REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

FOR MATANDA IRRIGATION SCHEME TO BE LOCATED IN KANUNGU DISTRICT

VOLUME II

Prepared for:

MINISTRY OF WATER AND ENVIRONMENT (MWE)
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FEBRUARY 4, 2025

Project index

Project Name:	Environmental and Social Impact Assessment (ESIA) and Ressetlment Acation Plan (RAP) for Matanda Irrigation Scheme in Kanungu District	
Project Ref No:	MWE/CONS/17-18/00014/1	
Report category:	Environmental and Social Impact Assessment (ESIA) Report	
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Disclaimer:

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TEAM

This Environmental and Social Impact Statement has been complied in accordance with Section 20(1) of the National Environment Act (NEA) and Environmental Impact Assessment (EIA) Regulations, 1998, in conformity with the National Environment (Conduct & Certification of Environmental Practitioners) Regulations, 2003, below are names of the Environmental Impact Assessors;

Sign:

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Ph.D. Renewable Energy (Atlantic International University, Honolulu, HI-USA,
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B.Sc. Eng. Agricultural Engineering (MUK) - Uganda
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Certified Occupational Safety and Health Professional**,** (*250851/18*-OSH Academy)-USA

Other Contributing consultants on the ESIA team

Contributing Consultants	ESIA- Expertise
Dr. Phillip Mayanja Nyenje PhD Hydrology and Water Resources (UNESCO-IHE) MSc (Hons) in Water Resources Engineering (Leuven, Belgium) BSc. Civ Eng (Hons) -(MAK)	Hydrologist
Madinah Namyalo KASAULI B.Sc Botany and Zoology., (MAK),	Zoologist
Benson Asiimwe MUKIRANE B.Sc. Land Economics (Hons)(2009)	Land valuer
Ronald S. MUSENZE BSc Eng (MAK), MScEng (Belgium), PhD (Australia)	Civil Eng. /Water and Environment/ Project Manager
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Ivan KIBUKA- KIGULI Dip Pollution Control (UK), BScTech (UK)	Pollution Control Expert
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Solomon Jackson MUDDUKAKI BA (Education) (MAK), MSc Social Sector Planning and Management)	Social Development
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Richard Ssemmanda Msc. Env & Natural Resources, Bsc. Wildlife Health & Mangament, PGC. Wildlife telemetry.	Ecologist
Oluka Aggrey Bsc. Environment management, Cert. Enviroment auditing.	Environmentalist

ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AfDB:	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AWE:	Air Water Earth
CAO	Chief Administrative Officer
CDP:	Consultation Disclosure Plan
CFR:	Central Forest Reserve
CMP:	Catchment Management Plan
CO	Carbon monoxide
CO2	Carbon dioxide
DC	Direct Current
DE	District Engineer
DEO	District Environmental Officer
DIA	Directly Influenced Areas
DPO	District Production Officer
DSP:	Dam Safety Plans
DWD:	Directorate of Water Development
DWRM:	Directorate of Water Resources Management
EA	Environmental Assessment
EHS	Environment, Health and Safety
EIS:	Environmental Impact Statement (or "EIA report")
ERA:	Electricity Regulatory Authority
ESIA	Environmental & Social Impact Assessment
ESIS	Environmental and Social Impact Statement
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP:	Environmental and Social Management Plans
FAO:	Food and Agriculture Organization
FGD	Focus Group Discussion
FSL:	Full Supply Level
GIS	Geographical Information System
GoU	Government of Uganda
GPS	Global Positioning System
HC	Health Centre (e.g. HC I, II, III, IV)
HIV	Human immune Virus
IP:	Indigenous People
IPMP:	Integrated Pest Management Plan
KADI:	Kanungu Development Initiative
LADA:	Literacy Action Development Agency

LC:	Local Council (used for various tiers of local councils e.g. LC 1, 2, 3, 4 or 5 or I, II, III, IV, V)
LG	Local Government
MAAIF:	Ministry of Agriculture, Animal Industry and Fishers
MGLSD	Ministry of Gender, Labour and Social Development
MoH:	Ministry of Health
MTWA	Ministry of Tourism wildlife and antiquities
NEMA	National Environment Management Authority
NFA:	National Forestry Authority
NGO:	Non-Governmental Organization
NKKD:	North Kigezi and Kinkizi Diocese
NOx:	Oxides of nitrogen
O&M	Operations and Maintenance
OHS	Occupational Health and Safety
OP:	Operational Procedure
PAP:	Project Affected Person
PCR:	Physical Cultural Resources
PH:	Public Health
PM:	Particulate matter (e.g. PM10, PM5, PM2.5)
PPE	Personal Protective Equipment
PSO	Private Scheme Operator
PV	Photovoltaic
RAP:	Resettlement Action Plan
REA:	Rural Electrification Agency
RoW:	Right of Way
SDG	Sustainable Development Goals
SOx:	oxides of sulphur
STD	Sexually Transmitted Diseases
TOR	Terms of reference
TSP	Total Suspended Particulates
UBOS	Uganda Bureau of Statistics
UNBS	Uganda National Bureau of Standards
UWA:	Uganda Wildlife Authority
VIP	Ventilated Improved Pit-latrine
VMGF	Vulnerable and Marginalised Groups' Framework
VMGP	Vulnerable and Marginalised Groups' Plan
WB:	World Bank
WBS	World Bank Safeguards
WfP:	Water for Production
WSSB	Water Supply and Sanitation Board
WUC	Water User Committees

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APPENDICES

APPENDIX A NEMA APPROVED TOR NOTICE

NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY (NEMA)

NEMA House
Plot 17,19 & 21, Jinja Road.
P.O.Box 22255, Kampala, UGANDA.

Tel: 256-414- 251064, 251065, 251068
342758, 342759, 342717
Fax: 256-414-257521 / 232680
E-mail: info@nemaug.org
Website: www.nemaug.org

NEMA/4.5

26th August, 2019

The Permanent Secretary
Ministry of Water and Environment,
P.O. Box 20026,
KAMPALA.

Tel: +256 (0) 414 505942

REVIEW OF THE SCOPING REPORT AND TERMS OF REFERENCE FOR THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR THE PROPOSED MATANDA AND ENENGO IRRIGATION SCHEMES IN KANUNGU AND RUKUNGIRI DISTRICTS

The above subject matter refers, we note that you submitted a single TOR for two assessments. This is to remind you that two independent assessments will have to be undertaken, and hence two ESIA reports submitted to this Authority for review. While undertaking the assessment, and in addition to your proposal, we advise that you also take the following into consideration during the assessment.

a) Provide a detailed description of the contemporary baseline information (biophysical and socio-economic) of the project site and its environs;

b) Ensure that the report has accurate GPS coordinates (UTM) of the boundary of the project area, including a legible site layout plan of the project area, and ensure it shows all the areas supposed to be excluded from use;

c) Ensure that comprehensive consultations are carried out with all key stakeholders, including the local community around the project area, and that the views/concerns of the stakeholders are well documented and integrated in the ESIA report;

d) Carry out soil analyzes based upon a spatially exhaustive soil sampling strategy, and ensure to make use of the findings in the report.

e) In regard to the (d) above, enlist the services of a soil scientist to assist interpret soil data and advise as necessary.

Page 1 of 2

f) Undertake consultations with scientists based at the National Agricultural Research Laboratory (NARL), Kawanda, on the suitability of the area for the rice cultivation and make use of this guidance in the ESIA report;

g) Engage with the production departments of Kanungu and Rukungiri districts in order to ensure the project is in harmony with the plans of the said local governments.

h) Provide a succinct description of all the project components.

i) Be sure your presentation of environmental impacts considers surrounding developments, of similar or larger magnitude, whose operations are likely to amplify impacts due to the proposed development;

j) Consider any other environmental aspects/concerns which may have been overlooked during the preparation of the scoping report and TOR, and include an evaluation of such concerns in the ESIA report;

k) Present an exhaustive Environmental and Social Management Plan, discussing ways in which potential environmental impacts will be mitigated at every stage of the project, including the responsibility centers and projected cost of mitigating each impact as will be defined; and

l) Include in the ESIA REPORT the total project (investment cost) covering all the components of the project.

m) Attach to the ESIA report legible and authentic evidence of ownership of the land you plan to develop;

This is therefore to recommend that you proceed with the ESIA for the proposed project. Please note that this is NOT a certificate of Approval and does not constitute permission to start project implementation.

Dr. Jerome Lugumira
For: EXECUTIVE DIRECTOR

Cc: Eng. Dr. Lammeck Kajubi (Team Leader)
27 Binayomba Road, Bugolobi
P.O. Box 22428
KAMPALA.
Tel: 0712 403357 / 0782580480

ESIS Consideration of pointers from the: Review of the Scoping Report and Terms of Reference for the Environmental and Social Impact Assement for the proposed Matanda Irrigation Scheme in Kanungu District

No	Approval Conditions	ESIS Address	Reference Section
a	Provide a detailed description of the contemporary baseline information (biophysical and socio-economic) of the project site and its environ;	Detailed Baseline description has been provided	Chapter 5 and Appendix E and F
b	Ensure that the report has accurate GPS coordinates (UTM) of boundary of the project area, including eligible site layout plan of the project area, and ensure it shows all the areas supposed to be excluded from use;	Geo-refrencing of all baseline data has been included	Entire ESIS
c	Ensure that comprehensive consultations are carried out with all key stakeholders, including the local community around the project area, and that the views/concerns of the stakeholders are well documented and integrated in the ESIA report;	Comprehensive consultations has been conducted	Chapter 6 and Appendix C
d	Carry out soil analyzes based on a spatially exhaustive soil sampling strategy, and ensure to make use of the findings in the report,	Soil analyzes was conducted	Appendix I
e	In regards to the (d)above, enlist the service of the soil scientist to assist interpret soil data and advise as necessary	Soil scientist (David KIRYA) was included on the team	Contubuting consultantants Table
f)	Undertake science-based consultations with National Agricultural Research Laboratory (NARL), Kawanda, on the suitability of the area for the rice cultivation and make use of this guidance in the ESIA report;		
g	Engage with the production department of Kanungu and Rukungiri district in order to ensure the project is in harmony with the plans of the said local governments.	The production department of Kanungu district was enegeged and guided, supported the study	Chapter 6 and Appendix C
h	Provide succinct description of all the project components.	Deatailed project description has been provided	Chapter 2 and Appendix D
i)	Be sure your presentation of environmental impacts considers surrounding developments, of similar or lager magnitude, whose operation are likely to amplify impacts due to the proposed development;	Has been considered	Chapter 7

No	Approval Conditions	ESIS Address	Reference Section
j)	Consider any other environmental aspects/concerns which may have been overlooked during the preparation of the scoping report and the TOR, and include an evaluation of such concerns in the ESIA report	Has been considered	Chapter 7
k	Present an exhaustive environmental and social management plan, discussing ways in which potential environmental impacts will be mitigated at every stage of the project, including the responsibility centers and projected cost of mitigating each impact as will be defined ; and		A detailed ESMMP has been included
l)	Include in the ESIA Report the total project (investment cost) covering all the components of the project.		
n	Attach to the ESIA report legible and authentic evidence of ownership of the land you plan to develop;		

APPENDIX B LIST OF PROJECT VILLAGES

DISTRICT	SUBCOUNTY	PARISH	VILLAGES
KANUNGU	KIHIIHI	KIBIMBIRI	KIRURUMA B
			KIRURUMA A
			RUSOROZA
			OMWIRANGIZO
			GROUP FARM A
			GROUP FARM B
			RWERERE B
			RWERERE C
			RWERERE A
			KYENYABUTONGO
			KAMEME
			MATANDA
			KANYINABURIMANO
		RUSHOROZA	KIBIMBIRI
			KAZINGA LOWER
			KAZINGA UPPER
			CUMBUGU
			TUKUNDANE
			KYAKATARANGI
			KASHOJWA
			NYARURAMBI
			RWERERE
			IBAMBIRO
		KABUGA	MATANDA I
			KAYEMBE
			KIRURUMA
			BUSHERE
			MATANDA II
			KABUGA
	KIHIIHI TC	Rwanga Ward	BINYUNGU
			KAZINGA I
			IBAMBIRO
			NYAKATUNGURU
			KARAMBI
			KAZINGA II
			RUKARARA
			MUZIZI
			RWEMISISI
			NYAKIYAGA
		Nyakatunguru Ward	BUBAARE
			RWENYERERE
			KINYASHWEHERA
			KIRURUMA
			KABUKWENDA
			BUGONGO
			NDEEBA
			KAMUTUNGU
			KINYAMASHE
			KARAMA
			RUSHENYI
			NKUMBAGARA
			KISHUNJU
			NYAMWEGABIRA
		Kihiihi Town Ward	RUYAYO
			NYAKIYAGA
			NDEEBA
			KASIIRO
			RUTWE
			MARKET
			BUGONGO
			CENTRAL
		Bihomborwa Ward	KINYASHOHERA
			RWEMISISI Kihihi TC
			RWEMISISI
			RWENYERERE A
			RWENYERERE B
			KAZINGA
			KINYANGWE
			BUZANIRO
			BIHOMBORWA
			NCUNDA
			KAKYENKYE
			KIBAYA
			RUTOOMA

DISTRICT	SUBCOUNTY	PARISH	VILLAGES
KANUNGU	NYAKINONI	Kanyambeho	KASIRO
			BURUHUKIRO
			NYAKAYANGA
			KANYAMBEHO
			NYAKAHITA
		Karubeizi	BUHUMIRIRO
			MURUHURA
			RWAMAHAMBA
			NYAMBALE
			KAMUSHWA
			OMUKIBUNGO
			OMUKIRWA
			RWANGOBOKA
			NYAMIYAGA
		Nyakinoni	KARONDE
			NYAKINONI
		Samaria	NYAKASHURE
			KIRURUMA
			SAMARIA
			NYAKARAMBI
			BUSHOGYE A
			BUSHOGYE B
	NYAMIRAMA	MASHAKU	RWEMISHINYA
			MASHAKU II
			MASHAKU I
		NTUNGWA	OMUKISHAHA
			KANIABIZO
			KAGUNGA
		NYAKASHURE	KAHAMA
			SAMARIA
			KIBARAMA
			KARONI
			KARUKONDO
		KIGARAMA	KARONI
			AHAKIBUNGO
			SAMARIA
		RUSHAKA	MASHOOKO
			KIRURUMA
			NYAKAGYERA
			NYARUHUNGYE
			NYABUSHORO
	NYANGA	BUKORWE	KARAMBI
			KAZINGA
			BUKORWE
			NYAKASHOZI
			NYAKABUNGO
		NKUNDA	NKUNDA
			KAZINGA
		NYANGA	RUTOOMA
			NYANGA
	KANYANTOROGO Mwesigye Kenneth 0783346704	BUREMA	KASHANDA
			KITOOKYE
		KIHEMBE	KIHEMBE CENTRAL
			KENGOMA
			KYOZI
			NYAKASHARARA
			RUKARARA
			KANYASHANDE
			NYABIREHE
			RUGARAMA
		NYAMIGOYE	KYAJURA
			BUSHORO
			ISHASHA
			NYABUBARE
			BUGIRI
			NYABIHOKO

Appendix C MINUTES FROM STAKEHOLDERS ENGAGEMENT

Meeting 1: World Bank

<table>
<tr><td colspan="3">Inception stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) for Matanda Irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder/ Funder: World Bank</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd and Aarvee Associates</td></tr>
<tr><td>14th November, 2018</td></tr>
<tr><td>World Bank Offices</td></tr>
<tr><td>Compiled by: Abel Mutyaba</td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Remarks from world Bank Irrigation Engineer
2. Communication from the Chairman
3. Presentation from the Feasibility and design consultant
4. Discussions and way forward
5. Presentation from the ESIA and RAP consultant
6. Discussions and way forward</td></tr>
<tr><td>1. Remarks from the world Bank Irrigation Engineer</td><td colspan="2">Ms Gabriella Izzi introduced herself as the World Bank senior Irrigation Specialist and introduced the meeting subject “Discussion on Matanda and Enengo both the feasibility studies/ design to be presented by Design consultant and the ESIA/RAP to be presented by AWE” to the chairman.</td></tr>
<tr><td>2. Communication from the chairman</td><td colspan="2">The meeting was chaired by Eng. Gilbert Kimanzi- Commissioner Water for Production-MWE. He apologised for his absence for the earlier meeting (World Bank, Ministry of Water and Environment, Design consultant and New Plan). He welcomed every one present for the ongoing meeting. He then invited the consultants to make their presentations.</td></tr>
<tr><td>3. Presentation from the Feasibility and design consultant- Aarvee Associates

aarvee associates
architects engineers & consultants pvt. ltd.</td><td colspan="2">Aarvee Associates team leader introduced the team to the chairman and made opening remarks for the presentation. Three (3) feasibility topics where presented;

i) Hydrology
ii) Agronomy
iii) Soils

Aarvee Associates then presented feasibility and design preliminary findings including;
i) Various preliminary hydraulic structural types and location options below;

▪ Option 1: Construct a dam at the chosen site to act as a reserve for Matanda irrigation scheme.
▪ Option 2: “No Dam” option but build a canal downstream of the proposed hydropower plant on River Kiruruma, as intake for the irrigation scheme.

Identified and illustrated where the proposed dam construction for Enengo irrigation scheme will be located on River Mitano.</td></tr>
</table>

	ii) Social issues faced and registered by the inception team, including; ▪ The experience from the RAP for the hydropower project delayed compensation had resulted into community fatigue in the earlier 2019 studies. During the second appraisal in 2023, there was at least hope and communities had become positive about the project
4. Discussions and way forward	The chairman and World Bank officials agreed that; i) As per Option 2 (**NO Dam**) the chairman will get back to World Bank, MWE and design consultant about Electricity Regulatory Authority, ERA's stand on the validity of the permit held by the hydropower project. ii) The design consultant will have to identify, analyse various options in relation to the location and type of hydraulic structures to be designed under the feasibility study report including; ▪ Use of weirs instead of dams ▪ Use a single dam for both schemes ▪ Location of Matanda dam upstream of the current suggested location (as illustrated in the meeting) more especially the sited hydropower plant site. iii) In spite the hard carps being faced by the design consultant, the consultant should proceed with the design for the scheme components as the water abstraction/ source is being handled by Chairman. iv) The design consultant will have to compressively under take more feasibility studies mainly the agronomics of the scheme, showing dominant crops grown and land use, justifying which crops are proposed for the scheme and carry out an economic analysis for the scheme in relation to why the Bank and Ministry of Finance should bear financial interests in the project.
5. Presentation from the ESIA and RAP consultant	The team leader made a presentation on ESIA and RAP for Matanda and Enengo including; i) Subject Introduction ii) Objectives of consultancy iii) Legislative and regulatory framework iv) World Bank Environmental and Social Standards (ESS) v) ESIA process and methodology vi) Inception vii) RAP process, conceptual model and methodology viii) Time lines and deliverables
6. Discussions and way forward	**Expectation**: The consultant was expected to brief the meeting upon the feel the inception team had as per the inception field visit. **Reponses from AWE**: The inception team leader elaborated broadly the findings from inception field visit, including;

	i) Stakeholder engagement with Kanugu district officials (on 1st November, 2018) that enlightened about Matanda scheme. ii) The proposed scheme site, was relatively of low built density, with Matanda Health Center II, Matanda Refugee Transit Center and Matanda Primary School in the 500 m radius. iii) Agriculture/ crop growing was dominant in the area and specifically the command area. Millet and maize was observed to be dominant crops grown. **Correction:** The project was approved before the ESSs came into action, hence the consultant is advised to use WB-OPs instead of the ESSs. **Reponses from AWE**: All WB-OPs that will be triggered by the project will be discussed against the project. **Clarity:** The chairman demanded clarity on the timelines in relation to deliverables against the designer's schedules and efforts. **Reponses from AWE**: AWE and Aarvee Associates had a brief discussion concerning timelines versus deliverables and an agreement was made that; i. AWE will try to deliver as per presented timelines, hence; ▪ ESIA and RAP inception report will be submitted to the client before 23rd November, 2018. ▪ ESIA scoping report will be submitted before 23rd December, 2018. ii. ESIA study will commence as soon as possible, however finalization and submission of the report to the client will depend on the timelines of Aarvee Associates, since both studies feed into the other (ESIA and design). iii. RAP studies can only commence upon final project design. The RAP was undertaken following the completion of designs for the dam and pipe network. **Advice:** The consultant was advised on clearance procedure including; i) *Inception report*- the draft report will be submitted to MWE, who submits it to World Bank for review and approval after all comments have been incorporated by the consultant. ii) *ESIA report*- the draft report will be submitted to MWE, who submits it to World Bank (Uganda) for review after all comments have been incorporated by the consultant, World Bank then submits it to the Regional Safeguards Advisor (Washington) after its comments have been incorporated by the consultant seeking review and approval. On approval it is then submitted to NEMA.

	iii) *RAP report*- The RAP report will follow the same sequence as that of the ESIA, as the valuation report on compilation by the consultant, through MWE, will be submitted to the CGV directly. **Response from AWE**: The clearance procedure will be followed, however AWE was concerned with the review time lag. **WB Safeguards**: Since the World Bank is the financier, the World Bank environmental and social safeguards, rather than IFC's E&S Performance Standards shall be used. **Response from AWE**: IFC has elaborate guidelines for Stakeholder Engagement, Cumulative Impact Assessment and Resettlement planning, which also the World Bank adopts. Reference to these guidelines and using them where they exhaustively elaborate necessary processes shall not belie the fact that IFC is not a financing party in this project.

Meeting 2: Kanungu District

Inception stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) for Matanda Irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Kanungu District 1st November, 2018 Kanungu District Office Compiled by: Abel Mutyaba and Ivan Ntege	**Consultant:** AIR WATER EARTH (AWE) Ltd.
		
Agenda;	1. Introduction 2. Welcoming remarks from the chair 3. Project introduction 4. Remarks from the members present 5. Discussions and way forward	
1. Introductions and Welcoming remarks from the chair;	The meeting was chaired by Kanugu District Production Officer (DPO), Peter Turiyo who welcomed Air water Earth for considering Kanugu District as a main stakeholder. He then requested all members present to introduce themselves then invited the consultant to brief the members present about their visit.	
2. Project introduction	The inception team leader, was thank full for the opportunity and time given to the team in relation to discussion on the proposed Matanda irrigation scheme. He then introduced the assignment of the team (ESIA and RAP studies), objectives, methodology, timelines and expectations from the district.	
3. Remarks from the members present	DPO and the members present highlighted the following key issues: (i). Recently the district visited the command area with World Bank and MWE and had a lengthy discussion about the proposed scheme. (ii). Involvement of the community and the local leaders (including; CDO, LC, Agricultural extension officers, sub county chief, Agricultural Engineers) from the start of this project is key. Consultative meetings with the communities has already begun from the side of the district. So far three meetings have been held one with Kihihi and two with Nyamirama sub counties. (iii). Land ownership will be very key during the RAP studies, hence the specialist should consider the fact that land tenure is mainly free hold, were a few people/ land owners in Kanungu district bear land titles. There is a big area owned by MAAIF (about 300 acres) and the community hires it for annual crop cultivation. (iv). There must be rigorous sensitization for both studies and project implementation. (v). Should be careful with influential political leaders since they are not technical (vi). The proposed and identified source is located in Nyamirama Sub County serving both Nyamirama and Kihihi sub counties. (vii). The predominant soils are sandy loamy in the command area.	

	(viii). The major crops grown in the command area include; rice, maize, millet, coffee and tobacco. However since the command area bears a flat topographical profile, and not densely populated, rice is the dominant crop grown mainly in Kihihi. Watermelons, tomatoes, Onions, Mangoes are other perennial crops grown since the temperatures in the command area are relatively the same as that of Mubuku Irrigation Scheme and Kasese. (ix). Livestock is minimal since historically the command area has been previously been infected with tsetseflies, ticks since the area is contident with Bwindi National Park. (x). The terrain is steeper in Nyamirama than Kihihi. (xi). The whole of Uganda has faced climate change and to this the studies should assess the impact of such changes to the project. Historically, Kanungu district never used to experience dry spells, of which currently during February and early July, there is a lot of dry spells. (xii). Source of the water for Matanda scheme is River Mitano (xiii). The design should consider the impacts of the scheme such as Damming may reduce water volumes of River Mitano reaching the Park and Lake Albert and also routing of water through the command area may expose flooding of certain sections (xiv). Anticipate displacements near the reservoir and some hydraulic infrastructures (xv). Kihihi has the most low level income earners in the area since they used to grow Tobacco for their livelihood
4. Way forward from the consultant.	The consultant will constantly engage the local leaders and community. Currently, this is inception stage, however after this is the scoping stage, followed by full ESIA studies, where the entire team will be engaged.

Meeting 3: Bukorwe Parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Bukorwe parish **Date:** 15.11.2019 **Venue:** Bukorwe Parish Headquarters **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	**1. Opening Prayer** **2. Self-Introduction** **3. Welcoming remarks by chairperson LC1** **4. Remarks by LCIII** **5. Communication from the area councillor** **6. Communication from District Agricultural Officer** **7. Communication from MWE Representative** **8. Communication from the consultant** **9. Discussion by members present** **10. A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members (Benon) and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 welcomed the teams and thanked the residents for attending. He apologised on behalf of those that did not attend and highlighted that most people were in their gardens following the heavy rains but will turn up in the subsequent meetings. He urged the community to participate in project activities whenever called upon as the project is meant to benefit them.	
3. Remarks by LC III	He welcomed the team and thanked them for consulting the community and called upon the community to pay attention to the information and pass it on to those that were not able to attend. He pledged support for the project at all stages.	
4. Communication from the area councillor	The area councillor welcomed the consultant team to Bukorwe parish. He highlighted that 90% of the residents in the area are farmers and so the irrigation project brings hope to the people. He urged the residents to pay attention and corporate with the project teams.	
5. Communication from District Agricultural Officer	The District Agricultural Officer thanked the community residents for turning up for the meeting. He gave a brief background of the project and the areas the scheme will cover. He informed the meeting that a District Task force for the project was formed with representatives form each subcounty and each parish within the command area and is headed by him.	

	He mentioned that the scheme is aimed at supporting the farmers and helping them improve their yields especially during the long dry seasons. He urged the community to support the project and all studies involved since they are all intended to help the government plan better and implement a project that will indeed benefit the community.
6. Communication from MWE representative	She thanked the District and local council leadership for the support they have given the project and urged them to carry on with the cooperation. She thanked the community for turning up and urged them to be cooperative and give the right information to the assessment teams to enable the ministry plan better.
7. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
8. Discussions by members present	**Discussion** Question: Will the water be free or people will pay for it? Response: the water users will pay a small fee that will help in maintenance of the irrigation infrastructure. Question: Will people be allowed to dig where the pipes are passing? Response: To avoid damage to the transmission infrastructure, a safe distance will be stated and marked beyond which people shall not plant. Question: As the community awaits the project, what is their role or how should they prepare for the project? Response: The community should cooperate with the assessment teams and give the right information whenever required. This will enable the government plan the project better. Additional requirements or information to the community form the ministry will be passed on timely. Question: Since there is no government land in Nyanga Sub County, will it benefit the people? Response: The project will not only benefit farmers on government land and so those in Nyanga will also benefit. Question: Why don't they source the eater from Ishasha River such that people in Nyanga that are far away from R. Mitano also benefit.

