that the current border sub counties with the park are not Aber but Myene and Kamdini; Myene Sub county Chief is Joel Atine; Kamdin Sub county chief Okwanga Robert 0772962526 • On the project implications on the lives of the communities, the physical planner argued that since the two sub counties are fertile, they will produce more since there is likely to be more market for their products due to the likely increase in population and also because agro processing industries may be started to give more value to the crops grown hence more income. The crops

	grown include Mukwano crops for oils and fats namely sun flower, sim sim soay beans, maize etc. which have replaced the traditional cash crops • However she feared that the access roads and transmission lines may encroach on peoples' property and may even disrupt their routine lives • At Kamdini Sub county at 12.00pm we met the sub county chief-Robert Okwanga • According to him the idea of the hydropower project at Ayago is good. He argued that with hydro [power it will have positive effects on the population although some displacement of the population may take place • He also fears that since people in the area are not familiar with power usage, it may end up electrocuting them if there is no public education on the precautions • He also observed that some people purely depend on fishing for their livelihoods and this project might interfere with their source of income if the project management comes with strict regulations for entering the park • On collaborative management of the park he said the sub county was planning to have a beach management unit that will help track the activities of the park users so that some revenue in form of taxes can nbe obtained from them. Thus he feared that such revenue may be lost of the project stops the people currently permitted to access park resources like fish. He said however that if this happens the sub county should still get royalty fees from the park/hydro project • About the income fishermen get, he could not tell how much but said that was the reason they were starting the beach management unit. In addition, he said when they get to know their activities they can check their compliance with park regulations • NB: In future it would be of interest to have an FGD with the beach management unit: contact person is fisheries officer based at Kamdini tel 0785440823 Ogwang DC

Date/Time	**5th July 2012 12.30pm**
Venue	Oyam district head quarters
Participants	Agong John Mark, Community district development officer; Riai Yamashita, JICA Study Team; Anthony Begumisa, WSS
Agenda	To collect socio economic information about the district and also to obtain their perspectives on the likely impact of the project on the lives of the communities To establish the existing relationship between the park management and the communities
Memo	• The planner was not in office. However, we were told that the development plant is ready but has not been printed and therefore still with the planner • The district physical planner promised to give us the document by email when the planner comes back

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
Composition, activity, or Issues	Concerns, comments , Observations & fears	Responses , Remarks
The team leader introduced the issue at hand.		
Officials Present	1. Olaboro Franco-D/CAO-0772469767 2. Edith Kahubire-Sociologist 3. Mayanja Charles-Socio Economic Surveyor	
List of participants	Attached to the report	N/A
Purpose of meetings	The main objective of these consultation meetings was to conduct an Environmental and Social Impact Assessment for the proposed Ayago Hydro Power Project.	N/A
Date and Place held	**07th January 2015, 10.35Am District:Nwoya , Anaka Town Council (D/CAO-Office)**	
Introductory remarks by team leader-Edith Kahubire (Sociologist)	Precisely for the most of the meetings; The Team leader started by introducing the team members well we are a team working with WSS Ltd. Briefly she explained that we are here doing consultations about the Proposed Ayago Hydro Power Project and we are doing the Environmental and Social Impact Assessment and part of it	D/CAO: He further said he was aware of the Project before he had met some Chinese from Jica who were doing the design.

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	is Consultation though they were other consultations done at first but they were about the design and then they will be a big meeting in Feburary in Nwoya District where they will present to you the design. Now that they have finalised the design we want to know the issues, concerns and recommendations that can be taken into account and integrated in the contract which is to be signed by Chinese with Ministry of Energy; Social issues like employment, livlihood, we know there many villages around the park like koch-goma S/B County, Purongo S/B County and Anaka S/B county besides issues that may araise and would also like to capture related to infrastructure depending on the number of people that will be coming in if they set up a camp and then whether people have a memorandum of understanding with the park and I think this will be answered by UWA. There will be jobs but we need a functional framework they can use; we don't want a situation where workers are got from Kampala especially with unskilled labor. We don't expect any displacement of people the person selling the land is one or a clan.There will also be a waste	

