RWIMI SMALL HYDRO POWER PROJECT KASESE; UGANDA

SUPPLEMENTARY REPORT ON AQUATIC SPECIES & WATER AUDIT

[*In connection with the proposed Rwimi Small Hydro Power Project, a Social and Environmental Impact Assessment (SEIA) Report had already been prepared and the same was approved by National Environmental Management Authority, Uganda. This is a supplementary report to furnish additional information on the status of aquatic species and the status of the use of water consumed by the adjacent communities. The results of the survey revealed that there will not be irreversible impacts on the aquatic species or on the communities whose water requirements for drinking and various other purposes have been met. Mitigation actions have been proposed and it is assumed that those mitigation actions will be implemented by them being duly incorporated into the ESMP*]

Contents

SUPPLEMENTARY REPORT ON AQUATIC SPECIES & WATER AUDIT FOR RWIMI MINI HYDRO POWER PROJECT IN UGANDA

1. CHAPTER ONE: INTRODUCTION & SURVEY METHOD

1.1. Introduction

This survey was undertaken to supplement the studies carried out previously to prepare the Environmental and Social Assessment (ESIA) report by the developer in connection with the proposed Rwimi Small Hydro Power Project, Kasese, Uganda. Although the National Environmental Management Authority had already approved the SEIA and conditions of compliances thereto have been conveyed, it has been necessitated to carry out this supplementary study on the advice of the financiers to ensure that necessary mitigation actions are well incorporated into the Environmental and Social Management Plan (ESMP) in respect of conserving aquatic species and to ensure that water use by the communities will not be impacted due to the project. In this exercise, the survey covered the aquatic species (with particular reference to the fish species living in the river) and the other uses of water especially by the adjacent communities. This report will serve the purpose of making additional mitigation measures if at all there will be environmental and social impact to the aquatic species and the volume of water to be extracted by the communities during and after the construction of the proposed project.

1.2. Survey of Aquatic Species and survey methods*:*

The animals living in a stream/river provide the best indicators of its overall health and ecological condition. Human activities that alter a river catchment interfere with its natural ecological processes and have immediate as well as long-lasting effects on the animals that live in the stream river. Monitoring of river quality was based on macro invertebrate's assemblages because they represent an enormous diversity of body shapes, survival strategies, and adaptations. Many macro invertebrates require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. These animals, in turn, provide food for other higher aquatic animals like fish, frogs etc. Below are descriptions of the macro invertebrates sampling methods used, and the aquatic macro invertebrates found, categorized basing on their sensitivity to organic loading.

1.2.1. Site selection and sampling for benthic macro-invertebrates

Sampling for benthic macro-invertebrates was done from two stations chosen along river Rwimi. Station one was at the position of the dam; and the other station at 100 meters below the dam.

1.2.2. Site selection and sampling for aquatic benthic fauna

The following materials were used: Surber sampler, Peterson mud grabber, sweep net, binocular microscope, Parlinda 2x4x folding magnifying glass.

1.2.3. Sampling method

Kick sampling. This was used in stony shallow areas of the river to capture floating organisms dislodged from the river substratum. Before disturbing the river sub stratum, a Surber sampler with a netting of 0.5mm mesh opening was placed in the river with the wider end facing up stream and the corn end downstream. The river was then disturbed up stream by kicking to dislodge organisms from boulders and sand. These then drifted into the netting of the sampler where they were captured, later removed and preserved with 95% ethonal and packed in vails. A minimum of three kicks were done for each station.

Apeterson mud grabber with area of 1.74m^2 was used to collect mud sediments at each station. Three samples were taken from each station two at the edges of the river and where silt/ mud had accumulated.

A sweep net was also used to capture flying insects at all stations. The slow moving arthropods were picked directly by hand when observed. In the field all captured fauna were put in veils with tight caps and preserved with 95% ethanol.

A binocular microscope and **Parlinda 2x4x folding magnifying glass w**ere used to view the microscopic taxonomic features on the captured fauna for easy identification in the laboratory.

Fish sampling; Fishes were sampled using a piece of mosquito net of about 4m^2. The net was manipulated manually by two people in water in pools of water along the river bank. The same sampling method was applied at each of the selected stations.

Identification: In the laboratory all preserved samples were sorted and identified to the lowest practical taxon, usually species, using keys of Clesceri*et al* (1989), Needham (1962), and Pennack (1978).