	Response: A number of factors were considered in selecting the river from which the water will be drawn. The community should not be worried about how far the water is coming from, technology and infrastructure will be out in place to ensure the entire command area is supplied with water.
	Recommendations by community
	i) Those to be affected by the project should be compensated fairly and promptly ii) The local communities should be given first priority during recruitment of workers during construction especially for casual labour. iii) Contractor's workers that commit crimes in community e.g theft, family breakages and defilement should be punished by law
A.O.B and Closure	Meeting was adjourned by the chairperson who thanked members present for their participation and called upon all the leaders present to work hand in hand with all project teams.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Karubirizi				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 16/11/2019					
Project name:					
Proponent:					

Name of Person	Village	Contact	Sign/ initial
Kyarikunda Sophia	Bukangaragara	077192077	Sophia
Mugyenyi Gershom	Mwogibwa cell	—	
Tumuhairwe Erica	Rwamahamba	0772385661	
MR MASIKO Tombson	RwAGOBOrea	0788185817	
Natukunda Evasi	Rwamahamba	0789931191	Evasi
Twebaze Alice	nyamabate	0718489094	Alice
Akatuhura	MAIKLINE Rwamahamba	0718481094	MAKLINE
Mpirirwe Jane	Rwamahamba	0779918466	Jane.
Tumwebaze Justus	Rwamgoborea	0789269880	
Tushabe HERBERT	Mukirwa	0788554717	
Tumusiime Caleb K.	Nyamabale	0783000989	
Muhangijingana Joseph	Nyamabale		Joseph
TUKAHIIRWA ABRAHAM	RWAMAHAMBA	0787988509	
Bamwangirako A	Kamushwa	0780440178	
ARITHO NOEL	Nyamabare	0772552292	Aritho Noel
Haguma Amos	Mitojo	0773206376	
Kyomugisha	ABREN		ABREN
Sunday F	Kurukura	—	Sunday F.
Apophia Bagowabo Akampurira	Nyamabare	0781268891	Abagowabo

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: BUKORWE				
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑
	Sensitisation:	☐	RAP:	☐
	Environmental Audit:	☐	Other (specify):	
Date: 15 / 11 / 2017				
Project name: MATANDA - BUGANGU IRRIGATION SCHEME				
Proponent: MWE				

Name of Person	Village	Contact	Sign/ Initial
MUSH. BRAHCK	KATRAMIZI	078 7920 357	[illegible]
TUMUKUNDE EZRA KASIGWA	BUKORWE	0787634265	[illegible]
MUGISHA G. ERIC	Yerusalemu	0787210622	[illegible]
Bikorwomuhangi John	Bukorwe	0778545777	[illegible]
NZABONIMANA DAVID	Nyakabungo	0784008692	[illegible]
HABIMANA AGUSTINE	Nyakashozi	0784938073	[illegible]
KUHANGARIYU RICHARD	NYAKABUNGO CELL	0782551153	[illegible]
BAOMUHANGI MIZAMIRU	NYAKASHOZI	078468316 6	[illegible]
KALANGWA ARTHUR	KARAMBI CELL	0772022806	[illegible]
NTEZIRYAYO SIRAS	KARAMBI CELL	0775505248	[illegible]
Nsabimana Vumansiu	Kazinga Cell	0789222923	[illegible]
KAGURIRO MOSES	LC1 BUKORWE	0777247252	[illegible]
Biikunuacane Didas	Nyakashozi Cell	0788767599.	[illegible]
Nkyeremijigo Kasozi	KARAMBI CELL	0785260787	[illegible]
TIBWOMWE ERIC	KARAMBI CELL	0786311696	[illegible]
Hakizimana Bevon	Bukorwe cell	0786788565	[illegible]
Ndagije Gregory	Kazinga	0778988471	[illegible]
Tumukwasire [illegible]	Bukorwe	0787834995	[illegible]
BYOBUSINGYE BEDA.	NYAKASHOZI CELL	0777271823	Byabusingye.

Meeting 4: Nyanga Parish

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Nyanga parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 15.11.2019</td></tr>
<tr><td>Venue: Nyanga Subcounty Headquarters</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Remarks by LCII
5. Communication from LCIII
6. Communication from District Agricultural Officer
7. Communication from MWE Representative
8. Communication from the consultant
9. Discussion by members present
10. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 thanked the community members for attending and welcomed the consultant team and representative of MWE to the parish. He mentioned that the project will benefit the community since most of them are farmers.

He urged the community to always respond positively whenever called upon on matters concerning the project.</td></tr>
<tr><td>3. Remarks by LC II</td><td colspan="2">He thanked the government for the irrigation scheme and for considering Nyanga as a beneficiary. He welcomed the team and thanked them for engaging the community and requested that the engagements continue even during the construction phase such that community and leaders participate actively throughout all the phases.</td></tr>
<tr><td>4. Communication from LCIII</td><td colspan="2">The Chairperson thanked the Ministry for such an opportunity of the Scheme that will benefit farmers especially during the dry seasons that greatly affect yields.</td></tr>
<tr><td>5. Communication from District Agricultural Officer</td><td colspan="2">The District Agricultural Officer thanked the local council leadership for the support in mobilization and community residents for turning up for the meeting. He gave a brief background of the project and the areas the scheme will cover. He informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him.</td></tr>
</table>

	He mentioned that the scheme is aimed at supporting the farmers and helping them improve their yields especially during the long dry seasons. He called upon the community and local leaders to continue cooperating with the government to ensure that the project is implemented successfully.
6. Communication from MWE Representative	She thanked the District and local council leadership for the support shown towards the project. She thanked the community for turning up and urged them to be cooperative and give the right information to the assessment teams to enable the ministry plan better.
7. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
8. Discussions by members present	**Discussion** Question: if one has gardens or farms in different areas within the command area, will the water reach all the farms or each person will access water on only one farm? Response: the water will reach all farms in the command area and farmers will benefit regardless of how far apart or the number of farms they have. Question: will those in valleys benefit from the irrigation scheme? Response: Yes, they will. Question: Will all the people within the command area be compensated when constructing the irrigation scheme: Response: Compensation will only be made to property that will be affected during the construction of infrastructure that will support the project e.g storage, distribution etc, and not the entire area. **Recommendations by community** i) There are a number of able youths in the community and these should be given job opportunities during construction especially casual work ii) The agriculture officer should sensitize the community and give them advise on better farming methods such that the community benefits from the project. iii) Compensation to those affected should be done early enough and adequately.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: Nyanga					
Purpose of consultation (*tick appropriate box*):	**Scoping:**		**ESIA:**	✓	
	Sensitisation:		**RAP:**		
	Environmental Audit:		**Other (specify):**		
Date: 15/11/19					
Project name: Matanda - Enengo Irrigation Scheme					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Bakanyana David	IBAMBIRO	0784937988	David/Bakanyana
Ben Binugura	Rutoma	0775581190	[illegible]
Kaapa Emmanuel	Rutoma	—	[illegible]
Nyiramahoro Clare	Nyanga	0789252768	Cleare
Musanwenimana Ayida	BUSANZA		mukane
Nyirabagande Budoriya	Busanza		Y
Kanyarushoke Lydia	Kazinga	07722677125	Lidia
Nyiramugisha Topisto	Muntuha		Nyiristo
NKUKIYIMANA GERVAZIO	Nyanga	0775325491	[illegible]
Tusiime Immaculate	Nyanga	0777274099	Immaculate
Tushabe Federesa	Nyanga	0773067786	federesa
Ngabire Venat	Nyanga	— —	[illegible]
Basabane Steven	Kitoma	— —	SF
TURYATUNGA Emmanuel	Busanza	0772509734	[illegible]
PANDA Francis	Busanza	- - - -	R
Nacoruse Mukayeze	Bwanza		
Habumugisha Richard	Busanza	0774508610	[illegible]
HILDA Mugisha			

AWE is ISO 9001:2015, ISO 14001:2015, and OHSAS 18001:2007 certified company.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: NYANGA					
Purpose of consultation (*tick appropriate box*):	**Scoping:**	☐		**ESIA:**	✓
	Sensitisation:	☐		**RAP:**	☐
	Environmental Audit:	☐		**Other (specify):**	
Date: 15/11/2019					
Project name: MATANDA - GWEBEGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
TUMWESIGYE Buni	NYANGA	0786366769	[signature]
NKWASIBWE VINCENT	NYANGA	0786356838	[signature]
HABOMUGISHA EMMANUEL	BUSANZA	0771671882	[signature]
RUMUMBA DAVID	NYANGA	0778425641	Rumba.
KAMBEDE INNOCENT	BUSANZA	0782430516	[signature]
NSHEKANABO ROSE	BUSANZA	0782430516	ROSE
ASIIMWE KENETH	NYANGA		
BYOBUSINGYE ONESMUS	BUSANZA		
MUGISHA JORAM	NYANGA		
KAKURU WELLEN	NYANGA		Kakuru
KIYENDEYE VASTINE	NYANGA	0780472118	Vastine
TUMUHIMBISE PHIONAH	NYANGA	0787494124	[signature]
Joy H	Nyanga	0771426174	Joy
TUDYAHABWA MARTIN	NYARUTEMBE 'A'	0756196616	Martin
MUSIMENTA JACKLINE	NYANGA	0788050273	MUSIME
NIYONZIMA HONEST	BUSANZA	–	ONESTA
MICHEAL NTAKIRUGIRA	BUSANZA	0785737462	Micheal

AMS - ISO 9001:2015, ISO 14001:2005 and OHSAS 18001:2007 certified company

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NYANGA				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date:	BASAJA : AA 15.11.19				
Project name:	MATANGA GWOKO IRRIGATION SCHEME				
Proponent:	MWE				

Name of Person	Village	Contact	Sign/ initial
BASAJA	NT. NYANGA	—	Basaja
ARINAITWE CHRISTINE	Nyanga	0785377682	
Hilda Mugisha	Katoma		—
Takyebigira Michael	Busansa	0785737462	
HAKERIMANA DONALD	RUTOOMA	0774772064	Herera

Meeting 5: Nkunda Parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Nkunda parish **Date:** 15.11.2019 **Venue:** Nkunda Catholic Church **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	**1. Opening Prayer** **2. Self-Introduction** **3. Welcoming remarks by chairperson LC1** **4. Communication from District Agricultural Officer** **5. Communication from MWE Representative** **6. Communication from the consultant** **7. Discussion by members present** **8. A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by the councillor and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 welcomed the consultant, district and MWE representative to Nkunda and thanked the community members for attending. He mentioned that the dry seasons affect farmers and some households go without food, the project will thus benefit the area and increase income for farmers. He requested that the project begins as soon as possible before another dry season sets in.	
3. Communication from District Agricultural Officer	The District Agricultural Officer thanked the community and local council leadership for supporting the project. He gave a brief background of the project and the areas the scheme will cover. He mentioned that the scheme is aimed at supporting the farmers and helping them improve their yields especially during the long dry seasons. He informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him. He called upon the community and local leaders to continue cooperating with the government to ensure that the project is implemented successfully.	
4. Communication from MWE Representative	She thanked the residents for turning up in large numbers and the local council leadership for the support and mobilization. She urged them to be cooperative and give the right information to the assessment teams to enable the ministry plan better.	

5. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
6. Discussions by members present	**Discussion**
	Question: What will happen to the water sources e.g boreholes that will be affected? Response: The water sources will be avoided as much as possible, and in cases where avoidance is not possible, they will be replaced. Question: Will the water be free or people will have to pay for it? Response: The users will contribute a small fee periodically for operation and maintenance of the water supply system. Question: Will there be job opportunities during the construction of the supply system? Response: Jobs available and required skills will be communicated to the public through community notice boards, meetings, radio stations and other media where necessary and guidance will be given on how to apply.
	Recommendations by community
	i) The local community especially youths should be given first priority when recruiting. ii) Property that will be affected by the system should be compensated for.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NKUNDA			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 15·11·2019				
Project name: MATANDA [illegible] IRRIGATION SCHEME				
Proponent: MAA				

Name of Person	Village	Contact	Sign/ initial
Icimpaye Furora	Nyebinga		
Burabenga Alice	Nyebinga		
Nyirasafari Feresta	Kazinga		
Kabushagye Peron	Nkunda	0775078505	peron
HABYARIMANA Vang	Nkunda		
Ikyimanizanye [illegible]	Nkunda		
NTAKIRUTIMANA [illegible]	Nkunda	0754418152	
NYIRABARINDA VICTORIA	NKUNDA		
NINSIMA Nangi	Runyinya		
Nyirarukundo [illegible]	Nkunda		
Nyiramujisha [illegible]	Nkunda		
Kemhabazi Susan	Nyebinga		
Nyirabikari Flora	Nkund	0789926994	Flora
Tushabomure susan	Nkunda	0786231170	susan
Mukakimenyi charlotte	Nyabinga	0783533938	Charlotte
Hope Bindreta	Rurama	0785782940	Hope
Imaniriho Editha	Rurama	0779165284	Editha.

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STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NKUNDA		
Purpose of consultation (*tick appropriate box*):	Scoping: [ ] / Sensitisation: [ ] / Environmental Audit: [ ]	ESIA: [✓] / RAP: [ ] / Other (specify):	
Date: 15/11/2019			
Project name: MATANDA - GNGOLO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ Initial
BYARUGABA BERNARD	NKUNDA	0775850744	Byarugaba.
MUSINGUZI JAMES	KAZINGA	0782716916	[illegible]
MUGABIRWE EDWARD	RUNYINYA	0771447673/0753447673	Edward.
MBOMBO AMOS	KAZINGA	077415469 2	[illegible]
NTEZIYAREMYE FRANCIS	RUNYINYA	0782504900	[illegible]
Kamarande .N. Aaron	KAZINGA	0777863053	[illegible]
KAFUKUZI	Nkunda	—	
FUDDI SIMON NSABIBITSE	KURAMA	0786884650	[illegible]
SUNDAY BRAVE	KAZINGA	0771662314	Sunday
TUMUSIIME OBED	NKUNDA	—	[illegible]
Bigirimana James	Nkunda	0779282245	[illegible]
Bahemutiyiki Deo	Nyarutembe B	0785820348	[illegible]
Himbara Edson	Nyeibuga	0785820318	[illegible]
Katarehwere G	Nkunda	—	[illegible]
JENERASII	KANSIIKA		
MASIKO	HOPE NKUNDA		
Tumusime	Jogisi NKUNDA		
Fororo	NY NKUNDA		
TERENZA	NYEBINGA		

NKUNDA.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: NKUNDA					
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑	
	Sensitisation:	☐	RAP:	☐	
	Environmental Audit:	☐	Other (specify):		
Date: 15/11/19					
Project name: MATANDA - GENGA IRRIGATION SCHEME					
Proponent: MWE	NKUNDA				

Name of Person	Village	Contact	Sign/ initial
NDUWAYEZU DISMUS	NYARUTEMBE A	0788302900	[illegible]
Rufuragenda. L	Nyarutembe	0774629784	[illegible]
IMANISHIMWE M	NYARUTEMBE	—	IMANISHIMWE.
KWIZERA Micheal	NKUNDA CELL	0788738269	Kwizera.
UKWITEGETSE MABLE	NKUNDA Village	0774165?4	Mable
UKWIGEZE BEATRANCE	Nkunda Village		Beaty
NTUYEHABO EMMANUEL	MUNTIMA "	078864845?	[illegible]
NDIKUBWIMANA FROLENCE NYAMAREMBE	NKUNDA VILLAGE	0771021893	Frolence
Mugisha. BANABASI	yarutembe A	0755511325	[illegible]
Ndizihiwe moses	Nkunda	0789009400	moses
masinguzi Allan	Nyarutembe A	0721981841	Allan
Nahimana Samuel	Rurama Village	0756655226	Nahimana
Nyiramugisha Monica	Ntebingo	0782733508	Monica.
Orishaba Immaculate	Nyarutembe A	0773482212 | 0704281136	[illegible]
Kabanyoro Beatrace	Nyarutembe A		
orishaba brendah	Rurama	0776093607	brendah
Tukamwesiga Sane	Nkunda	0782622394	Sane
Mugabirwe. D.	Nkunda		Mugabirwe
Ndamuhawe. T.	Nkunda		Ndamuhawe

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	MKUNDA				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 15/11/2019					
Project name: MAYANGA - GAHINGA IRRIGATION SCHEME					
Proponent: MHE					

Name of Person	Village	Contact	Sign/ initial
Nyirabagyenyi	Kutama	0783622238	Feresa
Rwabishanyana	RAMA	0742764942	Ruman
NDAMANAYIRE GAD	NYEBINGA	0774156888	[illegible]
RUTEISIRE VIAN	RURAMA	—	vian
AKAMPURIRA BRIAN	NYEIBINGA	0752434828	Bauulenui
magusha	Bnnadi	0772276908	
KASheija	Nyebiga		Emdle
Nyiransaba MARIYA	KAZINGA	0789925264	Nyiran
Angella Merisi B.	Kazinga	0771484747	Angella B.
KAMUSIME IVASI	NKunda		[illegible]
TURYAMUREEBA YASON	NKUNDA		

Meeting 6: Karubeizi Parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Karubeizi parish **Date:** 16.11.2019 **Venue:** Karubeizi C.O.U **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by Vice chairperson LC1** 4. **Remarks by Sub county mobiliser** 5. **Communication from District Agricultural Officer** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by Mr. Adomson and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by Vice chairperson LC1	The vice chairperson welcomed the consultant's team, District and MWE representative and thanked them for considering to engage the community regarding the irrigation scheme project. He mentioned that the project brings hope to the farmers in the area who are usually affected by dry seasons.	
3. Remarks by Subcounty mobiliser	He thanked the team lead by the District Agricultural Office for engaging the community at early stage of the project. He informed the community that a task force had been formed and all sub counties and parishes within the command area are represented, these will work with all project teams, mobilizing communities, through all stages to ensure the project is implemented successfully.	
4. Communication from District Agricultural Officer	The District Agricultural Officer thanked the subcounty, parish mobilizers and local council leadership for mobilization and community residents for attending the consultation meeting. He gave a brief background of the project and the areas the scheme will cover. He then called upon the community and local leadership to continue supporting the project and respond positively whenever called upon on matters regarding the project.	
5. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project	

	implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
6. Discussions by members present	**Discussion** Question: if the pipes pass through graves, is it the responsibility of the residents or the government to relocate them? Response: the project developer will engage the affected families and the local leaders to ensure that relocation of these graves is done in a culturally accepted manner. Question: is the water for free or the users will be required to pay for it? Response: water users will pay a small amount of money to assist operation and maintenance of the system. Question: Will the project also provide tanks containing water for drinking purposes? Response: No, the water under the irrigation scheme will be strictly for farming purposes and will not be fit for domestic use, therefore community should desist from using this water for domestic purposes. Question: if the water from the river is diverted for irrigation, wont the people and plants downstream suffer drought? Response: No, the river will not be diverted, the percentage of water that will be diverted for use in irrigation is a small percentage and will not affect activities downstream.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Karubiizi			
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑
	Sensitisation:	☐	RAP:	☐
	Environmental Audit:	☐	Other (specify):	
Date: 6/11/2019				
Project name:				
Proponent:				

Name of Person	Village	Contact	Sign/ initial
Kyarikunda Sophia	BAHORABE	0771920777	Sophia
Mugyenda Gordon	Mwoshuro Cell	—	[illegible]
Tumushabe Erica	Rwamahamba	0772385661	[illegible]
MR MASIKO JOATHAN	RWAKOBUGU	0788185817	[illegible]
Natukunda Evasi	Rwamahamba	0789931191	Evasi
Twebaze ALICE	nyamabare	0718481094	ALICE
ANASIYNA	MAIKLINE Rwamahamba	0718481094	MAKLINE
Mpirirwe Jane	Rwamahamba	0779918466	Jane.
TUMUHAMBISE JUSTUS	Rwengobora	0789269880	[illegible]
Tushabe HERBERT	MIKIKIRA	0788554717	[illegible]
Tumusiime Caleb K.	Nyamabale	0783000989	[illegible]
Muraajjinema Joseph	Nyamabale		Joseph
TUKAHIIRWA HANSON	RWAMAHAMBA	0787988509	[illegible]
Bamwangirah A	Kamushwa	0780440178	
ARIHO NOEL	Nyamabare	0772552292	A Raphael
Hagumo [illegible]	Mitojo	0773206576	[illegible]
Kyomugisha	ABREN		ABREN
SYLVESTER	Rurahura	—	Sylvester.
Apophia Bagowabo Akampurira	Nyamabare	0781268891	[illegible]

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STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Nyabale Kanubizi				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 16/9/2019					
Project name: MAYANJA - BAGUGA IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ Initial
MUNGUZI G.	RWAMAHABA	0780 745402	Munguzi
FRIDAY D.	RWAMAHAMBA	0779443873 / 0781818883	[illegible]
Kaguma D	KABAHAHA	0780 160 249	Kaguma
Eunice Byaruhanga	Kamushwa		Eunice
Tumusiime M	Kamushwa		midiasi
TUSIINGWIIRE J.	Kamushwa	0787313158	Jonas
Peninah	Kamushwa	0782644674	Peninah
Musimenta M.	Rwamahamba	0786211923	Maureen
BUJUME SYLVER	Rwamahamba	0779-783548	Bujume
Musemera Edson	Nyamabare	0778242102	Musemera
Nyabirane Frank	Nyamabare	0773077580	[illegible]
Ndyabahika Banabus	Omuhinga		Banabus
Ndabarela Baheni	Muhingi		
Mugabirwe Brian	Omuhigi	0778632760	Brian
MBASHASHA	Omuhigi	—	BASHASHA
Byaruhanga Fredigo	Nyamabale	-	

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Karubiriza			
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑
	Sensitisation:	☐	RAP:	☐
	Environmental Audit:	☐	Other (specify):	
Date:	16/11/2019			
Project name:	MATAMBA [illegible] IRRIGATION SCHEME			
Proponent:	MWE			

Name of Person	Village	Contact	Sign/ initial
Kemigisha Agnes	Shaba Murutura	0777118476	agnes
Kyiringyinda Florence	Kwamahamba	—	Florence
Tukahirwa Ann	Kwamahamba	0772979524	Tukahirwa
MUHUMUZA DICKSON	NYAMABARE	0788017279	[illegible]
Ndukukire, Francis	Murutura	0775630637	[illegible]
[illegible]			
Tushemereirwe Jackline	Nyamabare	0770866076	Jackline
TUMUHIMBISE CONSTANCE	Nyamabare	0773913779	[illegible]
Tusime Evas	Muhuhura	0781 829 55 6	Tevas
Mushoxoni Brian	Muhuhura	0745 16 17 14	[illegible]

Meeting 7: Kanyambeho Parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Kanyambeho parish **Date:** 16.11.2019 **Venue:** Kanyambeho Trading Center **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by chairperson LC1** 4. **Remarks by Subcounty mobilizer** 5. **Communication from area councillor** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 welcomed the consultant's team and thanked the community members for attending the meeting to get information pertaining to the proposed irrigation project. He mentioned that the project will benefit the community since most of them are farmers. He urged the community to always respond positively whenever called upon on matters concerning the project.	
3. Remarks by subcounty mobilizer	He thanked the ministry for the proposed irrigation scheme mentioning that it is a great relief to the farmers in the district. He informed the meeting the drought hit the area in 2017 to an extent that people cooked and ate roots of spear gras and pawpaw as meals. He pledged support on behalf of the subcounty in terms of mobilization of communities for the project.	
4. Communication from the area councillor	The area councillor thanked the Ministry for thinking about Kanungu, mentioning that for about 3 years, the area has been facing drought and could not harvest more than 1kg of food, the project thus brings hope. With this, he urged the residents to pay attention and ask questions so they can understand and support the project.	
5. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project.	

	She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
6. Discussions by members present	**Discussion** Question: Will the water be free or farmers will pay a fee to use it? Response: the water users will pay a small amount of money that will be used in maintenance and operation of the system Question: When is irrigation applied, during rainy or dry season? Response: the irrigation will be applied whenever needed; and will be available in all seasons. Question: Will the poor afford this scheme? Response: Yes, the fee that will be set will be agreed upon by the water users and will be affordable in order to make the project beneficial to the farmers. Question: If houses or crops are affected by the system, will they be compensated? Response: all eligible property that will be affected by project infrastructure will be compensated for. A plan will be prepared to guide land acquisition. **Recommendations by community** i) Local community should be given employment opportunities during construction.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Kanyambeho			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 16/1/19				
Project name: MATANDA ENERGO IRRIGATION SCHEME				
Proponent: MWE				

Name of Person	Village	Contact	Sign/ initial
[illegible]	Nyakalyaga		
Asiimwe Tereshono	Nyakayaga		
Turyamuruggyato OBED	NYAKATETA	0770866890	
mugisha chalia	Nyakayaga cell	0773637200	
mayumbu .W	Nyatahita	0781505329	
Kimanywenda .R.	Nyakayaga cell		
SATURDAY Bukenko	Nyakayaga cell	0789251060	
Tusinguire Justus	Kanyambeho cell	0777611157	
Sabiiti Asion	Nyakahita	0775702829	
Turyagumanawe Aggrey	Kanyambeho cell	0773221854	
Tumwijukye AGGREY	KASIRO CELL	0774916995	
Kwesiga Gad	Kasiro cell	0774245284	
Agatha Tibaliika	Nyakahita	~~ce~~ 0772692185	
Mujuni Jackson	Nyakahita	0783672257	
Kyomuhendo Herbert	Nyakayaga L.C.I	0775632242	
Joseph Atuhamuza	Nyakahita L.C.I	0787828863	
Rugasira Bashiru	Rukombaya	0779289461	
BYARUHANGA Edward	Nyarihahita	078~~1405~~719023	

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Kanyambeho				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:		
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 16/11/19					
Project name: MATANDA ENENGO IRRIGATION SCHEME					
Proponent: MWE.					

Name of Person	Village	Contact	Sign/ Initial
Biryomumaisho. S	Kasiro	— — —	[illegible]
Tumuhameripwe	nyakayaga		
Kundumutoma Faith	Nyakahita	—	Faith
Natukunda Mackline	Ntakahita	0783635300	N.Mackline
Kyakazi Peace	Kanyambeho	0773797944	Peace
Glorius Kanyeriaye	Kanyambeho	0772797944	GLORIUS
Nuwinabareeba	Kasyita	0781658839	Nuwinabareeba
Matsiko Ruth	Nyakayaga	0775760219	RUTH
Tony Tukurasibwe	Nyakahita	0795875543	[illegible]
Tuyamureeba Sam K	Nyakahita	0779782296	[illegible]
Rurakabijo Augustine	Ntakahita	0789926980	[illegible]
Ekinshabire Shallon	Kanyambeho	0772785098	Shallon
Kyaripa Joy	Kanyambeho	— — — —	Joy
Natukunda Patience	Kanyambeho	— — — —	Patience
Kyomuhendo Happy	Kanyambeho	— — — —	Happy
Natukunda Evalyne	Nyakahita	— —	EVALYNE

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STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Nyakahita – Kanyambabo				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:		
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 16/11/19					
Project name: MATANDA ENYANGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
NDYANABO AGGREY	KANYAMBEHO	0771457598	[signature]
Mbabazi Jiripina	Kanyambabo nyakahita	0779524440	[signature]
AINEMBABAZI J	Nyakabyonga	0779139597	[signature]
[illegible]	Nyakahita	–	[signature]
MUGISHA INNOCENT	NYAKAYAGA CELL	07759020 64	[signature]
Seyumpi EDWARD	NYAKAYAGA CELL	0785672400	[signature]
TURYAMUREEBA CHRISTOPHER	Nyakayaga Cell.	078698854.	[signature]
Tukwasibwe moses	Nyakahita	–	[signature]
Hakanijaruhijiko	Nyakayaga	0779716621	[signature]
Ikyomuhendo sarah	Nyakayaga Cell	0780521564	sarah
TUMUSHERURE ALEX	Nyakayaga Cell	0781268716	[signature]
Byomuhangi Paison	KASUBA C/	0782255991	Paison
Kyatuhaire	Nyakahita		Kyatuhire
Turabatogyereza	Kanyambeho		[signature]
Busigyereba	Kanyabeho		busigye
Turyahikayo Edson Kahima	Nyakayaga	0785817567	[signature]
Annah Tororo	Kanyambeho	0785000995	Tororo
Agaba Benson	Nyakahita	0784472029	Benson
Agaba Atanazio	Kanyambeho	077906585	—

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STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Kayambaho				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 16.11.19					
Project name: MATANDA ENSHORO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ Initial
Akankwasa Joseph	Kayambaho	0788488169 3	[signature]
Turyakira Flora	Kayambaho	—	Flora.