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	site.An access road of about 11Km will be constructed and what we know UWA will not accept them to stay in the park and so the housing infrastructure won't be constructed there but outside the park. We also intend to get construction materials like rock and murram within the park. Then UETCL will put the power generated to the national grid and I think REA will put a step down to distribute it.	
Name &designation	Concerns, comments , Observations & fears	Responses , Remarks
Olaboro Franco-D/CAO	Will the dam be constructed in the park? You talked about infrastructure and how big is the camp?	• Yes right within the park. • It's about 150ha but more land might be needed.
Edith Kahubire (Sociologist):	• Do people have any memorandum of understanding with the the park so that Ministry of Energy can reflect it in the contract for the Chinese? • In terms of unskilled population how can we proportionally distribute the labor?	• I'm a new person but they do have a memorandum of understanding with community members in relation to the park they get benefits; what is done is that UWA shares certain percentage of the revenue got from the park with those members of the community around the Park.so there's an interaction between the community and the park though it's a restricted area.Therefore they expect to benefit from it as a community. • He suggested that Purongo Sub County has the biggest population and decided as follows for

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
Composition, activity, or Issues	Concerns, comments , Observations & fears	Responses , Remarks
		unskilled labor distribution: Purongo sub county-40% Kochigoma sub county-35% Anaka sub county-25%
	• Issue of infrastructure depending on the number of people that will be coming in. if a camp is set up then are other services needed to be provided?	• With the problem of the existing infrastructure we don't want them to block other road users from using the road because of the heavy machinery they will be using.
	• With your experience at Karuma what observations do you have because they are also putting up a dam there?	• Because of labor migration; there young men who come in and pregnant the young girls and later they abandon them and live so there's need for sensitization.
	• Materials like the rock they will get from the park then any other materials like murram where can it be got?	• Materials are available like rock and murram can be easily got however I don't know what type of murram they need.
	• What are the environmental implications?	• You talked of having a waste site here we had a bad scenario with the oil waste here whereby someones land was bought about seven million for dumpimg oil waste but eventually is wives and neighbors abandon the place having heard rumours that these hazardous waste has effects on human life like producing children with disabilities.With frustration the old man encroached on someones' wife and is now in prison. So when people here of "waste" they are

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
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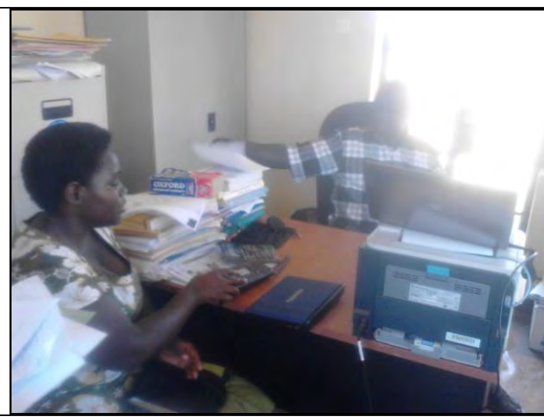
	• The issue of poaching; what happens if the people employed start poaching?	terrified. So the issue of managing waste we must involve NEMA to guide us in managing the waste. • We have already existing restrictions in place although times the rangers they can connive with the workers and later deny them but it's paramount to do sensitizations right from the time of employment.
Date and Place held	**07th January 2015, 12.01Pm District:Nwoya , Anaka Town Council (Planner-Office)**	
Officials Present	1. Opira Francis-Planner-077299263 2. Edith Kahubire-Sociologist 3. Mayanja Charles-Socio Economic Surveyor	
Edith Kahubire (Sociologist):	• What is their livelihood generally in this area? • We met D/CAO and had suggested with the employment issue we distribute the workers proportionally in relation to the size of population in the three	Mr. Opira Francis explained that: • The people in Purongo are: • Crop farmers. • Commercial farmers. • Livestock and some are workers.That's why they have a big population. • With the experience I have seen with the oil and gas companies in this area you agree to these terms but then they usually have their workers hired from else where well it's a big issue but I think we go with what was decided I have no problem with that in preference for unskilled