2. CHAPTER TWO: PRESENTATION OF RESULTS

2.1. Location, physical and biological characteristics of the sampling stations.

Following table indicates the details riverine vegetation characteristics and the characteristics of the river bottom, appearance of river water etc. in several locations that have been surveyed during the study. Four (4) locations have been studied one at the Dam and in a distance of 100 m, 500mand 1000 m from the dam towards the power house along the river for this study. The river appears to be gently sloping in the areas other than the areas close to the proposed dam the rock substratum is being observed throughout. The riverine vegetation comprises small bushes and there is no strong canopy along this stretch of the river. In terms of river characteristics, there are a few shallow pools right throughout the downstream which enables people to use the water for recreation and cloth washing purposes. River banks are degraded and eroded in most of the places needing more bank protection measures in the long term. Nevertheless the presence of indicator species of macro invertebrates indicates that the water quality of the river is good and that there are no human activities in its catchment to cause organic pollution. River Rwimi is considered one of the few rivers in the district which are suitable for water extraction for consumption purposes.

In terms of aquatic species, as shown in the tables below, Fish distribution along the river had varying relative abundance. *Varicorhinus ruwenzori* was significantly high at site four (I km below the proposed dam site) with 19.35% and completely no fish catches at the weir. Therefore the relative abundance of fish decreases upstream the river. This means latitudinal variation of the fish species whereby there was reduced abundance as you move upstream the river. The rest were ornamental fish. Consultations with the fishers showed that they fish other fish species.

Table (1) Location Characteristics

Station	Location	Vegetation cover/shading	River bottom/substratum	Water appearance	Shape of the river bank
1	At the dam	No canopy, natural small bushes, shrubs at the banks.	Rocky with a mixture of boulders, cobbles, Bed rock, Gravel and sand.(Hard bottom)	Colorless and transparent.	Undercut and steeply sloping.
2	100meters below the dam	No canopy of natural trees and shrubs all over.	Rocky with boulders, cobbles, Gravel, Bedrock, and sand.(Hard bottom).	Colorless and transparent	Gently sloping
3	500meters below the dam	No canopy of natural trees and shrubs all over.	Rocky with boulders, cobbles, Gravel, Bedrock, and sand.(Hard bottom).	Colorless and transparent	Gently sloping
4	1000meters below the dam	No canopy of natural trees and shrubs all	Rocky with boulders, cobbles, Gravel, Bedrock, and sand.(Hard	Colorless and transparent	Gently sloping

		over.	bottom).		

Table (2) River Characteristics

Site	Water Pools	Siltation	River side cover	River bank conditions	Shape of the river channel	Water flow speed
At the dam site 1	Shallow pools in the river bed and banks.	Silted	Natural plant cover degraded	Degraded/eroded.	U-shaped.	Very high
Other 3 sites	Shallow pools in the river bed and banks.	Silted	Natural plant cover degraded	Degraded/eroded.	Wide.	High in the middle and slow at the banks.

Table (3) Presence of aquatic vertebrates

Fish	Frogs and toads
Varicorhinus ruwenzori and other riverine ornamental fish.	Frogs present

Table (4) Peripytic and floating plants

Floating/sub merged plants	Micro and macro algae	Blue green algae	mosses	Littoral zone vegetation
None	Present attached to boulders ,gravel	none	Present attached to un submerged bed rocks, and boulders	Present.

Table (5) Composition and abundance of benthic macro invertebrates

Taxon		Stations		Total For All Stations	Abundance
Order	Species	1	2		
Diptera :	*Chironomus calipterus*	**2**	**3**	**5**	**R**
	Chironomus callichirus	**0**	**1**	**1**	**R**
	Tipula maxima	**1O**	**4**	**14**	**C**
Ephemeroptera:	*Beatis tricaudatus.*	**80**	**108**	**186**	**D**

	Caenis tardata	**70**	**98**	**168**	**D**
	Ecdyonurus venosus	**20**	**14**	**34**	**C**
Plecoptera:	*Isoperla fulva*	**40**	**32**	**72**	**C**
	Perla bipunctata	**3**	**0**	**3**	**D**
	Nemouratrispinosa	**1**	**0**	**1**	**R**
Odonata :	*Helocordulina sp.*	**0**	**4**	**4**	**R**
	Ischnura sp	**4**	**2**	**6**	**R**
Coleoptera	*Psephenus herricki*	**0**	**1**	**1**	**R**
	Gyrinuss ubtriatus	**0**	**1**	**1**	**R**
	Enochrus sp	**1**	**1**	**2**	**R**
	Oreodytes rivalis	**0**	**2**	**2**	**R**
Annelida	*Glossiphonia complanata*	**0**	**4**	**4**	**R**
Total number of taxa		**10**	**14**		
Total number of individuals		**231**	**275**	**506**	

Key: R (Rare): 1-9 organisms were found in the sample. D (Dominant): 100 or more organisms found in the sample.