Meeting 8: Kabuga Parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Kabuga parish **Date:** 16.11.2019 **Venue:** Kabuga Subcounty Headquarters **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by chairperson LC1** 4. **Remarks by Subcounty mobilizer** 5. **Communication from area councillor** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	One of the community members led the opening prayer which was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The chairperson LC1 thanked the community members for turning up for the meeting and welcomed the consultant team to Kabuga. He urged the community to always respond positively whenever called upon on matters concerning the project.	
3. Remarks by Subcounty mobilizer	The mobilizer thanked the ministry for the project. He welcomed the team and thanked them for engaging the community and requested that the engagements continue throughout all the phases. He pledged support in terms of community mobilization of the subcounty.	
4. Communication from area councillor	The councillor thanked the government for the Scheme, emphasising that it will boost economic growth of the area and generally improve the way of life of farmers in the area.	
5. Communication from the consultant	The sociologist thanked the local council leadership for the support shown towards the project. She thanked the community for turning up and urged them to be cooperative and give the right information to the assessment teams to enable the ministry plan better. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.	
	Discussion	

6. Discussions by members present	Question: will there be compensation for crops and houses that will be affected by the project? Response: compensation will be made for property that will be affected by project infrastructure. A plan will be prepared to guide land acquisition process. Question: is the water for free or the users will be required to pay for it? Response: water users will pay a small amount of money to assist operation and maintenance of the system. Question: will there be an opportunity for youths to be employed on the project especially during construction? Response: Jobs available and required skills will be communicated to the public through community notice boards, meetings, radio stations and other media where necessary and guidance will be given on how to apply.
	Recommendations by community
	i) Construction workers should be given employment contracts and should be paid fairly ii) Compensation should be fair and prompt.
A.O.B and Closure	There being no other business, the meeting was adjourned.

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	MATANDA			
Purpose of consultation (tick appropriate box):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 18/11/2019				
Project name: MATANDA - GREENED IRRIGATION SCHEME				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ Initial
Kwikiriza Godfrey	MATANDA	0781998892	[signature]
Byamugisha Moses	Matanda	0775670966	[signature]
Mugungu Issah	MATANDA	0779155857	[signature]
ABDUL FATAHA Z.U.	MATANDA	0787749101	niwabiin
[illegible]	Kanyinabakuru	0789264816	[signature]
John Wasaki	MATANDA	0789982370	[signature]
JOHN BOSCO	MATANDA	—	[signature]
TUMUSHABE GODOVI	MATANDA	0780909274	[signature]
KENYONGOZI VASITAH			
Anitah [illegible]	Matanda	0783024024	[signature]
Fatuma Ziatagama	Matanda	—	—
Tumushwasa John	Matanda.		

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KAYEMBE – MATANDA II			
Purpose of consultation (*tick appropriate box*):	**Scoping:**		**ESIA:**	✓
	Sensitisation:		**RAP:**	
	Environmental Audit:		**Other (specify):**	
Date: 16/11/2019				
Project name: MATANDA - GWANGO IRRIGATION SCHEME				
Proponent: MWE				

Name of Person	Village	Contact	Sign/ Initial
ARINEITWE PURUDENCE	BUSHERE		purudence
Ntegyereize Catherine	matanda II	0789292892	[illegible]
Nzamuhabwa Purisa	Kirurumu		Purisa
SARAH BUMARI	Matanda II	0774124179	Sarah
Tushemereirwe Joy	Matanda II	0777866303	Joy
Tindyebwa Simplisio	Matanda I		[illegible]
Kesiime Hope	Matanda II	0789920699	K. Hope
Nyesigomwe Deus	matanda I	0773108388	[illegible]
Bigirimana David	Matanda II	0774797109.	[illegible]
ASIIMWE MOSES	Matanda II	0783 217830	[illegible]
OWOMUGISHA DAPHIN	matanda II	0788176580	Daphin
Musimenta Annah	Matanda II	0781204100	M.A
FRIDAY HERBERT	Kayembe	0786508132	[illegible]
Kyarisiima Emily	~~Emily~~ matanda II	–	Emily
Nyamishana Loy	Kirurumu		Loy
Tumushabe Hope	Kirurumu	0778479977	[illegible]

/

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	MATANDA				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date:	18/11/2019				
Project name: MATANDA - GUGUGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
MUKIGA NELSON	MATANDA	0773643040	[signature]
BULUNGI SAMUEL	KAMEME	0779-159920	[signature]
TWESIGOMWE GEOFREY	KYERAYABU TENGO	0776995866	[signature]
Bwihamutwe Johnson	Kameme	0777216270	[signature]
Muhwezi Jenipher	Kanyinaburimano	0775796096	[signature]
Ankunda Yosiya	Matanda		
Byamugisha Wilson	Matanda elected	0775670966	[signature]
NGABIRIZI Moses	Kibimbiri P.	0783857912	[signature]
NATUKUNDA NELSON	c/p LCIII Kayonza S/c	0782858320	[signature]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KAYEMBE – MATANDA II				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 16/11/2019					
Project name: MATANDA IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Mugabirwe Leminatah	Kayembe	0789926903	Leminatah
Kyasimire Kedress	Kayembe		Kedress
Tumuhirwe Nuriat	Matanda II	0773645648	Nuriat
Makazi Joy	Matanda II	—	
Kyesimiro Sarah	Matanda II	0777 563834	Sarah
Mustafa Iradukunda	Kirurima cell	0784442195	Iradukunda

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Matamba - Kayembe				
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑	
	Sensitisation:	☐	RAP:	☐	
	Environmental Audit:	☐	Other (specify):		
Date: 16/11/2019					
Project name: Matamba - Ifwenco Irrigation Scheme					
Proponent: MoAg					

Name of Person	Village	Contact	Sign/ initial
Musimenta C.	[illegible]	[illegible]	[illegible]
[illegible] L.	Mbwilonde II	[illegible]	[illegible]
FLORA Kapere	KIRUZOMA	0778423344	F. Kapere

Meeting 9: Samaria Parish

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Samaria parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 17.11.2019</td></tr>
<tr><td>Venue: Bushogyi Catholic Church</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Communication from area councillor
5. Communication from the consultant
6. Discussion by members present
7. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">One of the community members led the opening prayer, which was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 welcomed the consultant's team and thanked the community members for attending the meeting to discuss issues pertaining the irrigation scheme; a project that is expected to change the lives of farmers in the district.</td></tr>
<tr><td>3. Remarks by area council</td><td colspan="2">He appreciated the government for the project; which he believed will transform the area and improve livelihoods since majority of the people in the district depend on agriculture. He called upon residents to cooperate with the government to ensure that implementation of the project is successful.</td></tr>
<tr><td>4. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders and communities towards the project and urged them to carry it on even during construction and operation of the scheme.

She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at disclosing the project to the community and identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
<tr><td rowspan="2">5. Discussions by members present</td><td colspan="2">Discussion</td></tr>
<tr><td colspan="2">Question: Will the water be free or farmers will pay a fee to use it?

Response: the water users will pay a small amount of money that will be used in maintenance and operation of the system</td></tr>
</table>

	Question: If houses or crops are affected by the system, will they be compensated? Response: all eligible property that will be affected by project infrastructure will be compensated for. A plan will be prepared to guide land acquisition. Question: will the compensation be in cash or in kind? Response: compensation will either be in cash or in kind; this will be agreed upon by both the government and affected persons. Question: When will construction start? Response: The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid-19 pandemic, change in dam site, and additional scope of services thereunder, the start is now planned for 2024. Question: Will the project provide employment? Response: Yes. During construction, the project will require workers for setting up project infrastructure and, depending on the jobs available and skills required, local communities will be given opportunities. During operation phase of the project, alternative livelihood projects e.g. honey production can be ventured into by the communities to enhance their income.
	Recommendations by community
	i) Strict rules should be put in place to penalise construction workers who engage in sexual relations with married women breaking marriages and school going children leading to dropouts.
A.O.B and Closure	There being no other business, the meeting was adjourned.

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	Kyabalemira – Bushogye			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date:	13/11/18			
Project name: MATANDA GROWING IRRIGATION SCHEME				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ initial
MPUMUZA EMMANUEL	KIBURUMA	0789460827	[signature]
NATWIJUKA LAUBEN	Nyakarambi	0771286179	[signature]
Mugisha Moses	Bushogye		[signature]
Monday Stephen	Samaria	0777126028	Monday
Mattias Muronbe	Nyakarambi	0772533998	[signature]
HABAASA SALIVAN	V/PLC1 BUSHOGYE A	0775169030	[signature]
Kahimakazi HOPE	KIRURUMA	0782385787	Kahimakazi
Kengyeyo Jane	Nyakarambi	0775367535	[signature]
Tukwasibwe Topi	Kiruruma		[signature]
Twinomujuni PEN	Nyakarambi	0784722727	[signature]
Tushemereirwe Sheila	Nyarambi		[signature]
Turahirwa Veronica	Kiruruma	0781820005	Veronica
Kamuhanda G.	Kiruruma		
Arinaitwe Justus	V/PERSon LCII Samaria	0787860602	[signature]

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	Kyakalemera - Bushogye				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 17/11/2019					
Project name: MATANDA ENERGO [illegible] PROJECT					
Proponent: MWG.					

Name of person	Designation	Contact (Tel/email)	Sign/ initial
Agaba Banard	Bushogye	0784835547	agaba
Ahaman Abraham	Kiruma	—	[signature]
Kembabazi penilope	Kiruruma		Penilope
ORISHABA EVALYNE	Nyakarambi	0787763118	Orishaba
Asiimwe severina	Nyakarambi	0789674981	severina
Ndyomugyenyi Amos	Nyakarambi	0774625687	Ggyenyi
Akatwijuka Jerans	Nyakarambi	0786172347	[signature]
JACKLINE TWESIGYE	KIRURUMA	0783123574	Jackline
Christmas Mebie	SAMARIA	0780441495	christmas
TUMUSINGIZE SULAIT	Nyakarambi	0779994407	[signature]
BATuma Denes	Nyakarambi	0786974878	[signature]
Tibenderana matiy	nyakarambi	-	matiye
Tumwiwukye Annah	Samaria	0783597692	Annah

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	KYAKA LEMERA - BUSHOZI			
Purpose of consultation (tick appropriate box):	Scoping:		ESIA:	
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date:	17/11/2019			
Project name:	MATANDA - EHENGO IRRIGATION SCHEME			
Proponent:	MWE			

Name of person	Designation	Contact (Tel/email)	Sign/ initial
Mugabirwe Florance	Kirurumo	0788401383	F. M.
Tibamwenda Miria	Samaria Kigarama		Tibamwenda
Kebirungi Jomiah	Bushagye . o		Jomiah
Ndyahisaho Lestatuta	Kirurumo	0773359250	Ndyahisahe
MWESIGWA A	KIRURUMA	0773857963	[illegible]
KARORERO PAASCAL	KIRURUMA	0788408048	[illegible]
Kwesiga John	Samaria Kigarama	0782648663	JKwesiga
Butawanya Gabriel	Nyakarambi	0773117851	[illegible]
Ndyamanabo Steven	Nyakashure C/P.L.C.I	0782191676	[illegible]
DSERORI BUKO DRESINAND	Gen. Secretary LCI	0778958851	[illegible]
TUKWASIBWE DENIS	Mobiliser	0758650737	[illegible]
Twebaze Kamoven	Information		[illegible]
Murumbi Lazaro	Sec. RCI Kamaria	0784732538	Murumbi

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KYAKALEMIERA – BUSHOGYE				
Purpose of consultation (*tick appropriate box*):	**Scoping:**			**ESIA:**	✓
	Sensitisation:			**RAP:**	
	Environmental Audit:			**Other (specify):**	
Date:	17/11/2019				
Project name: MATANDA [illegible] [illegible] scheme					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
TURYAGYAMIDA ASUMAN	BUSHOGYE.	0782700342	Asuman
TUSHABE AGNESS	BUSHOGYE	0772033938	AGNESS
ARINEITWE SILVIA	NYAKARAMBI	0772312993	Sylivia
BARASAHA BENON	[illegible]	0779342765	BENON
[illegible] Mauina	Kirarama	–	Mauina
[illegible] Agatha	Kirarama	–	agatha

Meeting 10: Rushoroza Parish

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Rushoroza parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 18.11.2019</td></tr>
<tr><td>Venue: Kibimbiri C.O.U</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Remarks by LCII Chairperson
5. Communication from MWE representative
6. Communication from the consultant
7. Discussion by members present
8. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 welcomed the consultant's team and the representative of MWE and thanked the community members for turning up for the meeting.
He thanked AWE for consulting the community and requested that such engagements continue throughout the project lifetime.</td></tr>
<tr><td>3. Remarks by LCII Chairperson</td><td colspan="2">The LCII Chairperson, Mr. Asiimwe Suraiti welcomed the consultant team and official from the ministry. He thanked the ministry for the proposed irrigation scheme, mentioning that it is the long-awaited solution for the drought that greatly affects farmers in the district. He called upon the community to cooperate and participate actively in project activities whenever called upon, because they are the direct beneficiaries of the project.</td></tr>
<tr><td>4. Communication from MWE representative</td><td colspan="2">She thanked the community and leaders for the support shown to the project and urged them to carry it on throughout all project phases. She urged them to disseminate information received from the meeting to other residents that did not make it to the meeting. She encouraged members to ask questions where clarity is needed so as to gain better understanding of the project.</td></tr>
<tr><td>5. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project.

She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
</table>

<table>
<tr><td rowspan="4">6. Discussions by members present</td><td>Discussion</td></tr>
<tr><td>Question: Will the water be free or farmers will pay a fee to use it?

Response: the water users will pay a small amount of money that will be used in maintenance and operation of the system

Question: What will happen to the water sources e.g boreholes that will be affected?

Response: The water sources will be avoided as much as possible, and in cases where avoidance is not possible, they will be replaced.

Question: how long is the project and when is it starting?

Response: The project has a 6-year ducration. The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid pandemic, change in dam site, and additional scope of services thereunder, the start is now planned for 2024.

Question: Who will manage the irrigation scheme once its operational?

Response: the government shall, in consultation with MAAIF, local government ad farmers come up with the appropriate management system that will manage the scheme

Question: Will there be job opportunities during the construction of the supply system?

Response: Jobs available and required skills will be communicated to the public through community notice boards, meetings, radio stations and other media where necessary and guidance will be given on how to apply.</td></tr>
<tr><td>Recommendations by community</td></tr>
<tr><td>i) Local community should be given employment opportunities during construction especially for casual work. These should be paid fairly and on time.
ii) The contactor should sensitize his/her workers and the community regarding HIV/AIDS in order to control its spread as a result of interaction of the two.</td></tr>
<tr><td>A.O.B and Closure</td><td>There being no other business, the meeting was adjourned.</td></tr>
</table>

Kibimbiri

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 18/11/2019				
Project name: MATANDA - GACHO IRRIGATION PROJECT				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ initial
Fabith Tumwesigye.	Kyakatarangi	0777584815	Fabith.
Emmanuel Nkira Goro	Kyakataro gi.	0782688855	NKero
Aliwatwo Aisha	Kyakataragi.		
KYABISUMA MISIUS	CUMBUGU	0775292297	Midus
KYIKUHIERE PASKA	CUMBUGU	0779037873	Paska
Tugyasigura Allice.	KyaBiriri		Allice
Mundekye Feresita	Kyakatarangyi	0783389449	Feresita
Kemirembe Imaculeti	Kyakatarangyi		Imaculeti
Wini Tumwesigye	Kyakatarangyi	0783167086	Wini
Ampeire Wini	Kyakatarangyi		Wini
Kyarikunda Praize	Kyakatarangyi		Prize.
TUMUHERWE	HoPU	0774938038	HoP
Emilly mugisha	Rwerere	0778882547	Emily
TUMURAMYE ANNET	KYAKATARANGA	0781139405	

Kibimbiri

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:					
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date:	18/11/2019				
Project name: MATANDA ENTANGO IRRIGATION PROJECT					
Proponent: MWE					

Name of person	Designation	Contact (Tel/email)	Sign/ initial
Zaribwende Loy	Kyakatarangi	0777732541	
Turyahebwa Servia	Kibimbiri	0773362073	
Ebinaa habimana	18/11/2019 Kibimbiri	0773457215	[signature]
Harisi tukahabwa	18/11/2019 nyarurambi	07 — —	[signature]
turyashemerwa. J.	18/11/2019 kibimbiri	— — —	[signature]
Kyomuhendo Lovis	councilor	0772947879	[signature]
Magyera Badru	Kyakatarangi	0772-057670	[signature]
Byamugabi medard	Kyakatarangi	0783467998	medard
Akankunda Elias	Kibimbiri	0789920607	[signature]
Kashangirwe Stephen	Nyarurambi	0786512247	[signature]
MUGISHA EPHRAIM	Rwerere	0773205690	[signature]
Tumushabe Gouda	Kibimbiri	~~0773139333~~	[signature]
SATURDAY RICHARD	Rwerere	0773139333	Saturday
Rwandekeire Medard	Nyarurambi	0787828621	[signature]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Kibimbiri		
Purpose of consultation (*tick appropriate box*):	Scoping: ☐ Sensitisation: ☐ Environmental Audit: ☐	ESIA: ✓ RAP: ☐ Other (specify):	
Date:	18/11/2019		
Project name: MATANDA - KYENGO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
BAHATI SWAIBU	Ibambiro	0774753221	Ow.S
BAMUGISHA LAMBERT	NYABUBAMBARI	0773507232	[illegible]
N'GOBOLA ELIBALD	Ruserere	0773206054	[illegible]
NINSIIMA SOSTINE	Kibimbiri	0778148797	[illegible]
Zibangye ariver	kyakatarange	0778148797	arivera
Twikyirize	ANNAH	0785458522	anna
KIBAKORA GADIVINA	Rwerere	—	Kir[illegible]
Twinomujuni Jackline	Kyakatarangi	—	T[illegible]
BONIGABA ANNAH	Rwerere	—	Annah
KEMIGISHA FRIDA	Rwerere	0774214180	Kemigisha
KYABISIMA JEMIMA	Rwerere	0778806111	Kyaisi[illegible]

MWE – ISO 9001:2015, ISO 14001:2004 and OHSAS 18001:2007 certified company.

Meeting 11: Kibimbiri parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Kibimbiri parish **Date:** 19.11.2019 **Venue:** Kibimbiri Parish **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by chairperson LC1** 4. **Communication from LCIII** 5. **Communication from subcounty chief** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 thanked the community members for attending and welcomed the consultant team to Kibimbiri. He thanked them for considering to consult the community and also urged the community to always respond positively whenever called upon on matters concerning the project.	
3. Remarks by LC III	He thanked the government for the irrigation scheme and for considering and welcomed the team, appreciating their efforts in engaging the community and requested that the engagements continue even during the construction phase such that community and leaders participate actively throughout all the phases.	
4. Communication from Subcounty chief	The chief mentioned that Kibimbiri is the food basket for the district and so the irrigation project will boost agriculture. He thanked the ministry fir the project and urged community to embrace and support it.	
5. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at informing the community about the project and identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.	
	Discussion	

6. Discussions by members present	Question: will the pipes pass through houses, and if yes will there be compensation? Response: houses will be avoided as much as possible and where unavoidable, compensation will be made for eligible property Question: how much will compensation for graves be? Response: a resettlement action plan will be prepared to guide land acquisition and resettlement of affected person; the procedure will be communicated to the affected persons. Question: will there be a chance for community members to be employed on the project? Response: community will be made aware of job availability and guidance will be provided on how to apply
	Recommendations by community
	i) Compensation to those affected should be done early enough and adequately.
A.O.B and Closure	There being no other business, the meeting was adjourned.

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	KIBIMBIRI			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 19.11.2019				
Project name: MATANDA - E MEKO IRRIGATION SCHEME				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ initial
ASIIMWE ABIA MPORANTI	P/CHIEF FOR KIBIMBIRI	0778821699	[signature]
KYEMOEL GODLY	Sector social ser. & UCPLC III K/S	0788554536	Kyemoel
ALINAITWE DIANAH	SOCIOLOGIST - AIR WATER EARTH LTD	0777725651	[signature]
Kamusiime Ronah	Sociologist - MWE/WfP	0783389133 0701787556	[signature]
NATUKUNDA NELSON	c/p LCIII IGHIHI S/C	0782558320	[signature]
Pacifique TB Emmanuel	SAE/Kanungu	0772422021	[signature]
TWINAMASIKO DENIS	H/TR KIBIMBIRI PARENTS'S	0775638575	[signature]
SENGOMA E K JOHN	C/MAN LC I RUGYAOZA	0779665817	[signature]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Kibimbiri		
Purpose of consultation (*tick appropriate box*):	Scoping: [ ] Sensitisation: [ ] Environmental Audit: [ ]	ESIA: [✓] RAP: [ ] Other (specify):	
Date: Kibimbiri - 18/11/19			
Project name: MATANDA - ENGAKO IRRIGATION SCHEME			
Proponent: MAAIF			

Name of Person	Village	Contact	Sign/ initial
KARENZI KARORI	Kirurumu A.	0774029848	Karenzi K.
Tumwine BEN	Rwererere .B.	0782154558	Ben
Besigye Edison	K. Rurumu B.	0771864542	Besigye
Bagambe Ramon	Omwirabagiza	07855 198	Bagambe
Byabarintojo Sebastian	Kirurumu A	0789264808	[illegible]
Musinguzi Wellar	RWERERE A	0775891001	[illegible]
Mariya Tugumesi	Group Farm A		[illegible]
Tukamuhebwa Good	Group farm B	0780665380	[illegible]
MPEIRWE RENA	Group Farm A	0787747880	
NZABANITA PIPIP	KiRURUMA A	0785574468	NZe
Barigirana Appollin	Group Farm A		[illegible]
Tuhirirwe Edonace	Group Farm A	—	edonace
Mary Bwangirona	Group Farm A	—	Mary
Nahamya Sarah	Kirurumu B	—	Sara
Kyolinpa Edwina	Group Farm A	0776809583	edwina
Byaruhanga Costansiya	Kirurumu A	—	Costansiya
Kyarimpa Peace	Kirurumu A	—	Peace

AWE is ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified company.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: kibimbiri

Purpose of consultation (*tick appropriate box*):			
Scoping:	☐	ESIA:	☑
Sensitisation:	☐	RAP:	☐
Environmental Audit:	☐	Other (specify):	

Date: 18.11.19

Project name: MATANDA ENGECO IRRIGATION SCHEME

Proponent: MWE

Name of Person	Village	Contact	Sign/ Initial
Nzono Vastina	Kiruruma A	0782430518	
MATSIKO HABERT	Omwirangizo	0788321495	Matsiko
LINBYEBWA JULIUS	GROUP F. A		[illegible]
BARUSHA VIZENT	G. FARM A	0788040725	Barusya
AGABA JACKSON	Kiruruma A	0788781596	[illegible]
Agaaba Richadi	Kiruruma B	0782259628	Agaaba
Tumuhairwe Vanancio	Kiruruma B	0775703916	Tumuhairwe
TURYAHABWE SILVER	KIRURUMA A	0778711002	[illegible]
Mukiga Nelson	Matanda	0773643040	[illegible]
MUGANGIZI KEREST	Group Farm A	0774718551	Mubo.
BWAGUNGIRA GODFREY	OMWIRANGIZO Village	0773361151	[illegible]
TWINOMUGISHA SILVER	GROUP FARM A.	0778545739	S.Twin

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: Kibimbiri			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:
	Sensitisation:		RAP:
	Environmental Audit:		Other (specify):
Date: 19/11/2019			
Project name: MATANDA – ENGARO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
KOBUSHESHE VERONICA	RUBERERE C	0782586710	Kobusheshe
Cinkabashekye	Group Farm (B)	0779221939	[illegible]
Kamuhanda Gerasius	Group farm A	0785163790	Gerrs
Tumushabe Hope	Kirurumu A	—	Hope
Babasherekye Beatrice	Kirurumu B	—	Beatrice
Ahimbisibwe Joreosa	B Group farm A	—	Joreosa
Nyankoko Jackline	Kirurumu B		Jackline
MANI BAGUMA	G	0787685172	Man
ASIIMWE ABIA	Kibimbiri Parish	0778821699	Asiimwe
ILYENOEL GODLY	KIRURUMU "A"	0788554536	Kyenoel
ALINAITWE DINAH	AR WATER EARTH LTD	0779725651	[illegible]

AWE is ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified company.

Meeting 12: Mashaku parish

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Mashaku parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 19.11.2019</td></tr>
<tr><td>Venue: Mashaku C.O.U</td></tr>
<tr><td>Stakeholder: Mashaku parish</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Remarks by parish mobilizer
5. Communication from the consultant
6. Discussion by members present
7. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 welcomed the consultant's team and thanked the community members for attending the meeting. He thanked the government for the project that is expected to greatly benefit the community since most of them are farmers. He urged the community to ask questions and understand the project better so they can spread the good news to other people that have not been able to attend.</td></tr>
<tr><td>3. Remarks by parish mobilizer</td><td colspan="2">He thanked the government for the proposed irrigation scheme mentioning that will enable farmers increase their crop yield and income. He pledged support in terms of mobilization of communities for the project and called upon all leaders to cooperate for successful implementation of the project.</td></tr>
<tr><td>4. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project.

She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
<tr><td rowspan="2">5. Discussions by members present</td><td colspan="2">Discussion</td></tr>
<tr><td colspan="2">Question: When will construction start?

Response: The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid pandemic, change in dam site, and additional scope of services thereunder, the start is now planned for 2024.</td></tr>
</table>

	Question: Will the water be free or farmers will pay a fee to use it? Response: the water users will pay a small amount of money that will be used in maintenance and operation of the system Question: If houses or crops are affected by the system, will they be compensated? Response: all eligible property that will be affected by project infrastructure will be compensated for. A plan will be prepared to guide land acquisition. Question: will the project provide water for other uses like domestic use? Response: the water provided by the project will be for irrigation purposes only. The government will arrange for provision pf water for domestic use through other projects.
	Recommendations by community
	i) Compensation for affected property should be done before construction works start ii) Local community should be given employment opportunities during construction.
A.O.B and Closure	There being no other business, the meeting was adjourned.