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
Composition, activity, or Issues	Concerns, comments , Observations & fears	Responses , Remarks
	sub counties that are bordering that is unskilled labor. He suggested that Purongo-40%, Kochigoma-35% and Anaka 25%. Do you have any other recommendations in regard to this matter?	workers.
	• Do you have any other issues?	• My concern is whether the project won't impact the cultural sites • Forinstance there's a spot where the Mukama Kabalega of Bunyoro used to cross incase he had issues with the colonial Government. (We shall ask Ministry of Gender to put this into consideration)
	• Do you think will a big influx of people move to benefit from the Project?	• People here don't move because of customary reasons I have seen it in the areas where oil companies are operating here but if there's an influx of migrate workers those issues are wide spread like Aids and prostitution because they don't come with supervisors.
	• Do you have any District development plan at least for last two years?	• We are lucky we have a copy for this year although we have only one copy of the book but you can be able to pick one from UBOS though it's a national one but it's detailed if you open Nwoya District it can be able to assist you. • Incase of any calrifications we have left you a document with our contacts on it.

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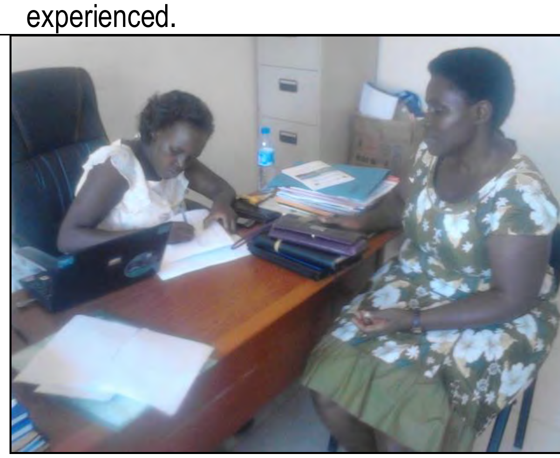
Opira Francis-Planner	• Will there be displacement of people? • Won't there be pollution like the noise, air, and dust pollution to impact the animals because the oil and gas activities have accelerated human and animal conflict like elephants coming into the communities and scaring people away from their houses? • Will the dam not affect the water levels?	• No one person/clan is affected who intends to sell about 150ha of land. • He pointed out that they are also other farms bordering the park which have to be put into consideration incase of any compensation if affected • Mitigation measures will be observed. • No it won't affect the water levels they are using run off; flooding and diversion will not be experienced.
Date and Place held	**07th January 2015, 2:16Pm District:Nwoya , Anaka Town Council (Environment Office)**	

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
Composition, activity, or Issues	Concerns, comments , Observations & fears	Responses , Remarks
Officials Present	1. Acca Everline-Environment Officer-0777482657 2. Edith Kahubire-Sociologist 3. Mayanja Charles-Socio Economic Surveyor	
Edith Kahubire-Sociologist	• An Environmental Officer is a very important stakeholder so we wouldn't like to do the EIA without consultating you.The consultations were done before but they were about the design. But now the design is finished we wanted to know if they are any other issues that can be integerated in the contract that the Chinese are going to sign with the Ministry of Energy. • We met D/CAO and discussed the issues of employment and how they should proportionally share out employment between the three sub counties bordering the park. • We talked about materials and pointed out that materials are every where. • The infrastructure itself is going to be in the park. • Then the housing infrastructure is going to be outside the park unfortunately UWA didn't accept them to construct in the	• N/A

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
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	park. • Then D/CAO he also recommended that once someone gets a job then he must be inducted about the safety measures of the park and regulations. • There will be a very big meeting for the stakeholders where they will be presenting the design well the issues we haven't captured or that you may think about you can present them that day. • Then 11Km access road will be constructed to transport workers to and fro from the site. • We also discussed how waste will be managed using NEMA guidelines.	
Acca Everline-Environment Officer	• You know this Project area is going to be in the vicinity of the park.Now you are just beginning you haven't done any other consultations before? I think the first consultations they talked to Emma. So this is the second phase? • I don't know the kind of design they are going to use and the conservation strategies they	No the first consultations were about the design but it's now complete. • Yes. • Alright that will also be reflected in their contract.