C (Common): 10-90 organisms were found in the sample.

Table (6) Sensitivity of macro invertebrates to organic loading

Taxon/species	**Sensitivity to organic loading**		
	Very sensitive	**moderate**	**tolerant**
Chironomus calipterus			**Tolerant**
Chironomus callichirus			**Tolerant**
Tipula maxima	**Sensitive**		
Beatis tricaudatus.	**Sensitive**		
Caenis tardata	**Sensitive**		

Ecdyonurus venosus	**Sensitive**		
Isoperlafulva		**Moderate**	
Perla bipunctata		**Moderate**	
Nemouratrispinosa	**Sensitive**		
Helocordulina sp.		**Moderate**	
Ischnura sp		**Moderate**	
Psephenusherricki	**Sensitive**		
Gyrinussubtriatus	**Sensitive**		
Enochrus sp	**Sensitive**		
Oreodytesrivalis	**Sensitive**		
Glossiphonia complanata		**Moderate**	
Total	**9**	**5**	**2**

2.2. Discussion of results and recommendations

2.2.1. Macro invertebrates

The dominant macro invertebrates found were members of the orders;

- Emphemeroptera (may flies),
- Plecoptera (stone flies), and
- Coleoptera (water beetles).

Ecologically the later are fresh water dwellers and dwell in excellent quality water environments free of organic matter and highly oxygenated (Mackie, 2000). This implies that human activities in its catchment have not negatively impacted on River Rwimi to cause organic pollution.

These macro invertebrates recorded require clear, cool water, adequate oxygen, stable flows, and a steady source of food in order to complete their life cycles. These animals, in turn, provide food for other higher aquatic animals like fish, frogs etc.

However any human activity that would cause changes in the current water conditions i.e. water volume and flow rates will affect the diversity and abundance of these sensitive organisms.

2.2.2. Fish species, distribution and abundance

River Rwimi is a fishing ground (Fig 1) by male young and male adults along the whole stretch from the weir through the site of the powerhouse. The fishing methods used by the community include lift netting; seining, gillnetting and hook-and-line.

Sampling for fish was done using 2 inch gillnet. Fishing was done at four sites (at the dam, 100 m below the dam, and 500 m below the dam and 1000 m below the dam). All the sites were taken between the proposed dam site and the proposed power house. The recorded fish species in all the four sites sampled was *Varicorhinus ruwenzori* (Fig 2).

The observed small number of fish in the river is probably due to the flood that swept through the river on May 1, 2013. Reports from the local fishers testify that since the flood, fish catches have drastically reduced.

Fig 1: Fishing in River Rwimi

Fig 2: Fish 'Varicorhinus ruwenzori'

Table (7) Fish abundance: Table of results

Site	Fish species	Number of fish	Relative abundance (%) of the total catch
At the dam (0 m)	*Varicorhinus ruwenzori*	2	6.451613
	Ornamental fish	5	16.12903
100 m below the dam	*Varicorhinus ruwenzori*	3	9.677419
	Ornamental fish	8	25.80645
500 m below the dam	*Varicorhinus ruwenzori*	5	16.12903
	Ornamental fish	0	0
1000 m below the dam	*Varicorhinus ruwenzori*	6	19.35484
	Ornamental fish	2	6.451613
	Total	31	100.00

2.2.3. Biometric measurements

Size and weight

The size distribution was in the range of 11-15cm focal length and 15-24gm by fresh weight. And all the fish had mature gonads.

Gut content analysis

Microscopic analysis of the gut contents of fish captured in the river at all stations showed broken parts of invertebrates of class Insecta, order Ephemeroptera (May flies) *and the representative species were Beatis tricaudatus and Caenis tardata.*

The relative abundance of emphemeroptera larvae was recorded highest. This tallies well with the percentage abundance of the fish *Varicorhinus ruwenzori*. The distribution of algae is throughout the river course. This shows a positive relationship along the food chain where increase in relative abundance among the invertebrate fauna translates into a corresponding abundance of the vertebrate fauna (fish population) in the river. Thus a decrease in algal population will directly reduce the fish population.

2.2.4. Other aquatic life (the herpertiles) in the river

Amphibians (Frogs) as shown below were also recorded in the river. These also need water in the river for continuity of life.