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	MASHAKU PARISH			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date:	19/11/2019			
Project name:	MATANDA - ENGOZO IRRIGATION SCHEME			
Proponent:	MWE			

Name of person	Designation	Contact (Tel/email)	Sign/ initial
1 Shanbumu	Mashaku II	0783167260	J.
2. KISODA PEARSON	MASHAKU II	0788490620	[illegible]
3 Mwarurga J	MASHAKU II	0787792593	[illegible]
4 Emmanuel	MASHAKU II	0780724316	[illegible]
5 AMBROSE NIWAGABA	RWEMISHINYA	0788 308 307	[illegible]
6 - AHIMBISIBWE GEORGE	MASHAKU II	0771-678579	[illegible]
7. Rahuka Fred	Mashaku	—	Rahuka
8 Turyahikayo M.	Mashaku	—	Turyahikayo
9. AHIMBISIBWE HARBERT	MASHAKU II	0775167744	Herbert
10. TABARUKA IVAN	MASHAKU II	0772 688539	[illegible]
11 JANUARY LAWRENCE	MASHAKU II	0775879457	January
12 TUHAME JAMES	Rwemishinya	0784408243	James

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MASHAKU II

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:					
Purpose of consultation (*tick appropriate box*):	Scoping:	☐		ESIA:	☑
	Sensitisation:	☐		RAP:	☐
	Environmental Audit:	☐		Other (specify):	
Date: 18.11.19					
Project name: MATANDA - BUGEKO [illegible]					
Proponent: MLG					

Name of Person	Village	Contact	Sign/ initial
1) Kiconce ... ridia	Kazindiro	0784680575	[illegible]
2) Karwasha	Rwemishinya	0779960369	Caus
Rongino	M	0789685044	
Anniet Katurasbi		0773571368	Anniet
Iramurangi Jane	Mashaku II	0788647088	J
Nyanduro Dono	Rwemishinya	077187153o	nyanduro
Happiness Friday	Rwemishinya		
Winnie Muhanda	Rwemishinya		
Kagorora	Mashaku II		Patrison
Amos Mpamizo	Rulemishinya	0786556687	Amos
Musiime pesley	Rwemishinya	0786556687	[illegible]
Sayuni Gurori	Rwemishinya	,,	
Mpumwire Ridia	Rwemishinya	0772920574	Ridia
Biriiso John	MASHAKU II	0784568622	[illegible]
KANYOMOOZI MOSES	MASHAKU II	0771932312	Kanyomoozi
Kyatuheire	Brendah		[illegible]
Byamumiaso	Zefirim	0775628369	[illegible]
Mutesigensi Salvano	Mashaku II	0781163355	[illegible]

AMEe ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified company.

MIASHAKU

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA: ✓	
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 18/11/2017				
Project name: MATANDA - ENGANGO [illegible] solar				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ Initial
Mukwenda James	Mashaku II	0774279845	[signature]
Ampomugisha Evans	Mashaku II	0778654863	[signature]
Twesigye Rudovik	Mashaku	0789410930	KRTwesigye
Namanya Nzeyiwa	Mashaku II		[signature]
Mauzi Hillary	Kazindiro	0788054496	[signature]
Abaasa Abraham	[illegible]	0787865624	[signature]
Bakampenk [illegible]	Rwemishinga	0778824925	[signature]
Nabasa Amon	Kazindiro	0787371806	Amon
ANDREW AINAMANI	Kazindiro	0775780491	[signature]
TURYAHEBWA JOAN	MASHAKU II	0788900093	Turyahebwa
TUHAME JAMES	Rwamishinga	0784408243	[signature]
Busingye orivia	mashaku		

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ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:	MASHAKU			
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	
Date: 19/11/2019				
Project name: MKTANDA - EHENGO IRRIGATION SCHEME				
Proponent: MWE				

Name of person	Designation	Contact (Tel/email)	Sign/ Initial
1. Jackline Bukoro.	Mashaku II		Jackline
2. Alice mutaajo.	mashaku II		alice
3. Nsheija Julius	Kazindiro		Julius
4. Kamanuma Ban.	Ruemshinga		Bm L.K
5. MAAMWESIGWA LEVI	kazindir		levi
6. Turyamwesimira Happiness	Rwemishinga		happiness
7. Atuheire Racheal	Kazindiro	0786527734	[illegible]
8. NIWAGABA CALEB	KAZINDIRO	0777247602	Caleb
9. KIOKUSHABA AGATHA	KAZINDIRO	0785056156	[illegible]
KURIKA RHODAH.	RWEMISHINGA	0771656714	Rhodah.
BAGONZIRABE JOLLY	MASHAKU II	—	Jolly
12 Tumusiime Juliet	Rwemishinga	0789472292	Tumusiime
12. Biryabaho Johnson	Rwemishinga	0773116082	[illegible]
13 ORIKIRIZA PAUL	mashaku II	0779931218	[illegible]
14 TUMUHIMBISE NASTOR.	KAZINDIRO	0771441774	[illegible]

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Meeting 13: Kigarama Parish

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Kigarama parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 20.11.2019</td></tr>
<tr><td>Venue: Kigarama Primary School</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Communication from LCIII
5. Communication from parish mobilizer
6. Communication from the consultant
7. Discussion by members present
8. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and was followed by self-introduction of the members in attendance.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The chairperson thanked the community members for attending and welcomed the consultant team, thanking them for considering to consult the community.</td></tr>
<tr><td>3. Remarks by LC III</td><td colspan="2">He thanked the government for the project and welcomed the team, appreciating their efforts in engaging the community and requested that the engagements continue even during the construction phase such that community and leaders participate actively throughout all the phases.</td></tr>
<tr><td>4. Communication from parish mobilizer</td><td colspan="2">The parish mobiliser also welcomed the team and thanked community members for turning up. He called upon fellow leaders to cooperate and mobilise communities whenever called upon to ensure that the project studies are completed so as construction of the scheme starts on time.</td></tr>
<tr><td>5. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project.

She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at informing the community about the project and identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
<tr><td></td><td colspan="2">Discussion</td></tr>
</table>

6. Discussions by members present	Question: will the pipes pass through houses, and if yes will there be compensation? Response: houses will be avoided as much as possible and where unavoidable, compensation will be made for eligible property Question: which crops will be grown in the scheme? Response: farmers will be free to produce the crops of their choice; however, support will only be provided for the development of the targeted value chains. Response: Will the water be free or farmers will pay a fee to use it? Response: the water users will pay a small amount of money that will be used in maintenance and operation of the system Question: will there be a chance for community members to be employed on the project? Response: community will be made aware of job availability and guidance will be provided on how to apply
	Recommendations by community
	ii) Compensation to those affected should be done early enough and adequately.
A.O.B and Closure	There being no other business, the meeting was adjourned.

ATTENDANCE REGISTRATION SHEET

Name of Agency/Stakeholder: Karoni _ Kagarama					
Purpose of consultation (tick appropriate box):	Scoping			IESIA	✓
	Sensitisation			RAP	
	Environmental Audit			Other (specify)	
Date: 20.11.19					
Project name: MATANDA - GAGAGA IRRIGATION SCHEME					
Proponent: MWE					

Name of person/ official met:	Designation	Contact (Tel)	Sign/ Initial
1. TUMWEBAZE DANIEL	KIBARAMA CELL	0776967218	
2. KANYESIGYE CALEB	KARONI CELL	0782849580	
3 Byamaisha Abed	K.BARAMA CELL	0789863703	Abel
4 Kyarisima Sikora	Buyunda CELL	0789869728	
5. Katesigwa Benon	Kamukondo cell	0775500327	
6 Tumusiime Joram	Kibarama Cell	0781819488 0776402651	
7 Tukahiirwa Fredi	Karoni Cell	0784816510	
Nuwagaba Joshua	Buyundo Cell	0772027700	
8 CHANCE JENIPER	Karukondo CELL	0785618678	CHANCE
9 TWANGYE EMMANUEL	BUYUNDO C/MLC I	0782184850	
10 Kahwine Patrick	Kahama cell		

Air Water Earth
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ISO 9001:2015

Stand. Doc No.: AWE/024

ATTENDANCE REGISTRATION SHEET

Name of Agency/Stakeholder: Karoni - KAGARAMA

Purpose of consultation (tick appropriate box):			
Scoping		ESIA	✓
Sensitisation		RAP	
Environmental Audit		Other (specify)	

Date: 20-11-2014

Project name: MATANDA - ONENGO IRRIGATION PROJECT

Proponent: MWE

Name of person/ official met:	Designation	Contact (Tel)	Sign/ Initial
Tushabomwe Scovia	Buyundo	—	Scovia
Shaaka Patrick.	Kharoni Cells	0787831498	[signature]
Busingye Grace	Karoni "	0782326047	Busingye
TURINAWSINGURA CHRISTOPHER	KARUKONDO "	0779905595	[signature]
KICONCO GRACE	Buyundo "	0772921691	KICONCO
Tushemereirwe Sifah	Samaria "	0781615113	[signature]
Kabunde Justus	Karoni cell	0784265525	Katunde
Byomuhangi GARD	KARUKONDO Cell	0783496528	[signature]
MBIRIRWE GRACE	KARONI CELL	0776747012	Grace

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ISO9001:2008

Stand Doc No.: AWE/004

Meeting 14: Rushaku

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Rushaka parish **Date:** 20.11.2019 **Venue:** Rushaka C.O.U **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	**1. Opening Prayer** **2. Self-Introduction** **3. Welcoming remarks by chairperson LC1** **4. Communication from District Agricultural Officer** **5. Communication from the consultant** **6. Discussion by members present** **7. A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The chairperson welcomed the consultant team and thanked the community members for turning up for the meeting. He called upon residents to pay attention, understand the project and thereafter share the information received with those that were unable to make it to the meeting.	
3. Remarks by District Agricultural Officer	The District Agricultural Officer thanked the local council leadership for mobilization and community residents for attending the consultation meeting. He gave a brief background of the project and the areas the scheme will cover. He informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him. He then called upon the community and local leadership to continue supporting the project and respond positively whenever called upon on matters regarding the project.	
4. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at informing the community about the project and identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.	

	Discussion
5. Discussions by members present	Question: Will all the people within the command area be compensated when constructing the irrigation scheme: Response: Compensation will only be made to property that will be affected during the construction of infrastructure that will support the project e.g storage, distribution etc, and not the entire area. Question: When will compensation start? Response: A plan will be prepared to guide land acquisition and the exercise will be conducted with involvement of the LC1s, parish and subcounty mobilizers and the Task force. The actual period of compensation will be communicated to affected persons. Question: when will the project start? Response: The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid pandemic, change in dam site, and additional scope of services thereunder, the start is now planned for 2024. Question: Will the water be free or farmers will pay? Response: water users will pay a small fee that will be used for maintenance of the system. Question: who will manage the scheme during its operation? Response: the government shall, in consultation with relevant stakeholders such as MAAIF, local government and farmers come up with the appropriate system to manage the scheme.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	MASHOKO – RUSHANGA PARISH				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 20.11.19					
Project name: MATANDA - ENENGO IRRIGATION SCHEME					
Proponent: MWE					

	Name of Person	Village	Contact	Sign/ initial
1	AMIHIHI RASHID	Nyabushoro	0783625107	[illegible]
2	NIWABINE SAMSON	MASHOKO	0781025233	[illegible]
3	MUHWEZIJOHN BOSCO	Bosco Mashoko	0785707632	BOS
4	Niwamunungabe Polipia	Nyabushoro	0789863547	[illegible]
5	Kemeza Yasinta	Nyabushoro	0779515377	Vasita
6	Tindyebwa Innocent	MASHOKO	0786025075	[illegible]
7	Tumusangise Paplina	Nyabushoro	0787369467	[illegible]
8	KIMASI APOLLO	MASHOKO	-	APOLLO
9	KAFURUKA FRANCIS	KIRURUMA	-	[illegible]
10	Kembabazi Susan	MASHOKO	0777487606	susan
11	AINEMBABAZI JACKLINE	Nyarubugye	0780233057	[illegible]
12	Kyarisiima Kashungi	Kiruruma	0783625102	[illegible]
13	MUSISI RICHARD	Nyarumwinye	0772757853	Musisi
14	Sunday Robert	Mashoko	0779192927	[illegible]
15	Kakuruza Benon	Mashoko	0776931627	[illegible]
16	Tukamushaba Gorrette	Nyabushoro	0789186427	T.Gorr
17	Kyarisiima Maria	Nyabushoro	0784667095	maria

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RUSHAKA

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: RUSHAKA PARISH			
Purpose of consultation (*tick appropriate box*):	Scoping: ☐ Sensitisation: ☐ Environmental Audit: ☐	ESIA: ☑ RAP: Other (specify):	
Date: 20/11/19			
Project name: MATANDA - BIHANGA IRRIGATION SCHEME			
Proponent: MWE			
Name of Person	**Village**	**Contact**	**Sign/ Initial**
Twebeyo Kefa			
Kobusheshe Patricia			
Kiiza Bosco			
N Tom			
Akampurira Seonia	Nyamukura		
Kyomuhendo			
Opera Amon	Kiruruma	0778569353	Amon
KIZZA BOSCO		0785963224	
KACHONGO WINNIE	Machoko		
Byabinome Benon	Nyakayyere	0787042653	
Tohimbise Moses	Machoko	0781998936	
Mubangize Ivan	Kiruruma.		
Bunagi Isaac	Kiruruma		
Barongenda Benon	Kiruruma		Benon
MBABAZI ELIAB	LARONI	0771433557	
ORISINGA ALEX	NISHENYI	0783617149	ALEX
Muhabozi Joshua.	Kigarama.	0783373971	
Mubangizi Elly	Kayenje	0787494204	

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Meeting 15: Nyakatunguru

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Nyakatunguru parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 21.11.2019</td></tr>
<tr><td>Venue: Rwenyerere C.O.U</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Remarks by Mayor
5. Communication from District Agricultural Officer
6. Communication from MWE Representative
7. Communication from the consultant
8. Discussion by members present
9. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 welcomed the team led by the District Agricultural Officer and thanked the community members for attending, highlighting that the community has been anxiously waiting for relief and the project has brought hope to farmers.</td></tr>
<tr><td>3. Remarks by Mayor</td><td colspan="2">The Mayor thanked the government for the project highlighting that it has for long been waited for, considering that dry seasons greatly affect farmers in area. He urged the community and LCs to cooperate and support the project for it to be implemented successfully.</td></tr>
<tr><td>4. Communication from District Agricultural Officer</td><td colspan="2">The DAO thanked the community residents for turning up for the meeting and local council leadership for the support in mobilization. He gave a brief background of the project, the command area, and also informed the meeting of a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him.

He called upon the support of local leaders and the community for successful implementation of the project.</td></tr>
<tr><td>5. Communication from MWE Representative</td><td colspan="2">She thanked the community for the support rendered to the project and the District and local council leadership for mobilizing the communities in support of the project. She thanked the community for turning up and urged them to be cooperative and give the right information to the assessment teams to enable the ministry plan better.</td></tr>
</table>

6. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
7. Discussions by members present	**Discussion** Question: how will the farmers get the water, will each one of them have a tap where they draw water and irrigate their gardens? Response: the system will incorporate equipment that will irrigate the farmers itself, there will be no taps where farmers fetch water. Question: will the scheme be permanent? Response: Yes, it will. Question: how will the local unemployed people benefit from the project Response: during construction, job availability will be communicated to the public through appropriate media and guidance will be given on how to apply. During operation of the scheme, water will be available and the unemployed people can fully engage in farming. Question: will people be allowed to use the land where pipes will pass? Response: the land where the pipes or any project infrastructure will pass will be acquired by the project and a safe distance will be demarcated beyond which no activity should be done in order to prevent damage to the system. **Recommendations by community** i) Compensation to those affected should be done early enough and adequately. ii) Local community especially youths should be given priority during recruitment of workers.
A.O.B and Closure	There being no other business, the meeting was adjourned.

NYAKATUNGURU

ATTENDANCE RECORD SHEET

Name of agency/stakeholder/community:					
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	

Date: 21.11.19

Project name: MATAMBA - GWENGO UGANGA GAM [illegible]

Proponent: MWG

Name of person	Designation	Contact (Tel/email)	Sign/ initial
Turyatemba Vanansio	Karama	0777115096	[signature]
Bitungwamugisha Selestino	Karama	0775580257	[signature]
Akampurira Elias	Kiruyu	[illegible]	[signature]
Kasiga Onesmus	Karama	0779863610	Kas[illegible]
SABITI STEPHEN	KABUKWENDA	0773447056	[signature]
NAHABWE GEREVAZIO	Kinshunju	0778278003	[signature]
FRIDAY CHRISTOPHER			
KAMUSIIME SYLVIA	KARAMA	0773038880	Kamusiime
BUSINGYE EDVINA	KARAMA		Busingye
Kendaba purisira	Karama		purisira
Kanyana mary	KARAMA		Kanyana
NATUKUNDA ROVIS	KARAMA		ROVIS
Byomuhangi Richard	Kinshunju	0778956299	Richard
BUGAANA SAMUEL	BUGONGO	0772920979	[signature]
KARYEIJA WILBERFORCE	KABUKWENDA	0775061091	[signature]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Nyakabungabira - Parish				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 21-11-19					
Project name: MATANDA - EKONGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Nyerimpa Olivia	Nyamwengabira	0779699739	
Twini E	Nyamwengabira	0772012330	
Baraba James	Karama	~~0774737462~~ 0774737462	
Jambo BENJAMIN	\	0777248983	
Kamushana Fulgensio	Karama	0785644207	
Mwasibwa Costance	Kishanda	0774121690	[signature]
David Kalanzi	AWE	0751657384	[signature]
MUNYAKARAGWE John	Nyamwegabira	0778 0785539950	[signature]
TURYAMUHAKI JONATHAN	KISHUNJU	0786288047	[signature]
Rugarofu yosia Bilimwoom	c/Person. Karama	0774644727	[signature]
Matsiko onesmus	Karama CL		[signature]
MUTESIGWA ALEX	KIRURUMA CELL	0774154685	[signature]
Katembeza Simon	Kishunju cell	—	[signature]
SIMGURA Innocent	Karama cell	0774035956	[signature]
Mbonimpa Samson	Kishanda Cell	0773076764	[signature]
ASHIMWE ROBERT	Nyakamwegabira	—	[signature]
Kayesiga Francisco	Kishunju Cell	0784380042	[signature]
Twinogabirwe Alice	Karama cell	0778423378	Alice

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NYAKATUNGURU				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 21.11.19					
Project name: MATANDA – EPONGO IRRIGATION PROJECT					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Kamuhanga Dariega	Kisunzu	0781031522	
Jenifeta Kobikubura	Karama	—	—
Kamashule Scholar			
Asiimwe Robert			
Katimba T			
Tugumisirize N			
Ziarinwirimbe C			
Nshekanabo Francis	Kishanda	0777801873	
Nyanabo Andrew	Nyamwegabira		
AMPIIRE GRACE			
Mutabazi J.	Karama		
TUKAMUSHABA ELIZABETH		0783572011	Mutabazi
Tadimwebwa Evas			
Byangire Luka			
Ngabirano Deus	Karama		
Kobusingye Vashina	Kiluaju		
Musiimenta Shallon	Karama		
Kyarisiima Jane	Nyamwegabira	0783417254	Jane
Byomuhangi B.	Karama	0786556994	Black.

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Meeting 16: Nyakatunguru parish

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Nyakatunguru parish **Date:** 21.11.2019 **Venue:** Ndeeba C.O.U **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	**1. Opening Prayer** **2. Self-Introduction** **3. Welcoming remarks by chairperson LC1** **4. Communication from area councillor** **5. Communication from District Agricultural Officer** **6. Communication from MWE Representative** **7. Communication from the consultant** **8. Discussion by members present** **9. A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 thanked the community members for attending and welcomed the consultant team and representative of MWE to the parish. He urged the community to cooperate with the government to ensure that the project is implemented successfully.	
3. Remarks by area councillor	She thanked the government for the irrigation scheme and for sensitising the community about the project. She welcomed the team and encouraged them to continue engaging community such that they and their leaders participate actively throughout all the phases.	
4. Communication from District Agricultural Officer	The District Agricultural Officer thanked the local council leadership for the support in mobilization and community residents for turning up for the meeting. He gave a brief background of the project and the areas the scheme will cover. He informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him. He mentioned that the scheme is aimed at supporting the farmers and helping them improve their yields especially during the long dry seasons. He called upon the community and local leaders to continue cooperating with the government to ensure that the project is implemented successfully.	
5. Communication from MWE Representative	She thanked the District and local council leadership for the support shown towards the project. She thanked the community for turning up and urged them to	

	be cooperative and give the right information to the assessment teams to enable the ministry plan better.
6. Communication from the consultant	The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.
7. Discussions by members present	**Discussion**
	Question: Will the water be free or farmers will pay? Response: water users will pay a small fee that will be used for maintenance of the system. Question: Will all the people within the command area be compensated when constructing the irrigation scheme: Response: Compensation will only be made to property that will be affected during the construction of infrastructure that will support the project e.g storage, distribution etc, and not the entire area. Question: When will compensation start? Response: A plan will be prepared to guide land acquisition and the exercise will be conducted with involvement of the LC1s, parish and subcounty mobilizers and the Task force. The actual period of compensation will be communicated to affected persons. Question: Will there be job opportunities for the local community? Response: jobs available and skills required will be communicated to the public and guidance will be given on how to apply.
	Recommendations by community
	i) Compensation for affected property should be done fairly and before construction begins ii) Local community especially idle youths should be given priority during recruitment.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NDEEBA – NYAKATUNGURU				
Purpose of consultation (tick appropriate box):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 21.11.17					
Project name: MATANDA – EHENGO IRRIGATION PROJECT					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
BARAGERE GEORGE	NDEEBA NYAKATUNGURU	0772096571	Baragere George
Ahumbisibwe Henry	NDEEBA Nyakatunguru	0781980746	Henry
NTAHONTUYE P.	KINYAMASHE.	~~0785~~ 0785461259	
AKANKWASA IVAN	NDEEBA NYAKATUNGURU	0771428290	[illegible]
TURINAWE GIDEON	Ndeeba Nyakatunguru	0774718191	[illegible]
Balyamengure moses	Kinyamashe/Kamitungu	0772472380	[illegible]
Betunga Lawrence	NDEEBA NYAKATUNGURU	0776952606	Betunga
Kacungira	NDEEBA NYAKATUNGURU	0782300388	[illegible]
Kyomuhendo Oliver	Ndeeba nyakatunguru	0773648378	Oliver
Adiah Twinyabonwe	Ndeeba nyakatunguru	0779699944	AT
KAWEESA Eliphaz	Ndeeba - Kinyamashe	0772347311	[illegible]
ZEBUKIRE STANLEY	KINYAMASHE NYAKATUNGURU	0782799762	[illegible]
Kobusingye christine	NDEEBA nyakatunguru	0786556100	[illegible]
KOBUSINGYE peace	NDEEB nyakatunguru	- - - -	P.
Tumushabe Evaj	NDEEBA nyakatunguru	0787476447	Evaj
Kankwasa Hope	NDEEBA nyakatunguru	- - - -	Hope
B. Siizi KATEBE	NDEEBA nyakatunguru	0779 55 ee 66	[illegible]
Twinamujuni	NDEBA	0775670884	[illegible]
BIRUNGI AISHI	Ndeeba nyakatunguru	0775828951	Birungi

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: NDG EBA – [illegible]					
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑	
	Sensitisation:	☐	RAP:	☐	
	Environmental Audit:	☐	Other (specify):		
Date: 21-11-19					
Project name: MATANDA ENGENGO IRRIGATION PROJECT					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
MAFUTA ROGERS	NDEEBA	0772563494	[illegible]
TOMSON Turyahabwe	NDEEBA	0777081184	Turyahabwe
Haning Turyahebwa	Ndeeba	0775777822	H T
Musinguzi [illegible]	Ndeeba	0772 950 238	[illegible]
Turyahikayo Edith	NDeeba	0787213202	Edith

Meeting 17: Bihomborwa

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td>Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Bihomborwa Ward
Date: 22.11.2019
Venue: Buzaniro Trading center
Compiled by: AD, GB</td><td>Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Communication from area councillor
5. Communication from the consultant
6. Discussion by members present
7. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 thanked the community members for attending and welcomed the consultant team to Bihomborwa. He pledged support for the project and called upon community to cooperate with the government in order to bring development into the area.</td></tr>
<tr><td>3. Communication from area councillor</td><td colspan="2">The area councillor welcomed the consultant's team and thanked them for involving community in early stages of the project. He called upon community to always turn up for meetings so that they can contribute ideas to projects that will benefit their area.</td></tr>
<tr><td>4. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project.

She gave a brief description of the project, mentioning that the scheme is aimed at supporting farmers and helping them improve their yields especially during the long dry seasons
She informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by the District Agricultural Officer.

She mentioned that the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
</table>

	Discussion
5. Discussions by members present	Question: Will the project include training of farmers on better farming methods and timing seasons? Response: Yes, the project will be implemented by MWE together with Ministry of Agriculture and other sectors to ensure that farmers are trained in farming methods that will enable them benefit from the irrigation scheme. Question: will the irrigation water be free or farmers will pay for it? Response: water users will pay a small fee that will be used for maintenance of the system. Question: will the project also bring free pesticides or herbicides to the farmers Response: the project will sensitize farmers on pest control and advise on effective pesticides and herbicides. Response: will the irrigation scheme only benefit those farming in groups or individual farmers will also access it? Question: the scheme will benefit both individual and group farmers. However, to effectively distribute water and ensure maximum efficiency of the system, farmers in the command area may be advised to organise themselves into groups whenever possible. Question: will there be possibility of employing local community during construction? Response: yes, the contractor shall be required to employ local people depending on job availability and skills.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Rwenyerere – Bitembeera		
Purpose of consultation (*tick appropriate box*):	Scoping: [ ] Sensitisation: [ ] Environmental Audit: [ ]	ESIA: [✓] RAP: [ ] Other (specify):	
Date: 22.11.19			
Project name: MATANDA - ENGAGO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
NTARE CYPRIANO	KINYASHOHERA	0772194095	[illegible]
NYAMBERE M	Bubare	-	Nyambere
Bahirwa Jackson	Bubare	0775625215	
Musekura Godwin	Bubare	0778873857	[illegible]
BAKAMA INNOCENT	RWENYERERE B	0777082221	[illegible]
TUKAMUSHABE ABRAHAM	//		
		0783230419	AB
BASHUNWE ABEL	KINYASHOHERA	077123733 6	[illegible]
TUSHABE GIDEON	KINYASHOHERA	0782767021	[illegible]
NYIRAHABINEZA LEHSKANIA	RWENYERERE B	———	
AGABA MOSES	BUBARE CELL	0775632001	Agaba
KYOMUHENDO JOHN	Bubale Cell	0788056103	John
Aninkiriza Dennis	Bubale Cell	0784047922	Dennis
TUHAIRWE FRANK	KINYASHOHERA	0773647410	[illegible]
Bagira Roza	Rwenyerere	0774218863	Bagira
TUMWEBAZE Lucky	Rwenyerere	0786061967	Lucky
ATUHEIRE ANGEL	Rwenyerere		Angel
AKAMPURIRA RUTH	Bubare	0782288314	Ruth
ATURINDA MOSES	Bubare	0775862343	Aturinda

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Rwenjeera – Bihomborwa				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 22-11-19					
Project name: MATANDA – GHENGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Rev Ephraim Kwizeera	Kanyabihohera	0782957568	Rev [illegible] Kwizeera
Akakwasa Ilias			
Orishaba Prudence	Bubale	0782010968	[illegible]
Niwamanya Judith	Bubale		
Nibenawe Caroline	Bubale		
Kyarisiima Sharon	Rurembyerere		
Peace Kwizera	Bihomborwa		
Kyomuhangi Babra	Bubare	0784227604	Babra
Arinaitwe Richard	Rwemmucu B	0782983829	Arinaitwe
Kwesiga Moses	Kwenyerere 'B'	0774 434315	[illegible]
Ainomugisha Allen	Bubale		Allen
Rujwenda Uraria	Rurembyerere B	078[illegible]012513	uraria

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KINYANGWE – BITHAMBORA				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 22.11.19					
Project name: MATANDA [illegible] IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Jeninah Tindikaho	Rwemisisi		J.T.
Sunday Javia	Kinyangwe		SJ
Ziragaba Halbert	Rwemisisi	0786288631	Ziragaba
IMANIRAKIZA Cefias	Kinyangwe	0773378195	[illegible]
NITAWUGIRA [illegible]	Rwemisisi	–	[illegible]
Kiiza John	Kinyangwe		K.J
Kwiyecera Emanuel	Rwemisisi		[illegible]
NZABIRWENSI BOSCO ISRAEL	Kinyangwe	0778934906	[illegible]
Serio Byamugisha	Rwemisisi		S.B

Meeting 18: Rwanga

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Rwanga Ward **Date:** 22.11.2019 **Venue:** Rukarara C.O.U **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by chairperson LC1** 4. **Remarks by area councillor** 5. **Communication from deputy mayor** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by Justus Byaruhanga and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 welcomed the team to the area and thanked the community members for attending. He mentioned that the low turn up was because residents were concentrating on the farms taking advantage of the rainy season. He pledged support for the project through disseminating information.	
3. Remarks by area councillor	She thanked the government for the irrigation scheme and mentioned that it will greatly benefit the area that is usually affected by the dry seasons. He welcomed the team and thanked them for engaging the community and requested that the engagements continue even during the construction phase such that community and leaders participate actively throughout all the phases.	
4. Communication from deputy mayor	The deputy Mayor thanked the Ministry for the opportunity of the Scheme that will benefit farmers and lead to development of the area.	
5. Communication from the consultant	The consultant's sociologist thanked the community for turning up for the meeting. She thanked the local council leadership for the support shown towards the project and urged them to keep up the spirit. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at informing the community of the project and identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.	