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
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	are to adopt; I think you know that is an area of importance then let us wait for the design. • You said you talked about employment with D/CAO. I have been seeing this with Total well I don't know whether our people aren' educated or their levels of Education are very low. My question why don't they also give us some skilled job opportunities other than causal workers only? • At times it can be put there in the contract and they don't comply. • Is it going to be only in the park and it doesn't affect any community member? • During the course of construction she recommended the issues of : - Protection Gear is observed. - Gender sensitivity observed. - How to handle HIV issues. • Do you have any idea how long will the construction take?	• I think that's when you come in as the District and present your recommendations because at times if the Contractors haven't budgeted for it they just ignore it. • But as a District if you come up with a presentation and show that these are the indicators that you would like to be followed as a solution to that. • Yes only one person/clan who is the seller of the land. • About three years but I will confirm that first and may be I can also give you construction proposal. • The other frequent question I have been asked is

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	• You discussed about waste management using NEMA guidelines. Although they are going to work using NEMA guidelines but what is their final destination for disposal of this waste is it gas,solid, or liquid because domestic waste is easy to manage because what I know there camp is temporary.	where the facility will be accessed from is it from Nando but the map is not so clear well the Probation Officer is also waiting for us.Thank you.
Date and Place held	**07th January 2015, 3:28Pm District:Nwoya , Anaka Town Council (CDO Office)**	
Officials Present	1. Okema Walter-CDO-0785550029 2. Edith Kahubire-Sociologist 3. Mayanja Charles-Socio Economic Surveyor	
List of participants	Attached to the report	N/A
Name &designation	**Summary of discussion &issues, comments raised**	N/A
Edith Kahubire-	• Have you had similar Projects in the area before?	• No.

RECORDS OF THE CONSULTATIVE MEETINGS ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED AYAGO HYDRO POWER PROJECT.		
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Sociologist	• How about the Oil operations so can we borrow experiences from the oil perspective? • How did you manage to intervene? • The D/CAO had recommended in terms of causal labor employment locally; He suggested that Purongo-40% because of a big population size then Kochigoma-35% and Anaka 25%.Which is the best way forward? • Any other issues do you think you have?	• Yeah definitely they are cross cutting when it comes to social issues.Right now we having sessions with Ministry of Gender at first before the Oil activities in the area the wild animals were not rampant but now you find elephants scaring people away from their homes, destroying their crops and also at times displacing people. • There's also one man who had a very serious issue who was abandon by the wives and the neighbours having sold is land to the Oil Company for waste disposal. • We also had the issue of employment especially the casual laboeres because they were being trafficked from else where instead of employing the local area we managed to intervene. • We sat with the Oil companies in Nwoya District and submitted our recommendations and took it up and they are now employing local casual labourers within the area. • For the issue of drivers they used also to get them from Kampala yet also here we have a potential supplying them with drivers.so now what they usually do they consult us first therefore enhancing good working relationship. • Yes but I think it will depend on the kind of jobs so at least we can say a small percentage left for others. • Yes with dams they are issues to deal with the

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		environment; how will you handle mitigation measures that will be so good.
Okema Walter-CDO	• I don't know what kinds of stakeholders are involved?	• Yeah there will be a big stakeholders meeting next month at Nwoya. At that time you can come out with your proposals and if you need support for sensitization then you can raise it and if you have a gap for staff then also raise it; so you can come up with a proposition paper.