Fig: 3 Tadpoles of amphibians

2.3. Ecological impacts and recommendations to manage the Impacts

2.3.1. Possible ecological issues/Impacts

Diversion of all the water into the canal will result into loss of these aquatic species including fish and invertebrates, algal and other sensitive organisms. The observed abundance of fish requires that a minimum volume of water should be left in the river since it is a habitat for ***Varicorhinus ruwenzori****, an endemic fish species of the river.*This high relative abundance for the sites below the dam is an indication that fish breeding grounds are downstream and adult fish only migrate upstream. This means that during the construction and operation of the project here should be a minimum volume of water be allowed to be left in the river to reduce any impact on the aquatic life and fish population in the river.

2.3.2. Recommendation

It is recommended that some volume of water be retained in the river (environmental flow) to allow survival of the fish, others such as amphibian's population and to maintain the diversity and abundance of these sensitive organisms such as algae between the weir and the power house.

In addition, fish pass may be necessary to link water in the dam to the river course below the weir to enable the altitudinal migration of the fish species past the weir. This can be designed taking into consideration the type of dam that will be constructed. Design of a fish pass in the form of a canal that can allow fish movements will be recommended.

It is necessary to ensure that those fishermen who used to catch fish in the river stretch between Dam and the Powerhouse be provided with alternative livelihoods (at least be considered to be employed in the project during the construction period) enabling them to sustain an income for living.

3. CHAPETER THREE: SOCIAL IMPACTS

3.1. Impacts on the livelihoods of the people at the impounded area (Kabarole side)

The community members of either side of the river live on crop cultivation and other supplementary livelihood systems. The major ones include crop growing (cassava, maize and bananas) and livestock such as cattle, goat etc. Although the previous studies had taken into consideration the loss of agricultural property on the right side of the proposed dam, it appears that due to water inundation and due to construction of the proposed Dam, agricultural property belonging to at least three farming families on the other side (left side of the Dam) can be impacted. The steepness of the land situated on this side of the land will have a greater probability of being slowly eroded when there will be water pooling effect after the Dam will be constructed.

Possible issues

During construction of the dam as well as during the commissioning of the hydropower project there will be a possibility that agricultural land of three households mentioned below can be affected.

1. Zakalia Muhindo,
2. Aminadab Mukirania Kitibitwa and
3. George Maate through daming.

There will be need for a meeting with these three families after dam construction having assessed how much of their land has been taken up by the dam waters. This will also be done after removing the riverbank area as stipulated in the riverbanks regulations in Uganda.[1] We understand that he project has received the Permit from NEMA to carry out development activities under the National Environmental (Wetlands, River Banks and Lake Shores Management) Regulations 2000. Since requireland intake for the project has already been finalised, we recommend that after consultation with the above three households, the project can support to improve their livelihoods

3.2 Water requirements for the community

The river is extensively used by the adjacent communities on both side of the river for water abstraction, bathing , fishing and for recreation. A detailed water audit was done in order to ascertain the average amount of water that the people use on a regular basis using two methods namely, direct observation and discussion with the community. It was observed that communities regularly gather at 05 main watering points between the dam and the power house. Each point is visited by at least 10-25 people for either water collection, bathing, washing (Cloths) and for recreation (swimming). Based on the

[1] Protected zone for the unlisted rivers is 30 meters from the highest water mark of the river (Section 29.2 of the National Environmental (Wetlands, River Banks and Lake Shores Management) Regulations 2000.

amount of water that the people use for bathing and for collection, an attempt was made to quantify the volume of water for such purposes using the Uganda per capita water use standards. Having observed the amount Although there are several points below the power house they were not included in the audit as the project will not impact on the river water below the power house due to tail race water release.

Table (8) WATER AUDIT ANALYSIS

Watering point	**Type of consumption**			**Methods of calculation**	
	Water collection	**Bathing**	**Washing**	**Factor ($1L=10^{-3}m^3$)**	**Seconds in a 2- hour day**
	Average volume (Liters/day)	**Average volume (Liters/day)**	**Average volume (Liters/day)**	0.001	86400
Kalhalhu	1280	140	920		
Nyaseke	1280	360	920		
Nyaseke/Gatyanga II	1280	120	400		
Nyakabale/Gatyanga I	1280	80	400		
Upper Rugendabara I	1280	80	400		
Total	6400	780	3040		
Total m^3/day	6.4	0.78	3.04		
	7.40741E-05	9.02778E-06	3.51852E-05		
Total m^3/s for domestic use	0.000118287				
Other water users					
School	**Population**		Total m^3/day		
Nyakabale Primary School	526	2104	2.104		
Gatyanga Primary School	420	1680	1.68		
Total m^3/day			3.784		
Total m^3/s			4.37963E-05		
Overall total water requirements by the community m^3/day			14.004		
Overall total water requirements by the community (m^3/s)			**0.000162083**		

Fig 4: People swimming and washing clothes

The average overall water requirements by the neighbouring communities is found to be **14 m^3/day** which is equivalent to a minimum of **0.000162083 m^3/s** volume of river flow downstream. In addition, the flora and fauna in the river requires sufficient water to maintain the other ecological functions of the river.