	She informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by the District Agricultural Officer. This will help in mobilising communities and disseminating information regarding the project at various stages.
6. Discussions by members present	**Discussion**
	Question: will the water also be used for domestic purposes or only irrigation? Response: the water will be strictly used for irrigation purposes and will not be fit for domestic use. Question: if coffee trees are affected by the project during construction, will they be compensated for? Response: yes, property that will be affected by project works during construction will be compensated. Question: will the land where pipes pass be compensated? Response: yes, a plan will be prepared to guide land acquisition and resettlement of property where project infrastructure will be constructed. Question: will there be job opportunities of jobs for the local community during construction of the project? Response: yes, jobs available and skills required will be communicated to the public and they will be guided on how to apply.
	Recommendations by community
	i) The project should incorporate sensitizing farmers on pest control because diseases, pests and vermin affect coffee farmers and crops greatly, during them and causing losses. ii) During construction, local community should be given priority in employment of especially the idle youths.
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: Rwanga			
Purpose of consultation (*tick appropriate box*):	Scoping: ☐ Sensitisation: ☐ Environmental Audit: ☐	ESIA: ☑ RAP: ☐ Other (specify):	
Date: 22.11.19			
Project name: MATANDA - GHENKO IRRIGATION SCHEME			
Proponent: MWE			
Name of Person	**Village**	**Contact**	**Sign/ initial**
TUMUKUNDE ZIPORAH	RUKARARA		
TUMUSHABE EVALINE	MUZIZI		
KYIMPAYE HOPE	MUZIZI	0786164929	
MBONIMPA ALICE	MUZI,ZI		
KYOMUHENDO CHARITY	MUZIZI		
TUKAMUHEBWA CLAIRE	MUZIZI		
NAHABWE EVALINE	MUZIZI		
TUSHEMEREIRWE DOREEN	MUZIZI		
ARINEITWE MONIKA	"		
TUMUSHABE FIONA	MUZIZI		
~~NA~~IRANKUNDA ANISHA	MUZIZI		

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	RUKARARA PARISH				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date:					
Project name:					
Proponent:					

Name of Person	Village	Contact	Sign/ initial
Minus KANYARUTOKYE	RUKARARA	0774036082	Minus
Elijah Kabenika	Rukarara	0786303213	Kanot
Francis Kwizera	Muzizi	0782369597.	Kwizera
Ndimubanzi Richard	Muzizi	0787898683	Richard
Kaheru Elvida	Muzizi		Elvida
Tushemereirwe Michas	Muziizi		Michas
Uwera Brigjet	Rukarara		B
Nyirazaninka Helena.	Rukarara		Helena.
Tuhumwire Jolly	Muzizi Cell		Jolly.
NIZEYIMANA AGNES	Rukarara	0771084585	agnes
Tumuhirwe Beni	Kazinga II Cell	0789048119	[illegible]
HATANGIMANA DEUS	MUZIZI		Hatangimana.
Kwizera Calisti	Muzizi Village	0750 929820	Kwizera
?IBESIGAKIA [illegible]	MUZIZI Village	0780651999	[illegible]
NYIRABIARA DINAH	Rukarara	0782530247	Dinah.
MRS KETTY MUGENYI	RUKARARA V.		[illegible]
Uwimaana Hairet	Kazinga II	0789926910	Hairet
Kwizera Melsie	Muzizi	0778468388	Kwizera
Dushimimaana Stephon	Rukarara	~~0778168388~~ 0789863020	Stephen

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: RUKARARA PARISH					
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑	
	Sensitisation:	☐	RAP:	☐	
	Environmental Audit:	☐	Other (specify):		
Date: 22.11.2019					
Project name: MATANDA - ENGARO IRRIGATION PROJECT					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
BYAMUGISHA. GEOFREY		0704592307	[illegible]
Namanyi Edward Richard		0705053895 / 0772246945	[illegible]
KANUNI WIAHIMAN		0702819226	[illegible]
ORIKIRIZA SUZAN	Rukarara	0771824401	[illegible]
AHEREZA EMMILE	Rukarara	0773006825	[illegible]
KABALE DEUS	Rukarara		Kabale
MUKIZA JIMMY	Rukarara	0779092228	[illegible]
MUSABIMANA ROSE	RUKARARA	0789268704	Rose
SHIRUBUKANA CHARLES	MUZIIZI	0781268744	[illegible]
SANUURA JOHN	MUZIIZI		[illegible]
NYIRAMAHORO ANNA	MUZIZI	0783273713	[illegible]
MAWS KANYARUTOKYE	RUKARARA	0774036082	[illegible]
Maniragaba Alex	Rukarara	0776034594	[illegible]
NSABA BENSON	Rwemisisi	0782313345	[illegible]
KYARIMPA JUDITH	RUKARARA	0774175425	[illegible]
KYOMUGABE ALLEN	RUKARARA		

Meeting 19: Kihembe

ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.		
Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)	**Stakeholder:** Kanyantorogo **Date:** 23.11.2019 **Venue:** Kabingo center **Compiled by:** AD, GB	**Consultant:** AIR WATER EARTH (AWE) Ltd.
Agenda;	1. **Opening Prayer** 2. **Self-Introduction** 3. **Welcoming remarks by chairperson LC1** 4. **Communication from District Agricultural Officer** 5. **Communication from MWE Representative** 6. **Communication from the consultant** 7. **Discussion by members present** 8. **A.O.B and Closure**	
1. Prayer and introduction	The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.	
2. Welcoming remarks by chairperson LC1	The LC1 thanked the community members for attending and welcomed the consultant team and representative of MWE to the parish, urging the community to operate and support the project since they are the direct beneficiaries.	
3. Communication from District Agricultural Officer	He thanked the local council leadership and community members for supporting the project by mobilizing and turning up in large numbers. He gave a brief background of the project and the areas the scheme will cover. He informed the meeting that a District Task force for the project was formed with representatives from each subcounty and each parish within the command area and is headed by him.	
4. Communication from MWE Sociologist	She thanked the District and local council leadership for the support shown towards the project. She thanked the community for turning up and urged them to be cooperative and always turn up whenever called upon on issues pertaining the project.	
5. Communication from the consultant	The sociologist thanked the community for turning up in large numbers to receive information regarding the project. She appreciated the support and cooperation of the local leaders in mobilising communities in support of the project. She gave a brief description of the project, the assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.	

<table>
<tr><td rowspan="3">6. Discussions by members present</td><td>Discussion</td></tr>
<tr><td>Question: what is the source of water?

Response: Matanda irrigation scheme will source its water from River Kiruruma.

Question: when is the project starting?

Response: The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid pandemic, change in dam site and additional scope of services thereunder, the start is now planned for 2024.

Question: will the water be dangerous if drunk or used for other domestic purposes?

Response: yes, the water will be used for irrigation and will not be fit for domestic purposes.

Question: will the water be free or users will pay for it?

Response: users will contribute a small fee to help in operation and maintenance of the scheme.</td></tr>
<tr><td>Recommendations by community
i) The construction contractor should be mindful of the nature and security of material of pipes and other equipment since there have been incidences where some people intentionally cut pipes to cause leakages so that they can tap off water to be used in other activities e.g brick laying.
ii) If jobs are available during construction especially casual work, opportunity should be given to the local people.</td></tr>
<tr><td>A.O.B and Closure</td><td>There being no other business, the meeting was adjourned.</td></tr>
</table>

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KANYANTOROGO – KIHEMBE PARISH		
Purpose of consultation (*tick appropriate box*):	Scoping: ☐ / Sensitisation: ☐ / Environmental Audit: ☐	ESIA: ☑ / RAP: ☐ / Other (specify):	
Date: 23.11.19			
Project name: MATANDA – EKAKO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
Byarahunga Silvester	Nyabirehe. Kihembe	078781215	Byarahunga
Nkwasibwe Laban	Nyabirehe	0775538085	Laban K
Tibesigwa Francis	Nyabirehe	0784061216	[illegible]
Tumwebaze Sirivano	Nyabirehe		[illegible]
Katungi Geofrey	Nyabirehe	0788454934	[illegible]
Rugomwa Laban	Kihembe central	0782723375	Rugomwa
Babate Rebob Naris	Nyabirehe –	—	Rebob
Rubahimbya Anthony	Nyabirehe	0774069338	[illegible]
Asiimwe Laban	Nyabirehe	0774963151	Asiimwe
Mugisha Twinomugisha	"	0779518293	
Beeigomwe Moses	Nyabirehe cell	0772986470	[illegible]
Mwesiga [illegible]	Nyabirehe cell	0783040360	[illegible]
Besigye [illegible]	Nyabirehe cell	0783756511	[illegible]
FRIDAY JOHN	Nyabirehe	0757540275	[illegible]
Ampeire Emmanuel	Nyabirehe cell	0777525615	[illegible]
MUJUNI MUBARAK	Rukararo cell	0777411894	[illegible]

AWE is ISO 9001:2015, ISO 14001:2004 and OHSAS 18001:2007 certified company

JAS-ANZ ICS

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: KANYANTOROGO – Kiterere Parish			
Purpose of consultation (*tick appropriate box*):	**Scoping:** ☐ **Sensitisation:** ☐ **Environmental Audit:** ☐	**ESIA:** ☑ **RAP:** ☐ **Other (specify):**	
Date: 23.11.19			
Project name: MATANDA – ENENGO IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
Justus Rubyogo	Nyabirehe	–	–
KENTONYOZI BRENDA	NYABIREHE	0772910033	brenda
TUSIIME ONESIMUS	NYABIREHE	0788316906	[signature]
Tumwiringire Francis	Nyabirehe cell	0792265027/0784185257	[signature]
NABZ JOELX	Nyabirehe Cell	0778540-935	[signature]
VENICIUS BRIGHT	RUKARARA cell	[illegible]	[signature]
Katabazi Amos	Nyabirehe Cell	0744129994	[signature]
MARIUS	BARIGE		
Zimbehi C.W	Nyabirehe cell		Z.W
Tumwesigye Godfrey	Nyabirehe cel	0780683337	[signature]
Bamwesiga			[signature]
Beregugira	Gudadi	0771492516	[signature]
Byangaba Godfrey	Rukararara cell	0782069740	[signature]
TUMUHIMBISE	Nyabirehe		J.T
Biyomuhangire Robert	Nyabirehe	–	[signature]
TUSHABIRANE LIDIA	NYABIREHE	0786429593	[signature]
Bainomugabo Francis	Nyabirehe		[signature]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	NYANTONGOGO – KIHEMBE PARISH				
Purpose of consultation (*tick appropriate box*):	Scoping:		ESIA:	✓	
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 23-11-19					
Project name: MATANDA ENGOKO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
1 Niwamanya Nixon	Nyamirimo	0787995314	[illegible]
2 Byamukama [illegible]	Nyabirehe	—	[illegible]
3 Tugumisirize D.		0775155862	
4 Mbango Isaac	Rukoranga cell	0784307537	[illegible]
5 AKAMPURIRA ENOCK	NYABIREHE	0773458055/0792423155	[illegible]
TURYAHEBWA AMOS	NYABIREHE	0784672919	Amos
7 MUHWEZI DISMASI			
8 TUMUSIIME MOREEN			
9 Muhwezi Prosper	Nyabirehe	0770942659	[illegible]
10 NATUKUNDA MOREEN	Nyabirehe	0779915051	[illegible]
TUMUGABIRWE MIDIUS	NYABIREHE	0773618408	MIDIUS
MWAJUMA Mirie	Nyabirehe	~~0784773919~~	Viconco
Viconco Prossy	Nyabirehe	0781473919	Viconco
Akampurira Magret	Nyabirehe	0775264569	Magret
Tumwebaze Tereza	Nyabirehe		
AINOMUGISHA JOEL	Nyabirehe	0774458281	Joel
Ezra Kamara	Rwanyara	0782551609	[illegible]
Natukunda John	Nyabareh	—	[illegible]

AWE is ISO 9001:2015, ISO 14001:2004 and OHSAS 18001:2007 certified company

IAS-ANZ
ICS

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: KANYANTOROGO – Kitende Parish					
Purpose of consultation (*tick appropriate box*):	Scoping:	☐	ESIA:	☑	
	Sensitisation:	☐	RAP:	☐	
	Environmental Audit:	☐	Other (specify):		
Date: 23-11-19					
Project name: MATANDA - ENENGO IRRIGATION SCHEME					
Proponent: MAAIF					

Name of Person	Village	Contact	Sign/ initial
KANYESIGYE PAMELA	NYABIREHE	0777716960	[illegible]
BYARUGUBA OSILIVA	NYABIREHE	0778022439	[illegible]
Kwarija Brenda	Ruhurura	0787401702	
Rakwo Kyalonki	Nyabirehe	0773151105 / 0755907717	[illegible]
ARINAITWE BANGAY	Nyabirehe		[illegible]
ARINO GEORGE BUNONO	Nyabirehe cell	0704803996	
KENETA	Nyabirehe cell	0775087367	
Matsiko Joab	Nyabirehe cell	0783834121	Matsiko
Musinguzi I.C	Nyabirehe cell		Musinguzi I.C
Matendo Jackson	Nyabirehe cell	0774952688	Matendo
Katiba	Nyabirehe		Katiba
Ayebare Doreen	Nyabirehe cell	0789240838	Doreen
Kyomuhangi Silivia	Ruhurura cell	0777448944	
GRACE TUMUSHABA	Nyabirehe cell	0781468781	Grace
Generous Harto	Nyabirehe		[illegible]

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	KANYANTORO GO – Kihembe parish				
Purpose of consultation (*tick appropriate box*):	Scoping:	☐		ESIA:	☑
	Sensitisation:	☐		RAP:	☐
	Environmental Audit:	☐		Other (specify):	
Date: 23.11.19					
Project name: MATANDA – RENONGO IRRIGATION SCHEME					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ Initial
ATUHWURA WILSON	Rucamara cell	0787364051	[signature]
BYABASHEIJA DAVID	NYABIRE CALL		
Bakampata Peter	Nyabirebe CALL	0789593387	[signature]
Rev. Geoffrey Tumwebaze	Kampeshande cell	0774069355	[signature]
NDYAMUHAKI	Nyabireche cell	0784357964	[signature]

AWE is ISO 9001:2015, ISO 14001:2015 and OHSAS 18001:2007 certified company.

Meeting 20: Nyamigoye

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Kanyantorogo</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 23.11.2019</td></tr>
<tr><td>Venue: Nyamigoye</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening Prayer
2. Self-Introduction
3. Welcoming remarks by chairperson LC1
4. Communication from LCIII
5. Communication from the consultant
6. Discussion by members present
7. A.O.B and Closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by one of the community members and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 thanked the community members for attending and welcomed the team of consultants led by the District Agricultural officer and a representative from MWE. He thanked the government for the project and mentioned that community anxiously awaits it and is ready to cooperate.</td></tr>
<tr><td>3. Communication from LCIII</td><td colspan="2">The Chairperson thanked the Ministry for such an opportunity of the Scheme that will benefit farmers especially during the dry seasons that greatly affect yields.</td></tr>
<tr><td>4. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for turning up for the meeting. She appreciated the support and cooperation of the local leaders and the community in Kanyantorogo.

She gave a brief description of the project mentioning that it is aimed at supporting the farmers and helping them improve their yields especially during the long dry seasons. She explained the ongoing ESIA assignment and the purpose of the meeting; highlighting that it was aimed at identifying likely impacts due to project implementation and suggestions of the community on the measures that should be implemented to mitigate such impacts.</td></tr>
<tr><td rowspan="2">5. Discussions by members present</td><td colspan="2">Discussion</td></tr>
<tr><td colspan="2">Question: when will the project start?

Response: The project had been estimated to start in 2020 but with the unforeseen circumstances including the Covid pandemic, change in dam site, and additional scope of services thereunder, the start is now planned for 2024.</td></tr>
</table>

	Question: Will all the people within the command area be compensated when constructing the irrigation scheme: Response: Compensation will only be made to property that will be affected during the construction of infrastructure that will support the project e.g storage, distribution etc, and not the entire area. Question: will there be jobs for the local community during construction? Response: yes, the jobs available and skills required will be publicised through effective media and community will be guided on how to apply. Question: will the farmers access the water for free? Response: a small fee shall be paid to help in operation and maintenance of the system.
	Recommendations by community
	i) Youths in the community should be given job opportunities during construction especially casual work
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community:	Bushoro - Ntamgote Parish				
Purpose of consultation (*tick appropriate box*):	Scoping:			ESIA:	✓
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 23-11-19					
Project name: Matanda - Ganeno Irrigation Scheme					
Proponent: MWE					

Name of Person	Village	Contact	Sign/ initial
Nicholas Ainomuk	Bushoro	0782036384	Nicholas.
Dinah Byamukama	Bushoro	0774884732	Dima
Agampurira Honester	Bushoro	0772697950	Honester
Komungisha Kenduresi	Bushoro		Kenduresi
Kyarikora Roseline	Bushoro	0773926661	Roseline
Nkwatsibure Alex	Ishasha	0784441239	Alex
Jackson Tumuhairwe	Ishasha	0779754135	Jackson
Ndyamugyenyi Penelo	Bushoro	0786556664	
Komujuni Annet	Bushoro		Annet
Grace Turyazayo	Bushoro	0778320759	Grace.
Maudah Kobiibi	Bushoro	0777885 0635	
NDASHANA JACK	Bushoro	0782802621	
Annah Ndyamugyenyi	Bushoro	0773571775	Annah
ATEBARE JUDITH	BUSHORO	0775704835/0703486362	A.J
Ampeesa Monica	Bushoro	0777737861	Ampeesa
Kemigisha Miria	Bushoro	0771439605	Miria
Musiimenta Catherine	Bushoro.	0773245748	Catherine
Turyasingura Peace	Bushoro.	0778598669	Peace
Dinah Tukahirwa	Bushoro	0787310311	Dinah

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: BUSHORO – NTAMGO [illegible]			
Purpose of consultation (*tick appropriate box*):	Scoping: ☐ Sensitisation: ☐ Environmental Audit: ☐	ESIA: ✓ RAP: ☐ Other (specify):	
Date: 23.11.19			
Project name: MATANDA – [illegible] IRRIGATION SCHEME			
Proponent: MWE			

Name of Person	Village	Contact	Sign/ initial
1 Tumusiime Robert [illegible]	Bushoro	0785589124	[signature]
2 Musimenta Dabrine	Bushoro	–	[signature]
3 Tusingwire Tenerous	Bushoro	–	[signature]
4 [illegible] FORTUNATE	BUSHORO		
5 Musiimenta Evace	BUSHORO	0789452523	Evace.
6 TURYAHUMURA MARY	BUSHORO	0787389947	[signature]
7 Byamukama Emmanuel	Bushoro	0772268931	[signature]
8 Tindimwebwa Jackline	Bushoro	0789253185	Jackline
9 Ndyomugyenyi Ambrose	Bushoro	0775597790	[signature]
10 Uwamahoro Aderine	Bushoro	0783356299	Aderine
11 Kyomuhendo Hope	BUSHORO	0789991718	Hope
12 Daniel Byabagambi	Bu		
13 Elizabeth Tushabe	Bushoro	0776924939	Tushabe
TWEBAZE [illegible] SCOVIA	BUSHORO	0781998580	[signature]

Meeting 21: Batwa community

<table>
<tr><td colspan="3">ESIA stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Batwa Community</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>Date: 23.11.2019</td></tr>
<tr><td>Venue: Model village in Kengoma</td></tr>
<tr><td>Compiled by: AD, GB</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Opening prayer
2. Self-introduction
3. Opening remarks by LC1
4. Welcome remarks by LC3
5. Communication by MWE Representative
6. Communication by consultant
7. Discussions by members present
8. A.O.B and closure</td></tr>
<tr><td>1. Prayer and introduction</td><td colspan="2">The opening prayer was led by Ms. Penina and this was followed by self-introduction of the consultancy team and community members present by identifying themselves by village.</td></tr>
<tr><td>2. Welcoming remarks by chairperson LC1</td><td colspan="2">The LC1 of Kengoma cell welcomed the team and thanked all the members for accepting the invitation and turning up for the meeting in big numbers. He appreciated the project and that the residents are ready to learn and support the project.</td></tr>
<tr><td>3. Communication from LCIII</td><td colspan="2">The LCIII chairperson, Mr. Tumuhunde Joab thanked the residents for turning up for the meeting despite the bad weather. He thanked the team of representatives from AWE, Kanungu District and MWE for considering engaging the Batwa during the project assessments. He thanked the community for giving the team a warm welcome and urged them to be attentive and listen to the information they were about to pass on.</td></tr>
<tr><td>4. Communication by MWE Representative</td><td colspan="2">Ms. Rhonah thanked the Batwa community and their leadership for welcoming the team into the village and turning up for the meeting in large numbers.</td></tr>
<tr><td>5. Communication from the consultant</td><td colspan="2">The sociologist thanked the community for the welcome from the Batwa through the music and dance, and for turning up in large numbers despite the bad weather. She thanked the Chairperson LCIII and LC1 for the support coordination with the community.

She informed the community that the government of Uganda intends to implement an irrigation project in the district in order to enable farmers increase productivity, income and thus improve their ways of living.</td></tr>
</table>

	She mentioned that the team is undertaking studies to best understand the project area, in consultation with communities, to enable government plan and implement the project in the most feasible way.
6. Discussions by members present	**Discussion** The project will benefit the community if extended to the model village since majority of the residents practice agriculture, growing food crops such as Beans, Groundnuts, Maize, Cassava and other crops. They requested that they should be given enough land for farming and livestock, currently, those practicing farming do so on rented land. Those that cannot afford renting land do not do farming and sometimes even lack food to eat. They requested that they too should be considered as beneficiaries of the different government programs such as the proposed irrigation project, Operation Wealth Creation, bee keeping and NAADS among others. They requested for training of the women in handcraft work and weaving items such as baskets, mats such that they can sell them to a wider market and supplement their source of income. Water for domestic use (NWSC) that was extended to the village is expensive and most households cannot afford it, they requested that cheaper means of accessing safe water in the area be also considered by the government. In terms of representation, the Batwa community mentioned the need to also be represented in high government positions e.g parliament, citing that currently, all they have are cell leaders and nothing beyond that. They requested government or any organization to provide them beds, mentioning that while still in the forest, they used to gather shrubs (Ebitangamizi) from which they would make their beds, yet currently, they cannot access the forest. They also requested government to extend electricity to the model village because the only source of energy used for lighting is Kerosene and their children are constantly burnt by these Kerosene lamps (Katadooba).
A.O.B and Closure	There being no other business, the meeting was adjourned.

STAKEHOLDER ATTENDANCE RECORD:

Name of agency/stakeholder/community: BAKWA COMMUNITY

Purpose of consultation (*tick appropriate box*):			
Scoping:		ESIA:	✓
Sensitisation:		RAP:	
Environmental Audit:		Other (specify):	

Date: 23-11-19

Project name: MATANDA - ENENGO IRRIGATION PROJECT

Proponent: MWE

Name of Person	Village	Contact	Sign/ initial
KARIMUNDA BENON	KENGOMA	0787281920	Karimundabenon
Ndyanabangi James	kengoma	0789546840	Ndyan J.
Kabuzi Alekis	Kengoma		kabuzi A.
Mbabazi Kulisiloka	Kengoma		Mbabazi K.
Furaha Penina	Kengoma		Furaha
Bilumi Aikoti	Kengoma		Bilumi A
Byamuhanga Hopy	Kengoma		Byamuhanga H.
Kakulu Edisa	Kengoma		kakulu E
Bagileitima Ekaka	Kengoma		Bagileitima E
Kishekye Jeni	Kengoma		Kishekye J.
Nikoleye Rusi	Kengoma		Nikoleye R.
Kunyagaba Jeni	Kengoma		Kunyagaba J-
Bakakaeda Ridiya	Kengoma		Kakakada Ri
Kamasogi Jeseta	Kengoma		Kamasogi J-
Nyebiba Guloli	Kengoma		Nyebiba G.
Tushemeleitwe Oliva	Kengoma		Tushemeleitwe O
Mwanga James	C/MAN LCI Kengoma	0774523779	[illegible]
NABONGO MOLLY	Kengoma	0789457057	Nmolly.

Meeting 22: Kikarara Parish

<table>
<tr><td colspan="3">Scoping stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) for Matanda Irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client:: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Kikarara Parish</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>6th February, 2019</td></tr>
<tr><td>Kikarara Church of Uganda</td></tr>
<tr><td>Compiled by: Dianah Alinaitwe and Abel Mutyaba</td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Prayer
2. Introduction
3. Welcoming remarks from the chairperson
4. Project introduction/Presentation
5. Discussion by the members present
6. A.O.B and Closure</td></tr>
<tr><td>1. Prayer</td><td colspan="2">This was led by one of the community members; Mr. Kagayano Chris</td></tr>
<tr><td>2. Introductions and Welcoming remarks from the chairperson</td><td colspan="2">The meeting was chaired by the Chairperson LCII, Mr. Byakatonda Sadik who welcomed the AWE team and thanked them for considering engaging the people of KIkarara during the project studies. He then requested the AWE team to introduce themselves and brief the members present about their visit.</td></tr>
<tr><td>3. Project introduction/Presentation</td><td colspan="2">The AWE team leader thanked the members for the time spared to attend the meeting to discuss matters pertaining to the proposed Enengo irrigation scheme. He then explained the assignment of the team (ESIA and RAP studies), highlighting the objectives, methodology, timelines and expectations from the parish.</td></tr>
<tr><td>4. Remarks from the members present</td><td colspan="2">The members present highlighted the following key issues:
i) The land in Kikarara is very fertile and supports agriculture but production is mainly affected by the lack of water in the area. This has actually made it hard for farmers to rear animals, do fish farming or engage in brick laying, limiting themselves to crop farming. Women engage in hand craft work like knitting mats and baskets; Still, the lack of water has led to drying of papyrus making it hard for them to find raw materials;
ii) The current source of water for domestic use in the parish is mainly stagnant ponds in Queen Elizabeth National Park that is shared with animals. This is very dangerous for the community as cases of animal attacks on women when fetching water especially by buffalos have been reported. In addition, this community is always in conflict with the National Park management due to illegal entry into the park in search for water which is supposed to be left for animals;
iii) The lack of water in this area has affected other sectors especially education whereby teachers who are posted in the area fail to perform their duties due to lack of water. In addition, due to the same problem, the value of land in the area is very low;
iv) The parish has high prevalence of water related diseases especially Typhoid and Bilharzia due to the improper sources of water for domestic use;
v) The district has made efforts to construct some shallow wells in Kikarara, however, most of them are non-functional;
vi) Opportunities of rain water harvesting do exist since a number of houses are roofed with iron sheets;
vii) With availability of water through the proposed irrigation scheme, brick laying, fish farming, and nursery beds are some of the other income generating activities that can be explored;</td></tr>
</table>

	viii) The following stakeholders should be considered during engagements in the detailed studies; ▪ Uganda Wildlife Authority; ▪ Local leaders especially Subcounty Councillors, Parish Chiefs, LCIII, LCII, LCI; ▪ Farmer groups e.g. Bataka Kweyamba group, Kurambira Tukwatanise which majors in brick laying, Kikarara Coffee farmers, among others. ▪ NGOs in the command area especially LADA (Literacy Action Development Agency) which constructed some water tanks and shallow wells in the area; ▪ Religious institutions; ▪ General communities/villages within the command area
5. A.O.B and Closure	• A comprehensive ESIA study will be conducted and all the stakeholders will be consulted in detail and their concerns, comments and suggestions will be key in the findings and recommendations.

STAKEHOLDER CONSULTATION

f Agency/Stakeholder: KIKARARA PARISH

of consultation (*tick appropriate box*):	**Scoping**	✓		**ESIA**	
	Sensitisation			**RAP**	
	Environmental Audit			**Other (specify)**	

6th. Feb. 2019

name: MATANDA [illegible] IRRIGATION SCHEME IN KANUNGU AND RUKUNGIRI DISTRICTS

nt: MINISTRY OF WATER AND ENVIRONMENT

person met:	Village	Contact (Tel)	Sign/ Initial
[illegible]busingye Gideon Vikaramaji Defence L.C. II	NYAKABUNGO B CELL	0783434558	[signature]
[illegible]AYANO CHRIS (Hon.)	Nyakabungo A.	0773079722	[signature]
[illegible]ATONDA SAUBICH	KIKARARA C/P L.C. II	0779782399	[signature]
[illegible]RANO JUSTUS	SEC FOR PRODUCTION, Bwara	0774298649	[signature]
[illegible]me Habert	Kikarara Councillor Bwara	0784018162	[signature]
Sigire Stanley	Nyakabungo A-B Chairman	0781467449	[signature]

STAKEHOLDER CONSULTATION

f Agency/Stakeholder: KI KARARA PARISH

e of consultation (tick appropriate box):	Scoping	✓		ESIA	
	Sensitisation			RAP	
	Environmental Audit			Other (specify)	

6th Feb. 2019

name: MATANDA / EHONGO IRRIGATION SCHEMES IN KAKUMIRO AND BUNYANGABU DISTRICTS

ent: MINISTRY OF WATER AND ENVIRONMENT

f person met:	Village	Contact (Tel)	Sign/ Initial
Nora. Midiyasi	Kanyabusambwe	0788927946	Nm
yangayo Grace	Kagorogoro	0777249827	[illegible]
yasingura EUNICE	Kyehunde	07772762A3	[illegible]
ungwire Irene	Kanyabusambwe	0781011289	Irene
mubwine HoPe	Muyande	-	HoPe
Ihawe HAPPy		0781588727	

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STAKEHOLDER CONSULTATION

f Agency/Stakeholder: KIKARARA PARISH

of consultation (tick appropriate box):	Scoping	✓	ESIA		
	Sensitisation		RAP		
	Environmental Audit		Other (specify)		

6th Feb. 2019

name: MATANDA / ENANGO IRRIGATION SCHEMES IN KANUNGU AND RUKUNGIRI DISTRICTS

nt: MINISTRY OF WATER AND ENVIRONMENT

person met:	Village	Contact (Tel)	Sign/ Initial
...ata. Midiyasi	Kanyabusambwe	0788927946	Nm
...yangayo Grace	Kagorogoro	0777249827	[illegible]
...yasingura EUNICE	Kyehunde	07772762A3	Eo
...ngwire Irene	Kanyobusambwe	0781011289	Irene
...mubwine Hope	Muyayande	-	Hope
...hawe Happy		0781588727	

Meeting 23: Kanungu District

<table>
<tr><td colspan="3">Scoping phase stakeholder engagement meeting for the Consultancy Services for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda Irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Kanungu District</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>7th February, 2019</td></tr>
<tr><td>Kanungu District offices</td></tr>
<tr><td>Compiled by: Dianah Alinaitwe and Abel Mutyaba</td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Prayer
2. Introduction
3. Welcoming remarks from the chairperson
4. Project introduction/presentation
5. Discussion by members present
6. A.O.B and Closure</td></tr>
<tr><td>1. Prayer</td><td colspan="2">The opening prayer was led by Linnet from the water department</td></tr>
<tr><td>2. Introductions and Welcoming remarks from the chairperson</td><td colspan="2">The meeting was chaired by the Principal Assistant Secretary, Ms. Mutahakana Gertrude who welcomed Air water Earth to the district and thanked members for attending. She pledged support to the AWE team since the project greatly benefits the district.
She then requested all members present to introduce themselves before inviting the consultant to start their presentation..</td></tr>
<tr><td>3. Project introduction/Presentation</td><td colspan="2">The team leader expressed gratitude for the opportunity and time given to the team to discuss matters pertaining to the proposed Matanda irrigation scheme. He then explained the assignment of the team (ESIA and RAP studies), giving a recap of the preliminary activities so far conducted, highlighting the expected activities and the steps of undertaking the assignment among which was the Scoping phase.
He then invited other members to give their submissions regarding the existing situation of the project area (command area), the challenges faced by the communities, opportunities that can be realised as a result of project implementation and the key stakeholders that should be considered during detailed consultations in the ESIA studies.</td></tr>
<tr><td rowspan="2">4. Discussion by members present</td><td colspan="2">Existing situation</td></tr>
<tr><td colspan="2">i) Farming in the command area is majorly done on small scale; where a household cultivates on an average of 2.5 acres and commercial farmers utilise an average of 10 acres;
ii) Subsistence farming is the main source of livelihood in the area with rice, maize, ground nuts, cassava and millet among the main crops grown. Animal rearing is very limited due to lack of water;
iii) Market for the produce is largely local, but also often found in Kasese, Kabale, Rwanda and Kampala;
iv) Other sources of income are associated with tourism since the area neighbours Queen Elizabeth National park and Kigezi Wildlife Reserve. This is in addition to fish farming, coffee growing and distilling in Nyamirama;
v) Water sources in the area are majorly piped water from Kanyampamba and Mpangango and protected springs. Animal watering is done on River Kiruruma;
vi) There is a project for development of a Catchment Management Plan (CMP) to protect River Mitano banks funded by African Development Bank (AfDB) through MWE- LEAIF</td></tr>
</table>

	vii) There is a mini irrigation scheme on River Ntungwa under the presidential pledge covering 10 acres of land and is being championed by the President's Office; viii) In Kihihi Town Council is a tree to which the community has cultural attachment. Therefore this community must be consulted during detailed stakeholder engagements if project activities are likely to tamper with its existence.
	Challenges
	• The command area is water stressed. The existing water supply systems only supply water to households along the main road and do not reach the remote areas; • The soils in Matanda are basically sandy-loam with high percentages of sand and thus have low water and nutrient retention capacity; • The poor road network in the command area has made it hard to access the area;
	Opportunities
	• Matanda is a rift valley area and so presents an opportunity for fruit growing if water is made available through the irrigation scheme. Some of the fruits that can be grown include mangoes, water melon, tomatoes, and oranges; • Kihihi, Nyamirama and Nyakinoni areas have potential for mechanisation and thus present an opportunity for commercial farming; • The command area neighbours Rwanda whose arable land is limited compared to her population. This therefore presents ready market for the produce from the command area;
	Stakeholders
	i) The command area's immediate neighbour in Kanungu is Queen Elizabeth National park and Kigezi Wildlife Reserve and so Uganda Wildlife Authority (UWA) and the area park management team are key stakeholders that should be engaged during stakeholder engagements; ii) The newly set up Refugee camp in Matanda (Matanda Refugee Transit Camp): Since it is anticipated that more refugees are likely to come into the area as a result of the instability in DR Congo; iii) Ministry of Agriculture since they have a satellite research center in Matanda; iv) Uganda Police since they own a large piece of land within the command area; v) Local leaders especially Heads of Departments, district councillors, District Technical teams, SubcountyCouncillors, Parish Chiefs, LCIII, LCII, LCI; vi) Farmer groups/associations e.g. Kihihi Farmers' Association, Rice Growers' association, Coffee Development Academy; vii) Women groups; viii) NGOs e.g. Raising the Village, Farm Africa, Reach; ix) CBOs e.g. Kanungu Development Initiative (KADI), AWEC x) Religious leaders; xi) Operation Wealth Creation (OWC); xii) General communities/villages within the command area
5. A.O.B and Closure	The scoping phase will be followed by the detailed ESIA studies, where all the stakeholders listed above will be extensively engaged.

Stakeholder consultation record

me of Agency/Stakeholder: KANUNGU DISTRICT LOCAL GOVERNMENT

rpose of consultation (tick appropriate box):	Scoping:	/	ESIA:	
	Sensitisation:		RAP:	
	Environmental Audit:		Other (specify):	

e: 7th feb 2019

ject name: MATANDA ENHANCED IRRIGATION SCHEMES, KANUNGU & RUKUNGIRI DISTRICTS

ponent: MINISTRY OF WATER & ENVIRONMENT

ne of person	Designation	Contact (Tel)	Sign/ initial
UTAHAKANA GERTRUDE	PAS for CAO	0772423804	
UNDAY LINNET	for District Water Officer	0781710921	
tuhaire Innocent	D/Planner	0772472568	
bob TURYAGYENDA	DWC COORDINATOR	0772520793	
THAROSINGTON HAMUTUNI	OWC KINKIZI WEST CONST.	0772395053	
BURHESHE FULGE	D/DSO KANUNGU	0782136719	
musiime Dablience	Senior Labour officer for DCAO	0782434367	
AMWEANA MATHIAS T	Senior Agric officer	0776476266	
IRIYO. PETER.	Production Coordinator	0772558370	

er Earth (AWE) Ltd
we-engineers.com
0:2015
01:2008
18001:2007

Stand. Doc No. AWE/034

Stakeholder consultation record

Name of Agency/Stakeholder: KAHUNGU DISTRICT LOCAL GOVERNMENT					
Purpose of consultation (*tick appropriate box*).	**Scoping:**	✓	**ESIA:**		
	Sensitisation:		**RAP:**		
	Environmental Audit:		**Other (specify):**		
Date: 7th Feb. 2019					
Project name: MATANDA / ENENGO IRRIGATION SCHEMES, KANUNGU & RUKUNGIRI DISTRICTS					
Proponent: MINISTRY OF WATER & ENVIRONMENT					

Name of person	Designation	Contact (Tel)	Sign/ initial
Shafiq S. Sekanzi	RDC Kanungu	0772447074	[signature]
Mutabakana Gaitrude	PAS for CAO	0772423804	[signature]

Stakeholder consultation record:

Name of agency/stakeholder/community: KANUNGU DISTRICT LOCAL GOVERNMENT					
Purpose of consultation (*tick appropriate box*):	**Scoping:**	✓		**ESIA:**	
	Sensitisation:			**RAP:**	
	Environmental Audit:			**Other (specify):**	
Date: 27th/Feb/2018					
Project name: MATANDA/ENENGO IRRIGATION SCHEMES, KANUNGU & RUKUNGIRI DISTR					
Proponent: MINISTRY OF WATER & ENVIRONMENT					

Name of person/ official met:	Designation	Contact (Tel/email)	Sign/ Initial
Grace Baalikowa	Sociologist	0782409859	
Abiaanitwe Simon	Sociologist	0777725651	
Ivan Ntege	Irrigation Engineer / GIS	0780268731	
Atl Mutecki	Team leader Kanungu Site	0702831027	

Meeting 24: Nyamirama Subcounty

<table>
<tr><td colspan="3">Scoping stakeholder engagement meeting for the consultancy service for Environmental and Social Impact Assessment (ESIA) for Matanda Irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Nyamirama Subcounty</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>7th February, 2019</td></tr>
<tr><td>Nyamirama Subcounty offices</td></tr>
<tr><td>Compiled by: Dianah Alinaitwe and Abel Mutyaba</td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Introduction
2. Welcoming remarks from the chairperson
3. Project introduction/Presentation
4. Discussion by the members present
5. A.O.B and Closure</td></tr>
<tr><td>1. Introductions and Welcoming remarks from the chairperson</td><td colspan="2">The meeting was chaired by the Chairperson Local Council III, Mr. Kabyesiza James who welcomed the AWE team to Nyamirama Subcountyand thanked the members for attending. He then requested all members present to introduce themselves before inviting the consultant to brief the members present about their visit.</td></tr>
<tr><td>2. Project introduction</td><td colspan="2">The AWE team leader thanked the Chairperson for the opportunity and time members spared to discuss matters pertaining to the proposed Matanda irrigation scheme. He then explained the assignment of the team (ESIA and RAP studies), highlighting the objectives, methodology, timelines and expectations from the Sub County.</td></tr>
<tr><td>3. Remarks from the members present</td><td colspan="2">The chairman and the members present highlighted the following key issues:
i) The government, through Ministry of Water and Environment has been in the process of identifying potential sites for micro irrigation schemes in the area and so during stakeholder engagement, AWE team has to make the Matanda project clear to the community so that people do not confuse it with the micro schemes;
ii) The area is very fertile and productive and can support agriculture. Production is only affected by the prolonged dry spells;
iii) Currently, the main source of water is the gravity control schemes that are managed by National Water and Sewerage Corporation;
iv) In the area, women are predominantly the ones that do the hard work in the gardens from planting to harvesting. The men simply wait for their women to harvest and take on the role of selling but after getting the money marry other women to increase labour such that they can get more money from selling produce from multiple gardens;
v) Some of the challenges faced by the community include;
Lack of proper storage facilities for produce in the area;
Poor marketing and sale behaviours of farmers who sell immature crops while they are still in the gardens;
Long dry spells that interfere with the planting schedules;
Poor quality coffee with low market value because it is harvested prematurely due to urgent needs for money;
vi) Besides agriculture, the youth in the area are also involved in stone quarrying and brewing.
vii) The following stakeholders should be considered during engagements in the detailed studies;
▪ Local leaders especially Subcounty Councillors, Parish Chiefs, LCIII, LCII, LCI;</td></tr>
</table>

	▪ Farmer groups/associations e.g. Nyamirama Coffee Buyers, Nyamirama Coffee Traders, Nyamirama Quality Coffee Buyers and Traders, Nyamirama Rice Grower; ▪ SACCOs e.g. Nyamirama People's SACCO; ▪ NGOs in the command area e.g. Compassion; ▪ CBOs e.g. Nyamirama Community project – a faith-based CBO that operates within the Diocese, helping the vulnerable children and women; ▪ Religious leaders; ▪ General communities/villages within the command area
4. A.O.B and Closure	• Once the scoping phase is completed, AWE team will return for detailed ESIA studies in which all the stakeholders mentioned will be consulted.

Stakeholder consultation record

Name of Agency/Stakeholder: NYAMUROMA SUBCOUNTY					
Purpose of consultation (*tick appropriate box*):	Scoping:	✓		ESIA:	
	Sensitisation:			RAP:	
	Environmental Audit:			Other (specify):	
Date: 07.02.2019					
Project name: MATANDA / [illegible] IRRIGATION SCHEMES					
Proponent: MINISTRY OF WATER AND ENVIRONMENT					

Name of person	Designation	Contact (Tel)	Sign/ initial
Birungi Abel	For Subcounty chief	0782470413	Babel
ASIIMWE EMMANUEL	Agricultural Officer	074070285	
AKAMPURIRA GODWIN	Parish Chief	0779087664	
TUMWESIGYE PAUL	CDO	0770866849	
NAKAHIMA JANICE	COPY TYPIST	0779044562	
[illegible] SHEILA	Parish chief "Mashaku"	0788987900	
KABYESIZA JAMES	LCIII C/PERSON	0782941963	
Grace Baahkowa	Sociologist / Social expert	0782409889	
Ivan Ntege	Irrigation Engineer / GIS	078[illegible]68731	

Stakeholder consultation record

Name of Agency/Stakeholder: NYAMIRAMA SUBCOUNTY					
Purpose of consultation (*tick appropriate box*):	Scoping:	✓	ESIA:		
	Sensitisation:		RAP:		
	Environmental Audit:		Other (specify):		
Date: 7th. 02. 2019					
Project name: MATANDA / ENENGO IRRIGATION SCHEMES					
Proponent: MINISTRY OF WATER AND ENVIRONMENT					

Name of person	Designation	Contact (Tel)	Sign/ initial
Politique JB Emmanuele	Senior Agricultural Engineer	0772422021/0703469560	
Ahimbisibwe Dinah	Sociologist	0777725657	
Abel Mutsaba	Team leader - AWE	0702830020	

Meeting 25: Kihihi Subcounty

<table>
<tr><td colspan="3">Scoping phase stakeholder engagement meeting for the Consultancy Services for Environmental and Social Impact Assessment (ESIA) and Resettlement Action Plan (RAP) for Matanda Irrigation scheme in Kanungu District.</td></tr>
<tr><td rowspan="4">Client: MINISTRY OF WATER AND ENVIRONMENT (MWE)</td><td>Stakeholder: Kihihi Subcounty</td><td rowspan="4">Consultant: AIR WATER EARTH (AWE) Ltd.</td></tr>
<tr><td>7th February, 2019</td></tr>
<tr><td>Kihihi Subcountyoffices</td></tr>
<tr><td>Compiled by: Dianah Alinaitwe and Abel Mutyaba</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Agenda;</td><td colspan="2">1. Introduction
2. Welcoming remarks from the chairperson
3. Project introduction/Presentation
4. Discussion by the members present
5. A.O.B and Closure</td></tr>
<tr><td>1. Introductions and Welcoming remarks from the chairperson</td><td colspan="2">The meeting was chaired by the Assistant Chairperson LCIII Ms. Godly Kyenoel who welcomed the AWE team to the Subcountyand thanked them for considering including them in the project studies. She then requested all members present to introduce themselves before inviting the consultant to brief other members present about their visit.</td></tr>
<tr><td>2. Project introduction</td><td colspan="2">The team leader thanked the Chairperson for the opportunity and time spared for the meeting in regards to the proposed Matanda irrigation scheme. He then explained the assignment of the team (ESIA and RAP studies), highlighting the objectives, methodology, timelines and expectations from the Sub County.</td></tr>
<tr><td>3. Remarks from the members present</td><td colspan="2">The chairman and the members present highlighted the following key issues:
i) In the same Sub County, there is an irrigation scheme from a Presidential Pledge championed by the Office of the President serving 10 acres of land. The AWE team should visit this scheme and take lessons such that the mistakes that were made during its set up are not repeated on the proposed scheme;
ii) Kihihi Subcounty is the major food supplier of food to both the local and neighbouring market especially Kabale and Kasese. However, production is affected by long dry spells. In fact, animal rearing is quite limited due to lack of water;
iii) The major crops grown in the Subcounty include rice, maize, onions, cassava, coffee, ground nuts;
iv) The following stakeholders should be considered during engagements in the detailed studies;
▪ Local leaders especially Subcounty Councillors, Parish Chiefs, LCIII, LCII, LCI;
▪ Farmer groups;
▪ Religious leaders;
▪ General communities/villages within the command area</td></tr>
</table>

4. A.O.B and Closure	• The scoping phase will be proceeded by a detailed ESIA study during which all the stakeholders will be consulted in detail and their concerns, comments and suggestions will be key in the findings and recommendations.

STAKEHOLDER CONSULTATION

Name of Agency/Stakeholder: KIBADARA PARISH					
Purpose of consultation (*tick appropriate box*):	**Scoping**	✓	**ESIA**		
	Sensitisation		**RAP**		
	Environmental Audit		**Other (specify)**		

Date: 6th. Feb. 2019

Project name: MATANDA / GWENGO IRRIGATION SCHEMES IN ~~Bus~~ KAHUNGU & RUKUNGIRI DISTRICTS

Proponent: MINISTRY OF WATER & ENVIRONMENT.

Name of person met:	Village	Contact (Tel)	Sign/ Initial
Sadurday mbabro	Kiorumr parish	0724542694	[signature]
NIWARIMRA	0777408680		
Tushemerirwe Hope	Nyakatwngo A ~~0772033408~~	0772033408	
Grace Baalikowa	Air Water Earth	0782409889	[signature]
Abel Mutsch.	AWE	0702830021	[signature]
Ivan Ntege	AWE	0704269736	[signature]
Daniel Akinaihue	AWE	0777256[illegible]	[signature]

STAKEHOLDER CONSULTATION

Name of Agency/Stakeholder: KIKARARA PARISH					
Purpose of consultation (*tick appropriate box*):	Scoping	✓	ESIA		
	Sensitisation		RAP		
	Environmental Audit		Other (specify)		
Date: 6th Feb, 2019					
Project name: MATANDA / ENENGO IRRIGATION SCHEMES IN KANUNGU AND RUKUNGIRI DISTRICTS					
Proponent: MINISTRY OF WATER AND ENVIRONMENT					

Name of person met:	Village	Contact (Tel)	Sign/ Initial
Namara. Midiyasi	kanyabusambwe	0788927946	Nam
Turyamugayo Grace	kagorogoro	0777249827	[illegible]
Turyasingura EUNICE	Kyehunde	07772762A3	Eto
Tusingwire Irene	Kanyabusambwe	0781011289	Irene
Tumubwine HoPe	Muyayande	-	HoPe
Turinawe HaPPy		0781588727	

STAKEHOLDER CONSULTATION

Name of Agency/Stakeholder: KIKARARA PARISH					
Purpose of consultation (*tick appropriate box*):	**Scoping**	✓	**ESIA**		
	Sensitisation		**RAP**		
	Environmental Audit		**Other (specify)**		
Date: 6th. Feb. 2019					
Project name: MATANDA / ENENGO IRRIGATION SCHEMES IN KANUNGU AND RUKUNGIRI DISTRICTS					
Proponent: MINISTRY OF WATER AND ENVIRONMENT					

Name of person met:	Village	Contact (Tel)	Sign/ Initial
Twinobusingye Gideon Vikarara, Pr Defence L.C. II	NYAKIABUNGO B CELL	0783434558	
KAGAYANO CHRIS (Hon.)	Nyakabungo A.	0773079722	
BYAKATONDA SAMUEL	KIKARARA C/P L.C. II	0779932399	
NGABIRANO JUSTUS	SEC FOR PRODUCTION, Bw'ara	0774298649	
Tusiime Habert	Kikarara COUNCILLOR Bwambara [illegible]	0784018162	
Kibesigire Stanley	Nyakabungo A.B C/man.	0781467449	

APPENDIX D PROJECT DESIGN

APPENDIX E BIODIVERSITY REPORT

Appendix I Relative abundance of birds species recorded in Matanda irrigation scheme

		River sites								Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
17	CATTLE EGRET Bubulcus ibis	G						**0**	**0**	3			```				**3**	**0.43**
26	BLACK-HEADED HERON Ardea melanocephala	w	6		6			**12**	**2.4**	6	5						**11**	**1.57**
39	HADADA IBIS Bostrychia hagedash	w	2	4	4		6	**16**	**3.2**	4						3	**7**	**1.00**
73	BLACK-SHOULDERED KITE Elanus caeruleus	G						**0**	**0**	4							**4**	**0.57**
90	AFRICAN HARRIER HAWK Polyboroides typus (Gymnogene)	f				5		**5**	**1**	4	3					3	**10**	**1.43**
100	SHIKRA Accipiter badius (Little Banded Goshawk.)	F						**0**	**0**					5			**5**	**0.71**
109	LIZARD BUZZARD Kaupifalco monogrammicus	F	2					**2**	**0.4**							5	**5**	**0.71**
122	LONG-CRESTED EAGLE Lophaetus occipitalis	F	2	2	4			**8**	**1.6**	3			5				**8**	**1.14**
157	HEUGLIN'S FRANCOLIN Francolinus icterorhynchus	G						**0**	**0**	6							**6**	**0.86**
185	GREY CROWNED CRANE Balearica regulorum	EN, R-NTWG		5	3			**8**	**1.6**	4			6				**10**	**1.43**
250	COMMON SANDPIPER Actitis hypoleucos	PMPW		3				**3**	**0.6**								**0**	**0.00**
270	TAMBOURINE DOVE Turtur tympanistria	F	2					**2**	**0.4**								**0**	**0.00**
271	BLUE-SPOTTED WOOD DOVE Turtur afer	F	6	6	4		6	**22**	**4.4**			4	4			6	**14**	**2.00**
283	RED-EYED DOVE Streptopelia semitorquata	f	4	6	6	3	6	**25**	**5**	6	6	6		5	6	6	**35**	**5.00**
286	RING-NECKED DOVE Streptopelia capicola (Cape Turtle Dove)	f						**0**	**0**				6				**6**	**0.86**