4. SUMMERY IMPACTS, RECOMMENDATIONS & CONCLUSION

4.1 Ecological issues/Impacts

I. Loss of fish and other life forms.

II. Loss of fishing grounds for the fishing community (since it's a livelihood source) as a result of reduced water volume in the river

III. Loss of microhabitats of some aquatic organisms (*Beatis tricaudatus* and *Caenis tardata*) as well as terrestrial fauna. Habitat loss will be due to reduced river flow and volume of water in the river. This impact will result into a reduction in abundance of fish species as a result of degradation of their natural habitat.

4.2 Summery Social issues/Impacts

IV. Construction of the dam will possibly affect land of three households namely: Zakalia Muhindo, Aminadab Mukirania Kitibitwa and George Maate through daming.

V. Reduced river flow when the water is dammed and channelled compared to the average overall water requirements by the neighbouring communities of **14 m^3/day** which is equivalent to a

minimum of **0.000162083 m^3/s** volume of river flow downstream as well as water demands by the flora and fauna in the river.

VI. During the construction of the Dam and during the project is commissioned, water can be polluted causing problems for the community.

4.3 Recommendations to manage the issues/impacts

I. The issue of the envisaged loss of fish and other micro fauna in the river between the weir and the dam, will be remedied through maintaining a minimum volume of water into the river to ensure continuity of life of the various life forms therein.

II. There is need for **at least 0.001m^3/s** river flow to meet the water requirements by the neighbouring communities as well as water for the flora and fauna in the river requires water to maintain the other ecological functions of the river.

III. The slow flowing areas along the downstream of the river where the communities presently using can be further developed as water pools in order to ensure that adequate water is available during the dry seasons.

IV. It will be necessary that water quality be measured on a regular basis during the construction period and to keep the water quality at the baseline so that there will not be any threat from water quality either to the communities or to the sustenance of the aquatic biodiversity.

V. There will be need for a meeting with these three families after dam construction having assessed how much of their land has been taken up by the dam waters. This will also be done after removing the riverbank area as stipulated in the riverbanks regulations in Uganda.

VI. Fish pass may be necessary to link water in the dam to the river course below the weir to enable the altitudinal migration of the fish species past the weir. This can be designed taking into consideration the type of dam that will be constructed. Design of a fish pass in the form of a canal that can allow fish movements will be recommended.

VII. It is necessary to ensure that those fishermen who used to catch fish in the river stretch between Dam and the Powerhouse be provided with alternative livelihoods (at least be considered to be employed in the project during the construction period) enabling them to sustain an income for living.

4.5 Conclusion

The fluctuation of water flow in the river will impact on the biological productivity of the river, unless there will be sufficient water to sustain their productivity. There is a possibility that periphytons, bottom fauna and fish will decline both in production and in biodiversity. The fish species is endemic but projects impact on the productivity will be minimal as the abundance of the fish is more observed along

the downstream rather than the upstream. Nevertheless there is need to provide for fish pass for their mobility in search of breeding grounds. Changes in water levels of river flow downstream will also affect diversity and abundance of macro invertebrates since they are sensitive to organic loading. Therefore it will be very important to ensure that the water will not be polluted during the construction period as well as during the period the power facility is up and running.

The average overall water requirements by the neighbouring communities is found to be **14 m^3/day** which is equivalent to a minimum of **0.000162083 m^3/s** volume of river flow downstream. In addition, the flora and fauna in the river requires sufficient water to maintain the other ecological functions of the river. The river supports a variety of flora and fauna with varied water requirements for their sustenance

A recommendation that **at least 0.001m^3/s** of water should be left/allowed in the river as environmental flow to meet the water requirements of the flora and fauna in the river as well as maintain the other ecological functions of the river. These include maintaining the benthic community, the substratum and the existing microhabitats.

Above measures will be adequate (together with any other measures that have been prescribed in the SEIA) to mitigate the impacts that may arise from the construction and operation of the project in areas of aquatic species conservation and for the conservation of water for social requirements.