		River sites								Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
289	LAUGHING DOVE Streptopelia senegalensis				3			**3**	**0.6**	3	6		4	6	4		**23**	**3.29**
296	GREAT BLUE TURACO Corythaeola cristata	F	2				3	**5**	**1**								**0**	**0.00**
305	EASTERN GREY PLANTAIN-EATER Crinifer zonurus						3	**3**	**0.6**	1							**1**	**0.14**
309	RED-CHESTED CUCKOO Cuculus solitarius	AF	6		6		4	**16**	**3.2**	4				4		6	**14**	**2.00**
317	AFRICAN EMERALD CUCKOO Chrysococcyx cupreus	F	3				6	**9**	**1.8**								**0**	**0.00**
323	WHITE-BROWED COUCAL Centropus superciliosus		5	5		5		**15**	**3**	6		4		5		4	**19**	**2.71**
357	SCARCE SWIFT Schoutedenapus myioptilus	F	4					**4**	**0.8**	4							**4**	**0.57**
358	AFRICAN PALM SWIFT Cypsiurus parvus			2				**2**	**0.4**								**0**	**0.00**
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus					2		**2**	**0.4**								**0**	**0.00**
369	SPECKLED MOUSEBIRD Colius striatus		5	5	4	5	2	**21**	**4.2**	5	3	5	4		6	6	**29**	**4.14**
375	WOODLAND KINGFISHER Halcyon senegalensis	A					5	**5**	**1**					4			**4**	**0.57**
387	CINNAMON-CHESTED BEE-EATER Merops oreobates	R-RRF	2					**2**	**0.4**								**0**	**0.00**
390	WHITE-THROATED BEE-EATER Merops albicollis	AMAf						**0**	**0**						6		**6**	**0.86**
394	EUROPEAN BEE-EATER Merops apiaster	PMPf						**0**	**0**				4				**4**	**0.57**
422	BLACK-AND-WHITE CASQUED HORNBILL Bycanistes subcylindricus	F	2		6			**8**	**1.6**							6	**6**	**0.86**
435	HAIRY-BREASTED BARBET Tricholaema hirsuta	F	4					**4**	**0.8**								**0**	**0.00**
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	f	6					**6**	**1.2**			6					**6**	**0.86**

		River sites								**Impact area sites**								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
455	GREATER HONEYGUIDE Indicator indicator (Black-throated Honeyguide)	f						**0**	**0**		4						**4**	**0.57**
473	CARDINAL WOODPECKER Dendropicos fuscescens		2					**2**	**0.4**				5				**5**	**0.71**
512	ANGOLA SWALLOW Hirundo angolensis	w						**0**	**0**	4					5		**9**	**1.29**
520	AFRICAN PIED WAGTAIL Motacilla aguimp	w	6	2	6		2	**16**	**3.2**	6	6						**12**	**1.71**
547	YELLOW-THROATED GREENBUL Chlorocichla flavicollis (Yellow-throated Leaflove)	f	5	6			6	**17**	**3.4**								**0**	**0.00**
562	COMMON BULBUL Pycnonotus barbatus (Yellow-vented Bulbul)	f	6	6	5	5	6	**28**	**5.6**	6		6	6	6	6	6	**36**	**5.14**
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	f	6		4			**10**	**2**	6	3	5				4	**18**	**2.57**
589	WHITE-BROWED SCRUB-ROBIN Cercotrichas leucophrys			5		5		**10**	**2**		3		2		6		**11**	**1.57**
612	AFRICAN THRUSH Turdus pelios	f	6				5	**11**	**2.2**	6	5		4	5			**20**	**2.86**
621	MOUSTACHED GRASS WARBLER Melocichla mentalis (African Moustached Warbler)					3		**3**	**0.6**	6	3		5	5			**19**	**2.71**
638	RED-FACED CISTICOLA Cisticola erythrops	w	5	5	6	5		**21**	**4.2**	6	6	6	4	5	5	6	**38**	**5.43**
642	CHUBB'S CISTICOLA Cisticola chubbi	Fw	5					**5**	**1**								**0**	**0.00**
647	WINDING CISTICOLA Cisticola galactotes	w		6	5	4		**15**	**3**				6				**6**	**0.86**
650	CROAKING CISTICOLA Cisticola natalensis	G						**0**	**0**	5			6		3		**14**	**2.00**
658	TAWNY-FLANKED PRINIA Prinia subflava	fw	6	6		6		**18**	**3.6**	6	6	5	6	6	6	6	**41**	**5.86**
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f	6				5	**11**	**2.2**	5		5					**10**	**1.43**

		River sites									Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
701	GREY-CAPPED WARBLER Eminia lepida	R-RRfw		6	6		5	**17**	**3.4**			3					**3**	**0.43**
746	BROWN-THROATED WATTLE-EYE Platysteira cyanea (Common Wattle-eye)	f	3				4	**7**	**1.4**								**0**	**0.00**
764	BLACK-LORED BABBLER Turdoides sharpei (Sharpe,s Pied Babbler)		5					**5**	**1**	5			5	6	6	4	**26**	**3.71**
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	F	4					**4**	**0.8**								**0**	**0.00**
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f	6	5			5	**16**	**3.2**	3		6					**9**	**1.29**
790	BRONZE SUNBIRD Nectarinia kilimensis	f	4					**4**	**0.8**		4						**4**	**0.57**
796	OLIVE-BELLIED SUNBIRD Cinnyris chloropygius	F	4					**4**	**0.8**								**0**	**0.00**
802	MARICO SUNBIRD Cinnyris mariquensis (Mariqua Sunbird)							**0**	**0**	4							**4**	**0.57**
812	COMMON FISCAL Lanius collaris	G						**0**	**0**	6		6	6		6	5	**29**	**4.14**
814	MACKINNON'S SHRIKE Lanius mackinnoni	f	4					**4**	**0.8**	3							**3**	**0.43**
815	GREY-BACKED FISCAL Lanius excubitoroides	Afw						**0**	**0**			5					**5**	**0.71**
831	BROWN-CROWNED TCHAGRA Tchagra australis (Brown-headed Tchagra)		6					**6**	**1.2**		6			5		5	**16**	**2.29**
841	TROPICAL BOUBOU Laniarius aethiopicus	f	6	3	5		4	**18**	**3.6**	5	4	4	5		5	3	**26**	**3.71**
843	BLACK-HEADED GONOLEK Laniarius erythrogaster	f		6				**6**	**1.2**								**0**	**0.00**
855	PIED CROW Corvus albus		3					**3**	**0.6**	6				6			**12**	**1.71**
872	RUPPELL'S STARLING Lamprotornis purpuropterus (Ruppell,s Long-tailed Starling)		2		5	5	6	**18**	**3.6**				6		6		**12**	**1.71**

		River sites								Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
881	NORTHERN GREY-HEADED SPARROW Passer griseus			3	3		6	**12**	**2.4**		6	5	6	4		6	**27**	**3.86**
897	SPECTACLED WEAVER Ploceus ocularis	f	5	4	4	2	5	**20**	**4**					5			**5**	**0.71**
907	VIEILLOT'S BLACK WEAVER Ploceus nigerrimus	f		3				**3**	**0.6**								**0**	**0.00**
908	BLACK-HEADED WEAVER Ploceus cucullatus (Village Weaver)		5		6	5	6	**22**	**4.4**	6	6	5		6	6	6	**35**	**5.00**
910	YELLOW-BACKED WEAVER Ploceus melanocephalus (Black-headed Weaver)	W	4					**4**	**0.8**								**0**	**0.00**
931	YELLOW BISHOP Euplectes capensis	G	2					**2**	**0.4**								**0**	**0.00**
932	FAN-TAILED WIDOWBIRD Euplectes axillaris (Red-shouldered Widow)	w	2	5	6	6		**19**	**3.8**	5	5	4	6	6	5	6	**37**	**5.29**
933	YELLOW-MANTLED WIDOWBIRD Euplectes macrourus	G	3			2		**5**	**1**		3					3	**6**	**0.86**
937	GROSBEAK WEAVER Amblyospiza albifrons (Thick-billed Weaver)	fW			6			**6**	**1.2**								**0**	**0.00**
959	RED-BILLED FIREFINCH Lagonosticta senegala							**0**	**0**	4			4				**8**	**1.14**
969	COMMON WAXBILL Estrilda astrild	wG			4	6		**10**	**2**								**0**	**0.00**
970	BLACK-CROWNED WAXBILL Estrilda nonnula	f	4					**4**	**0.8**								**0**	**0.00**
980	BRONZE MANNIKIN Lonchura cucullata		6	4	5	6	4	**25**	**5**		5	6		6		6	**23**	**3.29**
984	VILLAGE INDIGOBIRD Vidua chalybeata (Red-billed Firefinch Indigobird)						3	**3**	**0.6**								**0**	**0.00**

		River sites								Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
994	BLACK-THROATED CANARY Serinus atrogularis		2					**2**	**0.4**								**0**	**0.00**
995	YELLOW-FRONTED CANARY Serinus mozambicus		6	3	3		4	**16**	**3.2**						5	3	**8**	**1.14**
999	STREAKY SEEDEATER Serinus striolatus	f				2		**2**	**0.4**								**0**	**0.00**
77	PALM-NUT VULTURE Gypohierax angolensis							**0**	**0**							3	**3**	**0.43**
268	AFRICAN GREEN-PIGEON Treron calvus	F			4			**4**	**0.8**				5				**5**	**0.71**
293	RED-HEADED LOVEBIRD Agapornis pullarius	F						**0**	**0**						4		**4**	**0.57**
385	LITTLE BEE-EATER Merops pusillus	G						**0**	**0**		4				6		**10**	**1.43**
404	GREEN WOOD-HOOPOE Phoeniculus purpureus (Red-billed Wood-hoopoe)					5		**5**	**1**							5	**5**	**0.71**
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f						**0**	**0**		6						**6**	**0.86**
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps (White-headed Rough-wing)	R-RRf						**0**	**0**						5		**5**	**0.71**
505	LESSER STRIPED SWALLOW Hirundo abyssinica						6	**6**	**1.2**				5	5			**10**	**1.43**
515	YELLOW WAGTAIL Motacilla flava	PMPwG						**0**	**0**				5				**5**	**0.71**
522	AFRICAN PIPIT Anthus cinnamomeus (Grassland Pipit or Richards Pipit)	G						**0**	**0**				1				**1**	**0.14**
601	SOOTY CHAT Myrmecocichla nigra							**0**	**0**				6				**6**	**0.86**
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	f					6	**6**	**1.2**			6					**6**	**0.86**

		River sites								Impact area sites								
Atlas No.	**COMMON NAME Scientific Name (Alternative Name)**	**Class**	**Kiru-ruma**	**Rwong-oboka**	**Nyaka-rambi**	**Nyaka-shure**	**Nyam-abale**	**Total**	**Rel. Abun**	**Group Farm**	**Nyaka-shure**	**Nyaka-rambi**	**Mata-nda II**	**Mata-nda I**	**Kash-ojwa**	**Bihom-borwa**	**Tot al**	**Rel. Abun**
742	BLACK-AND-WHITE FLYCATCHER Bias musicus (Vanga Flycatcher)	f						**0**	**0**		4						**4**	**0.57**
794	COLLARED SUNBIRD Hedydipna collaris	F					5	**5**	**1**			5			3		**8**	**1.14**
809	SUPERB COPPER SUNBIRD Cinnyris superba	F						**0**	**0**				5				**5**	**0.71**
810	COPPER SUNBIRD Cinnyris cupreus	fw						**0**	**0**						3		**3**	**0.43**
833	BLACK-CROWNED TCHAGRA Tchagra senegalus			6				**6**	**1.2**				3				**3**	**0.43**
836	NORTHERN PUFFBACK Dryoscopus gambensis	F			3			**3**	**0.6**								**0**	**0.00**
900	HOLUB'S GOLDEN WEAVER Ploceus xanthops	w			2			**2**	**0.4**								**0**	**0.00**
924	RED-HEADED QUELEA Quelea erythrops	A						**0**	**0**				3				**3**	**0.43**
925	RED-BILLED QUELEA Quelea quelea	A						**0**	**0**				3				**3**	**0.43**
928	BLACK-WINGED BISHOP Euplectes hordeaceus (Fire-crowned Bishop)				3	3		**6**	**1.2**			6	5		3		**14**	**2.00**
985	PIN-TAILED WHYDAH Vidua macroura	G			5			**5**	**1**		3		2				**5**	**0.71**
	Number of species per site		**48**	**27**	**31**	**21**	**28**	**155**	**31**	**35**	**25**	**22**	**34**	**20**	**23**	**25**	**184**	**26.29**

Table 1 Bird species categorised by habitat and IUCN classification

Atlas No.	COMMON NAME Scientific Name	Habitat class	Classification	IUCN Category
6	LONG-TAILED CORMORANT Phalacrocorax africanus	W	Water	LC
25	GREY HERON Ardea cinerea	W	Water	LC
27	GOLIATH HERON Ardea goliath	W	Water	LC
93	AFRICAN MARSH HARRIER Circus ranivorus	W	Water	LC
178	BLACK CRAKE Amaurornis flavirostris	W	Water	LC
185	GREY CROWNED CRANE Balearica regulorum	W	Water	EN
201	WATER THICK-KNEE Burhinus vermiculatus	W	Water	LC
213	THREE-BANDED PLOVER Charadrius tricollaris	W	Water	LC
221	AFRICAN WATTLED LAPWING Vanellus senegallus	W	Water	LC
245	MARSH SANDPIPER Tringa stagnatilis	W	Water	LC
250	COMMON SANDPIPER Actitis hypoleucos	W	Water	LC
28	HAMERKOP Scopus umbretta	w	Near water	LC
30	AFRICAN OPENBILL STORK Anastomus lamelligerus	w	Near water	LC
36	MARABOU STORK Leptoptilos crumeniferus	w	Near water	LC
39	HADADA IBIS Bostrychia hagedash	w	Near water	LC
520	AFRICAN PIED WAGTAIL Motacilla aguimp	w	Near water	LC
638	RED-FACED CISTICOLA Cisticola erythrops	w	Near water	LC
647	WINDING CISTICOLA Cisticola galactotes	w	Near water	LC
82	RÜPPELL'S VULTURE Gyps rueppellii	G	Grassland	LC
88	BATELEUR Terathopius ecaudatus	G	Grassland	LC
529	YELLOW-THROATED LONGCLAW Macronyx croceus	G	Grassland	LC
812	COMMON FISCAL Lanius collaris	G	Grassland	LC
142	HELMETED GUINEAFOWL Numida meleagris	G	Grassland	LC
109	LIZARD BUZZARD Kaupifalco monogrammicus	F	Forest generalist	LC
122	LONG-CRESTED EAGLE Lophaetus occipitalis	F	Forest generalist	LC
155	SCALY FRANCOLIN Francolinus squamatus	F	Forest generalist	LC
268	AFRICAN GREEN-PIGEON Treron calvus	F	Forest generalist	LC
270	TAMBOURINE DOVE Turtur tympanistria	F	Forest generalist	LC
271	BLUE-SPOTTED WOOD DOVE Turtur afer	F	Forest generalist	LC
273	EMERALD-SPOTTED WOOD DOVE Turtur chalcospilos	F	Forest generalist	LC
293	RED-HEADED LOVEBIRD Agapornis pullarius	F	Forest generalist	LC
302	ROSS'S TURACO Musophaga rossae	F	Forest generalist	LC

Atlas No.	COMMON NAME Scientific Name	Habitat class	Classification	IUCN Category
578	SNOWY-CROWNED ROBIN-CHAT Cossypha niveicapilla	F	Forest generalist	LC
692	GREEN CROMBEC Sylvietta virens	F	Forest generalist	LC
723	AFRICAN DUSKY FLYCATCHER Muscicapa adusta	F	Forest generalist	LC
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	F	Forest generalist	LC
794	COLLARED SUNBIRD Hedydipna collaris	F	Forest generalist	LC
796	OLIVE-BELLIED SUNBIRD Cinnyris chloropygius	F	Forest generalist	LC
319	KLAAS' CUCKOO Chrysococcyx klaas	f	Forest visitor	LC
547	YELLOW-THROATED GREENBUL Chlorocichla flavicollis	f	Forest visitor	LC
562	COMMON BULBUL Pycnonotus barbatus	f	Forest visitor	LC
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	f	Forest visitor	LC
588	BROWN-BACKED SCRUB-ROBIN Cercotrichas hartlaubi	f	Forest visitor	LC
612	AFRICAN THRUSH Turdus pelios	f	Forest visitor	LC
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f	Forest visitor	LC
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	f	Forest visitor	LC
746	BROWN-THROATED WATTLE-EYE Platysteira cyanea	f	Forest visitor	LC
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f	Forest visitor	LC
810	COPPER SUNBIRD Cinnyris cupreus	f	Forest visitor	LC
811	AFRICAN YELLOW WHITE-EYE Zosterops senegalensis	f	Forest visitor	LC
897	SPECTACLED WEAVER Ploceus ocularis	f	Forest visitor	LC
907	VIEILLOT'S BLACK WEAVER Ploceus nigerrimus	f	Forest visitor	LC
283	RED-EYED DOVE Streptopelia semitorquata	f	Forest visitor	LC
286	RING-NECKED DOVE Streptopelia capicola	f	Forest visitor	LC
419	CROWNED HORNBILL Tockus alboterminatus	f	Forest visitor	LC
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f	Forest visitor	LC
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	f	Forest visitor	LC
477	GREY WOODPECKER Dendropicos goertae	f	Forest visitor	LC
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps	f	Forest visitor	LC

Appendix II: Coordinates of sampled habitats within the Matanda area

Area	Coordinates	Photograph
Reservoir area This is adjacent to the Forest Reserve although agriculture dominates the landscape	0802535; 9913487	
Farm Group area The tank area is dominated with annual crops especially maize in various stages of growth.	0804761; 9926395	

Appendix III Mammal species in the different sites affected by the Matanda Irrigation Scheme

Order name	Family Name	Scientific name	Common name	IUCN status	Kish-unju	Group farm B	Nyaka-shure	Nyaka-rambi	Rwang-oboka
Artiodactyla	Bovidae	*Tragelaphus sylvaticus*	Bush buck	LC	0	0	0	6	0
Artiodactyla	Hippopotamidae	*Hippopotamus amphibius*	Hippopotamus	VU	0	0	0	0	QE, 2
Chiroptera	Pteroporididae	*Epomophorus labiatus*	Ethiopian Epauletted Fruit Bat	LC	0	4	0	0	0
Eulipotyphla	Soricidae	*Crocidura olivieri*	African giant shrew	LC	1	0	0	1	0
Rodentia	Gliridae	*Graphiurus murinus*	African dwarf mouse	LC	0	0	1	0	0
Rodentia	Muridae	*Arvicanthis niloticus*	African grass rat	LC	0	1	1	1	0
Rodentia	Muridae	*Gramommys dolichurus*	Woodland thicket rat	LC	0	0	0	1	0
Rodentia	Muridae	*Lemniscomys striatus*	Typical stripped grass mouse	LC	0	1	0	0	0
Rodentia	Muridae	*Lophuromys sikapusi*	Rusty-bellied Brush-furred Rat	LC	2	7	0	1	1
Rodentia	Muridae	*Mastomys natalensis*	Natal multimmate rat	LC	1	4	2	3	1
Rodentia	Muridae	*Rattus rattus*	The black rat	LC	2	0	1	1	0
Rodentia	Spalacidae	*Tachyoryctes splendens*	East African mole rat	LC	1	1	1	1	0
Rodentia	Sciuridae	*Xerus erythropus*	Side stripped squirrel	LC	3	0	3	2	0
Rodentia	Thryonomyidae	*Thryonomys gregorianus*	Lesser cane rat	LC	1	0	1	1	1
Rodentia	Thryonomyidae	*Thryonomys swinderianus*	Greater cane rat	LC	1	0	1	1	1
Carnivora	Herpestidae	*Atilax paludinosus*	Marsh mongoose	LC	4	0	3	5	2
Carnivora	Viverridae	*Civettictis civetta*	African civet	LC	1	0	1	1	0
Carnivora	Felidae	*Felis lybica*	African wild cat	LC	2	0	0	1	0
Carnivora	Felidae	*Leptailurus serval*	Serval cat	LC	0	0	0	3	0
Carnivora	Mustelidae	*Hydrictis maculicollis*	Spotted necked otter	NT	2	0	0	0	0
Carnivora	Felidae	*Panthera leo*	African lion	VU	0	0	0	0	QE, 1
Proboscidae	Elephantidae	*Loxodonta africana*	African bush elephant	VU	0	0	0	0	QE, 4
Primates	Cercopithecidae	*Chlorocebus pygerythrus*	Vervet monkey	LC	10	0	0	0	0
Primates	Cercopithecidae	*Colobus guereza*	Black and white Colobus monkey	LC	2	0	0	0	0
Total number of individuals					**33**	**18**	**15**	**29**	**6**
Species richness					**14**	**5**	**10**	**15**	**5**
Species diversity					**2.32**	**1.52**	**2.17**	**2.28**	**1.6**
Species evenness					**0.88**	**0.85**	**0.94**	**0.84**	**0.99**

Appendix IV. Some of the mammalian species recorded

Plate 1: Ethiopian Epauletted Fruit Bat (*Epomophorus labiatus*) at 811563, 920748.

Plate 2: African giant shrew (*Crocidura olivieri*) at 812156, 920859.

Plate 3: African grass rat (*Arvicanthis niloticus*) at 812035, 920906.

Plate 4: Woodland thicket rat (*Gramommys dolichurus*) at 811896, 920925.

Plate 5: Typical grass stripped mouse (*Lemniscomys striatus*) at 804766, 926446.

Plate 6: Rusty-bellied Brush-furred Rat (*Lophuromys sikapusi*) at 812207, 920807.

Plate 7: Natal multimammate rat (*Mastomys natalensis*) at 804803, 926363.

Plate 8: The black rat (*Rattus rattus*) at 802569, 913538.

Plate 9: Side stripped squirrel (*Xerus erythropus*) at 812196, 920817.

Plate 10: Marsh mongoose footprints (*Atilax paludinosus*) at 811858, 921682.

Plate 11: Cape hare (*Lepus capensis*) at 804757,926490.

Plate 12: Black and white colobus monkey (*Colobus guereza*) on the northern side at 811832, 921691.


Plate 13: African dwarf mouse (*Graphiurus murinus*) at 803457, 921951


Plate 14: Moon shrew (*C. luna*) at 808991, 931237


Plate 15: African black shrew (*C. nigrofusca*) at 808841, 931413


Plate 16: A hole made by the East African mole rat (*Tachyoryctes splendens*) at 809723, 926986.


Plate 17: Skat of the African civet (*Civettictis civetta*) at 808854, 931663

Appendix V Butterfly species recorded in the Matanda project areas

Family /Species	Eco. Type	Mira ra	Rwan-gobo	Nyak-ashu	Kiru-ruma	Kash-ojwa	Nyam-abale	Matan-da2	Mata-nda1	Bihom-borwa
Nymphalidae										
Acraea acerata	W	1		1		1		1		1
Acraea encedon	W		1	1		1	1	1		1
Acraea eponina	W	1		1		1		1		1
Acraea natalica	W				1				1	
Acraea neobule	W		1			1	1			1
Acraea pharsalus	f.	1	1			1	1			1
Acraea zetes	W	1	1	1		1	1	1		1
Amauris niavius	W				1				1	
Amauris tartarea	f.					1				1
Bicyclus anynana	O	1	1	1	1	1	1	1	1	
Bicyclus safitza	W	1	1			1	1			1
Bicyclus vulgaris	W	1		1		1		1		
Byblia anvatara	M			1		1		1		1
Charaxes candiope	W	1	1	1		1	1	1		
Charaxes etesipe	f.	1		1		1		1		1
Charaxes jasius	O				1				1	
Charaxes numenes	f.					1	1			1
Charaxes varanes	W	1	1			1	1			1
Charaxes zoolina	O			1		1	1	1		1
Danaus chrysippus	M				1				1	
Eurytela dryope	W	1				1				1
Hamanumida daedalus	W	1	1	1	1	1	1	1	1	1
Hypolimnas misippus	M	1	1				1			
Junonia chorimene	O	1		1		1		1		
Junonia oenone	W	1		1						
Junonia orithya	M		1	1		1	1	1		
Junonia sophia	W	1		1				1		
Junonia terea	W				1				1	
Melanitis leda	W	1	1			1	1			1
Neptis metella	f.		1			1	1			1
Neptis saclava	W	1	1	1		1	1	1		1
Neptis serena	W				1				1	
Precis Octavia	W	1				1				1

Family /Species	Eco. Type	Mira ra	Rwan-gobo	Nyak-ashu	Kiru-ruma	Kash-ojwa	Nyam-abale	Matan-da2	Mata-nda1	Bihom-borwa
Salamis parhassus	f.	1	1	1	1	1	1	1	1	1
Sallya garega	M	1	1				1			1
Sallya occidentalium	M	1		1				1		
Tirumala petiverana	M	1		1				1		1
Ypthima albida	f.	1	1	1		1	1			1
Ypthima asterope	O	1		1		1		1		1
Ypthima doleta	W				1				1	
Ypthomomorpha itonia	f.	1	1			1	1			1
Pieridae										
Appias epaphia	M	1	1	1		1	1	1		1
Belenois aurota	M				1				1	
Belenois creona	M	1				1				1
Belenois thysa	f.	1	1	1	1	1	1	1	1	
Catopsilia florella	M	1		1				1		
Colotis antevippe	O	1		1		1		1		
Colotis danae	W	1	1	1			1	1		
Colotis eucharis	W	1		1		1		1		1
Colotis evagore	M				1				1	
Dixeia pigea	W	1	1			1	1			1
Eurema brigitta	M	1	1			1	1			1
Eurema hapale	S	1	1	1		1	1	1		1
Eurema hecabe	M				1				1	
Eurema regularis	W	1				1				1
Leptosia nupta	F	1	1	1	1	1	1	1	1	1
Mylothris rubricosta	S	1	1			1	1			1
Nepheronia buqueti	O	1		1		1		1		1
Lycaenidae										
Anthene amarah	O	1	1	1		1	1	1		1
Anthene definita	W	1		1		1		1		1
Anthene lunulata	W				1				1	
Azanus jesous	M	1	1			1	1			1
Cupidopsis cissus	W	1	1			1	1			1
Eicochrysops hippocrates	W	1	1	1		1	1	1		1
Euchrysops malathana	O				1				1	
Freyeria trochylus	W	1				1				1

Family /Species	Eco. Type	Mira ra	Rwan-gobo	Nyak-ashu	Kiru-ruma	Kash-ojwa	Nyam-abale	Matan-da2	Mata-nda1	Bihom-borwa
Leptotes pirithous	M	1	1	1	1	1	1	1	1	1
Tuxentius cretosus	O	1	1			1	1			1
Zizeeria knysna	W	1		1		1		1		1
Zizina antanossa	W	1		1		1				1
Zizula hylax	W	1	1	1		1	1	1		1
Hesperiidae										
Ankola fan	F				1				1	
Borbo fallax	O	1	1			1	1			1
Coeliades forestans	W	1	1			1				1
Eretis lugens	W	1	1	1		1	1	1		1
Pelopidas mathias	M				1				1	
Papilionidae										
Papilio bromius	f.	1	1	1	1	1	1	1	1	1
Papilio dardanus	W	1		1		1		1		1
Papilio demodocus	M	1		1				1		1
Total = 79		57	37	41	21	56	38	38	21	52

Appendix VI: Herptilian species recorded in Matanda Dam project area

Common Name	Scientific name	Rwangoboko	Nyamabare	Matanda 2	Matanda 1	Kashojwa	Bihomborwa	Kameme	Rwerere	Kazinga	Species status
Blue-headed agama lizard	*Acanthocercus atricollis*	2	1	0	0	2	1	7	0	0	**LC**
Spotted bush snake	*Philothamnus semivariegatus*	0	0	0	0	0	0	0	2	0	**LC**
Graceful chameleon	*Chamaeleo gracilis*	2	0	0	0	1	2	0	1	3	**Appendix ii**
Angola green snake	*Philothamnus angolensis*	0	0	0	0	1	1	1	0	0	**LC**
Forest cobra	*Naja melanoleuca*	1	0	0	0	0	1	0	0	0	**LC**
Tropical house gecko	*Hemidactylus mabouia*	0	0	2	0	2	0	3	2	0	**LC**
Brown house snake	*Lamprophis capensis*	0	0	1	1	1	0	0	0	0	**LC**
Trachylepis maculilabris	Speckle-lipped skink	0	0	2	0	0	0	1	3	0	**LC**
Puff adder	*Bitis arietans*	0	0	0	0	0	0	1	0	0	**LC**
Christy's tree frog	*Leptopelis christyi*	0	0	5	0	0	0	0	0	0	**LC**
Flat-backed toad	*Sclerophrys maculata*	3	0	0	0	0	0	1	0	0	**LC**
Common African toad	*Sclerophrys regularis*	15	0	0	3	2	0	7	4	0	**LC**
Kivu reed frog	*Hyperolius kivuensis*	4	3	0	0	0	5	0	0	3	**LC**
Banana reed frog	*Afrixalis quadrivittatus*	4	6	0	0	0	0	5	0	3	**LC**
Common reed frog	*Hyperolius viridiflavus*	1	0	0	0	0	0	0	0	0	**LC**
Senegal kassina	*Kassina senegalensis*	3	3	0	0	0	0	0	0	0	**LC**
Cinnamon-bellied reed frog	*Hyperolius cinnamomeoventris*	0	0	0	0	0	3	0	0	0	**LC**
Mascarene redged frog	*Ptychadena mascareniensis*	5	9	0	5	6	6	13	0	10	**LC**
Anchieta's ridged frog	*Ptychadena anchietae*	2	0	1	0	0	3	0	0	3	**LC**

Appendix VII: Species recorded in different sites in Matanda project area

Cell/Village Name	*Amphibian/Reptile species*	Abundance	Common name	Family	Northings	Eastings
Rwangoboka	*Naja melanoleuca*	1	Forest cobra	Elapidae	802571	9919042
	Chamaeleo gracilis	2	Graceful chameleon	Chamaeleonidae	802571	9919042
	Acanthocercus atricollis	1	Blue-headed agama lizard	Agamidae	802480	9919088
	Hyperolius viridiflavus	1	Common reed frog	Hyperoliidae	802505	9919126
	Ptychadena mascareniensis	2	Mascarene redged frog	Ptychadenidae	802505	9919126
	Ptychadena anchietae	2	Anchieta's ridged frog	Ptychadenidae	802505	9919126
	Sclerophrys regularis	3	Common African toad	Bufonidae	802505	9919126
	Acanthocercus atricollis	1	Blue-headed agama lizard	Agamidae	802431	9919110
	Sclerophrys regularis	6	Common African toad	Bufonidae	802465	9918992
	Kassina senegalensis	3	Senegal running frog	Hyperoliidae	802465	9918992
	Afrixalis quadrivittatus	4	Banana reed frog	Hyperoliidae	802465	9918992
	Ptychadena mascareniensis	3	Mascarene redged frog	Ptychadenidae	802465	9918992
	Hyperolius kivuensis	4	Common African toad	Bufonidae	802465	9918992
	Sclerophrys regularis	6	Common African toad	Bufonidae	802465	9918992
	Sclerophrys maculata	3	Flat-backed toad	Bufonidae	802465	9918992
Nyamabare	*Acanthocercus atricollis*	1	Blue-headed agama lizard	Agamidae	802975	9915348
	Kassina senegalensis	3	Senegal running frog	Hyperoliidae	802898	9915402
	Chamaeleo gracilis	1	Graceful chameleon	Chamaeleonidae	802898	9915402
	Ptychadena mascareniensis	2	Mascarene redged frog	Ptychadenidae	802898	9915402
	Afrixalis quadrivittatus	2	Banana reed frog	Hyperoliidae	802861	9915446
	Ptychadena mascareniensis	1	Mascarene redged frog	Ptychadenidae	802911	9915442
	Ptychadena mascareniensis	1	Mascarene redged frog	Ptychadenidae	802900	9915490
	Ptychadena mascareniensis	1	Mascarene redged frog	Ptychadenidae	802912	9915462
	Hyperolius kivuensis	3	Kivu reed frog	Hyperoliidae	802906	9915318
	Afrixalis quadrivittatus	4	Banana reed frog	Hyperoliidae	802906	9915318
	Ptychadena mascareniensis	4	Mascarene redged frog	Ptychadenidae	802906	9915318
Matanda 2	*Leptopelis christyi*	5	Christy's tree frog	Arthrolepidae	804246	9929266

Cell/Village Name	Amphibian/Reptile species	Abundance	Common name	Family	Northings	Eastings
	Trachylepis maculilabris	1	Speckle-lipped skink	Scincidae	804097	9929160
	Lamprophis capensis	1	Brown house snake	Lamrophidae	804062	9929170
	Hemidactylus mabouia	2	Tropical house gecko	Gekkonidae	804062	9929170
	Trachylepis maculilabris	1	Speckle-lipped skink	Scincidae	804131	9929272
	Ptychadena anchietae	1	Anchieta's ridged frog	Ptychadenidae	804191	9929292
Matanda 1	*Lamprophis capensis*		Brown house snake	Lamrophidae	805212	9928690
	Sclerophrys regularis	1	Common African toad	Bufonidae	805212	9928690
	Ptychadena mascareniensis	3	Mascarene redged frog	Ptychadenidae	805212	9928690
	Sclerophrys regularis	2	Common African toad	Bufonidae	805165	9928594
	Ptychadena mascareniensis	2	Mascarene redged frog	Ptychadenidae	805174	9928498
Kashojwa	*Hemidactylus mabouia*	1	Tropical house gecko	Gekkonidae	799529	9920560
	Ptychadena mascareniensis	4	Mascarene redged frog	Ptychadenidae	799451	9920592
	Sclerophrys regularis	2	Common African toad	Bufonidae	799403	9920634
	Acanthocercus atricollis	2	Blue-headed agama lizard	Agamidae	799403	9920634
	Lamprophis capensis	1	Brown house snake	Lamrophidae	799403	9920634
	Hemidactylus mabouia	1	Tropical house gecko	Gekkonidae	799403	9920634
	Chamaeleo gracilis	1	Graceful chameleon	Chamaeleonidae	799308	9920694
	Philothamnus angolensis	1	Angola green snake	Colubridae	799308	9920694
	Ptychadena mascareniensis	2	Mascarene redged frog	Ptychadenidae	799272	9920706
Bihomborwa	*Hyperolius kivuensis*	3	Kivu reed frog	Hyperoliidae	797251	9914340
	Hyperolius cinnamomeoventris	2	Cinnamon-bellied reed frog	Hyperoliidae	797251	9914340
	Ptychadena mascareniensis	1	Mascarene redged frog	Ptychadenidae	797214	9914336
	Philothamnus angolensis	1	Angola green snake	Colubridae	797214	9914336
	Naja melanoleuca	1	Forest cobra	Elapidae	797159	9914310
	Ptychadena mascareniensis	5	Mascarene redged frog	Ptychadenidae	797159	9914310
	Ptychadena anchietae	3	Anchieta's ridged frog	Ptychadenidae	797159	9914310
	Chamaeleo gracilis	2	Graceful chameleon	Chamaeleonidae	797159	9914310

Cell/Village Name	Amphibian/Reptile species	Abundance	Common name	Family	Northings	Eastings
	Acanthocercus atricollis	1	Blue-headed agama lizard	Agamidae	797157	9914380
	Hyperolius kivuensis	2	Kivu reed frog	Hyperoliidae	797069	9914362
	Hyperolius cinnamomeoventris	1	Cinnamon-bellied reed frog	Hyperoliidae	797069	9914362
Kameme	*Ptychadena mascareniensis*	5	Mascarene redged frog	Ptychadenidae	803556	9933536
	Afrixalis quadrivittatus	3	Banana reed frog	Hyperoliidae	803556	9933536
	Sclerophrys regularis	5	Common African toad	Bufonidae	803556	9933536
	Sclerophrys maculata	4	Flat-backed toad	Bufonidae	803556	9933536
	Hemidactylus mabouia	1	Tropical house gecko	Gekkonidae	803571	9933464
	Acanthocercus atricollis	3	Blue-headed agama lizard	Agamidae	803571	9933464
	Sclerophrys regularis	7	Common African toad	Bufonidae	803571	9933464
	Ptychadena mascareniensis	6	Mascarene redged frog	Ptychadenidae	803589	9933322
	Sclerophrys regularis	5	Common African toad	Bufonidae	803589	9933322
	Ptychadena mascareniensis	4	Mascarene redged frog	Ptychadenidae	803591	9933224
	Sclerophrys regularis	5	Common African toad	Bufonidae	803591	9933224
	Trachylepis maculilabris	2	Speckle-lipped skink	Scincidae	803621	9933148
	Bitis arietans	1	Puff adder	Viparidae	803621	9933148
	Philothamnus angolensis	1	Angola green snake	Colubridae	803621	9933148
	Sclerophrys regularis	5	Common African toad	Bufonidae	803665	9932866
Rwerere	*Hemidactylus mabouia*	1	Tropical house gecko	Gekkonidae	801885	9927262
	Trachylepis maculilabris	2	Speckle-lipped skink	Scincidae	801885	9927262
	Sclerophrys regularis	3	Common African toad	Bufonidae	801885	9927262
	Chamaeleo gracilis	1	Graceful chameleon	Chamaeleonidae	801844	9927442
	Philothamnus semivariegatus	1	Spotted bush snake	Colubridae	801844	9927442
	Sclerophrys regularis	2	Common African toad	Bufonidae	801844	9927442
	Ptychadena mascareniensis	2	Mascarene redged frog	Ptychadenidae	801857	9927492
Kazinga Upper cell	*Afrixalis quadrivittatus*	3	Banana reed frog	Hyperoliidae	798189	9921314
	Ptychadena mascareniensis	3	Mascarene redged frog	Ptychadenidae	798189	9921314
	Ptychadena anchietae	2	Anchieta's ridged frog	Ptychadenidae	798189	9921314

Cell/Village Name	*Amphibian/Reptile species*	Abundance	Common name	Family	Northings	Eastings
	Hyperolius kivuensis	3	Kivu reed frog	Hyperoliidae	798189	9921314
	Ptychadena mascareniensis	3	Mascarene redged frog	Ptychadenidae	798213	9921338
	Ptychadena mascareniensis	4	Mascarene redged frog	Ptychadenidae	798259	9921360
	Chamaeleo gracilis	1	Graceful chameleon	Chamaeleonidae	798259	9921360
	Hyperolius kivuensis	3	Kivu reed frog	Hyperoliidae	798259	9921360

Appendix VIII Location and habitat description at component structures along River Kiruruma, Matanda

Kiruruma Upstream at 35 M 0812191, UTM 9920843 habitat characteristics and flow dynamics

***Habitat description*:** This section of the river is just located below the Bridge area. The river was flooded - characterised by fast-flowing, brown silted water, rapids and also falls at some points. The substratum submerged. The riverbanks were generally cultivated with major crops, including Banana, Eucalyptus plantation, coffee, rice and sugar cane. At the shoreline, there are some elephant grass shrubs. River width around 20m; dept could not be established due to high water volume. In all, NO sampling for macroinvertebrates was possible due to safety.

2. River Kiruruma Midstream at 35 M 0809783, UTM 9926900 around Kibalama village. Its habitat characteristics and flow dynamics

***Habitat description*:** Located in a U shape valley and very high water levels due to flooding. The river channel width is 12 – 18 m. There are pockets of reeds and papyrus. Sugar can and rice cultivation were still prominent at the riverbanks although there are also expanses of shrubs and bushes. Due to the high water levels, experimental fishing was disturbed while macro invertebrates were collected abit further from this point.

6. Kiruruma Downstream at 35 M 0809016, UTM 9931412 habitat characteristics and flow dynamics

***Habitat description*:** Located in a U-shaped valley with fast-flowing water, water levels of about 1.5 -2.1m. The channel width was between 5-7 m. This portion of the river has a plantation of millet. The river has been channeled to enable road and bridge construction. Herds of cattle were seen drinking from this point thus a potential source for N and P.

Appendix IX Vegetation assemblages within Matanda irrigation scheme

35 M 802516 9913513	Riverine bushed wooded grassland degraded with Eucalyptus growing and crop cultivation	*Eucalyptus grandis* *Manihot esculenta* *Markhamia lutea* *Albizia grandibracteata* *Pennisetum purpureum* *Vernonia amygdalina* *Coffea robusta*
35 M 802636 9913571	Degraded Riverine woodland with Sugarcane and Eucalyptus growing	*Coix lacryma-jobi* *Saccharum officinale* *Pennisetum purpureum* *Pseudospondias microcarpa* *Macaranga grandifolia* *Markhamia lutea* *Dracaena fragrans*
35 M 802689 9913713	Riverine Bushland degraded with Finger millet, Maize, sweet potato, Cassava and Eucalyptus growing	*Pennisetum purpureum* *Lantana camara* *Sesbania sesban* *Markhamia lutea* *Marantochloa purpurea* *Macaranga grandifolia* *Dracaena fragrans*
35 M 802757 9913788	Eucalyptus woodlot at the edge of sugarcane garden along the river Kiruruma	*Pterygota mildbraedii* *Ficus valis-chaude* *Eucalyptus grandis* *Vernonia amygdalina* *Pycnanthus angolensis* *Saccharum officinale* *Pennisetum purpureum* *Mitragyna stipulosa* *Leersia hexandra*
35 M 804792 9926402	Maize garden mixed beans with scattered trees of Ficus mucuso	*Zea mays* *Phaseolus vulgaris* *Ficus mucuso*
35 M 804772 9926436	Grassland fallow at the edge of maize garden	*Impereta cylindrica* *Targetis minuta* *Bidens pilosa* *Brachiaria scalaris* *Urena lobate* *Panicum maximum* *Melinus repens*
35 M 804827 9926318	Manihot garden at edge of Zea mays	*Manihot esculenta* *Zea mays*
35 M 802867 9914225	Eucalyptus woodlot and riverine bushed woodland	*Pseudospondias microcarpa* *Marantochloa purpurea* *Markhamia lutea* *Cola gigantea* *Alchornea cordifolia* *Paspalidum germinatum* *Erythrina abyssinica*
35 M 802858 9914288	Riverine bushed woodland partly degraded with Eucalyptus growing	*Pseudospondias microcarpa* *Albizia sp* *Ficus ovata* *Dombeya sp*

		Manilkara dawei *Albizia grandibracteata* *Pycnanthus angolensis* *Bridelia micrantha* *Sesbania sesban* *Mangifera indica*
35 M 802694 9914618	Eucalyptus-Coffea robusta plantation	*Eucalyptus grandis* *Coffea robusta* *Musa sp* *Panicum deustum* *Pennisetum purpureum* *Sesbania sesban*
35 M 802640 9914940	Coffea robusta farm along the river	*Coffea robusta* *Bridelia micrantha* *Mitragyna stipulosa* *Sesbania sesban* *Lantana camara* *Macaranga schweinfurthii*
Rwangoboka cell 35 M 802505 9919090 Alt: 1067 m	Eucalyptus woodlot along the river surrounded by sugarcane, Maize and Cassava garden	*Eucalyptus grandis* *Saccharum officinalle* *Zea mays* *Manihot esculenta* *Lantana camara* *Hoslundia opposite* *Pseudospondias micracarpa* *Phoenis reclinata* *Pennisetum polystachion* *Sesbania sesban* *Markhamia lutea*
Nyakasule village 35 M 805787 9923756 Alt: 1104 m	Coffee plantation in scattered Homestead	*Coffea robusta* *Musa sp* *Artocarcarpus heterophyllus* *Persea Americana* *Abilizia coriaria* *Panicum maximum* *Bidens pilosa*
35 M 805747 9923769 Alt: 1101 m	Maize garden in settlement opposite Musa-Coffea garden	*Zea mays* *Coffea robusta* *Musa sp*
35 M 805678 9923788 Alt:1095 m	Coffee plantation in settlement opposite sweet potato, Cassava and maize garden with scattered trees	*Coffea robusta* *Albizia coriaria* *Markhamia lutea* *Artocarpus heterophyllus* *Ricinus communis* *Zea mays* *Thevetia peruviana* *Melia azadirachta* *Blighia unijugata*
35 M 805686 9923831 Alt:1087 m	Sugarcane plantation	*Saccharum officinalle*
35 M 805636 9923765 Alt:1090 m	Coffee garden	*Coffea robusta*
35 M 805592 9923719 Alt:1089 m	Musa garden with scattered coffee trees	*Musa sp* *Coffea robusta*
35 M 805558 9923687	Sweet potato garden	*Ipomoea batatus*

Alt:1088 m		
35 M 805536 9923681 Alt:1087 m	Maize garden in Eucalyptus woodlot	*Zea mays* *Eucalyptus grandis* *Sorghum bicolor* *Bidens pilosa* *Lantana camara* *Panicum maximum* *Erythrina abyssinica* *Senna spectabilis* *Targetis minuta*
35 M 805475 9923643 Alt:1083 m	Millet, Maize, Sunflower garden	*Eleusine colona* *Zea mays* *Helianthus annus*
35 M 805443 9923601 Alt:1077 m	Millet and maize garden	*Eleusine colona* *Zea mays*
35 M 805408 9923593 Alt:1076 m	Coffee garden	*Coffea robusta* *Artocarpus heterophyllus* *Flueggea virosa*
35 M 805382 9923610 Alt:1075 m	Millet, Maize, banana garden with scattered trees of *Mangifera indica, Markhamia lutea, Artocarpus heterophyllus, Persea americana*	*Musa sp* *Coffea robusta* *Eleusine colona* *Zea mays* *Mangifera indica,* *Markhamia lutea,* *Artocarpus heterophyllus,* *Persea americana*
35 M 805357 9923617 Alt:1072 m	Sweet potato, maize, cassava, Millet and Musa garden	*Ipomoea batatus* *Zea mays* *Manihot esculenta* *Musa sp* *Eleusine colona*
35 M 805281 9923633 Alt:1068 m	Millet, Maize, Cassava, sorghum garden	*Zea mays* *Manihot esculenta* *Eleusine colona* *Sorghum bicolor*
35 M 805223 9923662 Alt:1054 m	Bushed grassland on steep slope with scattered trees (contour) adjacent Euclyptus woodlot	*Panicum maximum* *Lantana camara* *Hoslundia opposita* *Trema orientalis* *Markhamia lutea* *Spathodea nilotica* *Eucalyptus grandis* *Vernonia amygdalina* *Rhus vulgalis Meikle* *Albizia grandibracteata* *Flueggea virosa* *Mangifera indica* *Antiaris toxicaria* *Tephrosia elata* *Hyparrhenia rufa* *Combretum molle* *Cycnium herzfeldianum* *Neonotonia wightii* *Vigna reticulata* *Vigna vexillata*

		Ficus asperifolia *Albizia coriaria Oliv.* *Setaria homonyma* *Hibiscus diversifolius* *Cordia milleni Bak.* *Acalypha ornata* *Acalypha bipartita* *Ficus exasperata*
35 M 805176 9923702 Alt:1035 m	Maize, Millet garden	*Eleusine colona* *Zea mays*
35 M 805134 9923732 Alt:1021 m	Rice garden along the river	*Oryza sativa* *Sesbania sesban* *Triumfetta macrophylla* *Urena lobata* *Tristemma mauritianum* *Jussiaea abyssinica*
35 M 805050 9923745 Alt:1018 m	Riverine bushland degraded by rice growing	*Sesbania sesban (L.) Merr.* *Triumefetta macrophylla K. Schum.* *Urena lobata L.* *Cayratia ibuensis (Hook.f.) Suesseng.* *Vernonia amygdalina Del.* *Mimosa pigra L.* *Ageratum conyzoides L.* *Indigofera spicata* *Sorghum arundanaceum (Desv.) Alston.* *Erythrina abyssinica DC.*
Kiruruma village 35 M 804897 9921190 Alt:1146 m	Sorghum in settlement	*Sorgum bicolor*
35 M 804861 9921221 Alt:1142 m	Dairy Farm, Farm Plants	*Albizia coriaria Oliv.* *Spathodea nilotica Seem* *Eucalyptus grandis Maiden* *Croton macrostachyus Del.* *Psidium guajava L.* *Clerodendrum rotundifolium Oliv.*
35 M 804691 9921321 Alt:1124 m	Eucalyptus plantation	*Eucalyptus grandis*
35 M 804486 9921309 Alt: 1123 m	Pinus woodlot	*Pinus caribea*
35 M 804405 9921325 Alt: 1112 m	Musa-Coffea garden	*Musa sp* *Coffea robusta*
35 M 804211 9921397 Alt:1099 m	Maize, Millet and Cassava garden	*Zea mays* *Eleusine colona* *Manihot esculenta*
35 M 804144 9921438 Alt:1089 m	Homestead Plants	*Ananas sp. (Pineapple)* *Saccharum officinarum L.* *Coffea canephora Froehner* *Musa sp. - Kawanda hybrid, diplay*
35 M 804037 9921525 Alt:1079 m	Musa-Coffee-Maize with a network of trees of Markhamia lutea, Spathodea campanulata, Persea Americana and Carica papaya	*Zea mays L.* *Coffea canephora Froehner* *Markhamia lutea K. Schum.* *Spathodea nilotica Seem* *Carica papaya L.* *Musa sp. Kawanda hybrid , deep play* *Persea americana Mill.*

		Mangifera indica L.
35 M 803905 9921635 Alt:1075 m	Millet-Maize and Cassava garden	*Zea mays* *Eleusine colona* *Manihot esculenta*
35 M 803847 9921703 Alt:1069 m	Sorghum garden	*Sorghum bicolor*
35 M 803811 9921718 Alt:1069 m	Musa-Coffea garden	*Musa Sp* *Coffea robusta*
35 M 803803 9921765 Alt:1065 m	Ground Nuts, Maize and Yams Garden	
35 M 803771 9921809 Alt:1060 m	Homestead Plants	*Markhamia lutea K. Schum.* *Coffea canephora Froehner* *Zea mays L.* *Manihot esculenta Crantz*
35 M 803697 9921851 Alt:1059 m	Homestead Plants	*Zea mays L.* *Eleusine corocana Gaertn.* *Markhamia lutea K. Schum.* *Albizia coriaria Oliv.*
35 M 803686 9921988 Alt:1030 m	Rice Garden and Eucalyptus trees	*Oryza sativa* *Eucalyptus grandis*
35 M 803622 9921936 Alt:1028 m	Riverine bushland	*Triumffeta macrophylla K. Schum.* *Cyperus latifolius Poir.* *Sesbania sesban (L.) Merr.* *Leersia hexandra Sw.* *Urena loba L.* *Pouzotzia parasitica (Forssk.) Schweinf.* *Persicaria setosula (A. Rich.) K. L. Wilson* *Ipomoea cairica (L.) Sweet* *Phyllanthus nummulariifolius Poir.* *Sida rhombifolia L.* *Cayratia ibuensis (Hook.f.) Suesseng.*
35 M 803621 9921959 1032 m	Rice Garden	*Oryza sativa*
35 M 803590 9921980 Alt: 1032 m	Rice, Maize, Sorgum garden	*Oryza sativa,* *Zea mays* *Sorghum bicolor*
35 M 803510 9921992 Alt:1040 m Bushere Cell	Bushland on steep slope	*Albizia grandibracteata Taub.* *Albizia coriaria Oliv.* *Allophyllus macrobotrya Gilg.* *Acacia hockii De Wild.* *Phyllanthus ovalifolius Forssk.* *Phyllanthus nummulariifolius Poir.* *Markhamia lutea K. Schum.* *Alchornea cordifolia Muell. Arg.* *Rhus vulgaris Meikle* *Digitaria abyssinica (A. Rich.) Stapf* *Imperata cylindrica (L.) Beauv. var. africana (Andersson) C. E. Hubb.* *Spathodea nilotica Seem* *Leonotis nepetifolia (L.) Ait.f.* *Hewettia sublobata (L. f.) O. Ktze.* *Asystasia gangetica (L.) Andersson* *Ageratum conyzoides L.* *Urena lobata L.* *Tephrosia nana Schweinf.*

		Aspilia sp. *Triumfetta rhomboidea Jacq.* *Secamone africana (Oliv.) Bullock* *Senna spectabilis (DC.) H. S. Irwin* *Lantana camara L.* *Sapium ellipticum (Krauss) Pax* *Wissandra rostrata (Schumach.) Hookf.* *Paspalum scrobiculatum L.* *Jasminium eminii* *Combretum molle G. Don* *Vernonia amygdalina Del.* *Erythrina abyssinica DC.* *Dracaena fragrans (L.) Ker-Gawl.* *Ficus asperifolia Miq.*
35 M 0802543 / 9919090	Road Bridge Vegetation	*Lantana camara L.* *Senna spectabilis (DC.) H. S. Irwin* *Croton macrostachyus Del.* *Stachyrpheta urticifolia Sims* *Sida rhombifolia L* *Neonotonia wightii (Arnott) J. A. Lackey subsp. wightii var. longicauda (Schweinf.) A. A. Lackey* *Lepistemon owariensis (Beauv.) Hall.f.* *Momordica foetida Schumach.* *Oplismenus hirtellus (L.) P. Beauv.* *Zehneria scabra (Lf.) Sond.* *Phoenix reclinata Jacq.* *Erythrina abyssinica DC.* *Cordia milleni Bak.* *Hibiscus diversifolius Jacq.* *Solanum dasyphyllum Schum. & Thonn.* *Tinospora caffra (Miers) Troupin* *Acalypha ornata A. Rich.* *Urena lobata L.* *Albizia coriaria Oliv.* *Triumfetta microphylla K. Schum.* *Eucalyptus gandis Maiden* *Sorghum bicor (L.) Moench* *Zea mays L.* *Cynodon dactylon (L.) Pers.* *Saccharum officinarum L*
Nyamabare, Karubeizi 35 M 0802921 / 9915387, Alt. 1108 m	Bushland	*Sesbania sesban (L.) Merr.* *Spathodea nilotica Seem* *Alchornea cordifolia Muell. Arg.* *Senna didymobotrya Fresen.* *Cynodon dactylon (L.) Pers.* *Solanum dasyphyllum Schum. & Thonn.* *Amaranthus dubius Thell.* *Albizia coriaria Oliv.* *Eleusine indica (L.) Gaertn.* *Markhamia lutea K. Schum.* *Sida rhombifolia L.* *Urena lobata L.* *Dracaena steudneri Engl.* *Grevillea robusta R. Br.* *Eucalyptus grandis Maiden* *Jatropha curcas L.*

		Clerodendrum rotundifolius *Stachyrpheta urticifolia Sims* *Triumfetta rhomboidea Jacq.* *Ocimum ggratisissimum L.* *Pseudospondias microcarpa (A. Rich.) Engl.* *Erythrina abyssinica DC.* *Cissus petiolata* *Lepistemon owariense* *Capparis tomentosa Lam.* *Senna spectabislis* *Lantana camara L.* *Lovoa swynnertonii Bak.f.* *Jasminium dichotoma Vahl* *Hibiscus diversifolius Jacq.* *Malenthera scandenns (Schumach. & Thonn.) Roberty* *Measa welwitschii Gilg.* *Cussonia arborea A. Rich.* *Sporobolus pyramidalis Beauv.* *Pennisetum purpureum Schumach.*
35 M 0802869 / 9915424 : Alt. 1106 m	Fallow / Pasture	*Mimosa pudica L.* *Digitaria longiflora* *Fimbristylis dichotoma* *Persicaria madagascariensis* *Cyperus distans L.f.* *Ageratum conyzoides L.* *Mitracarpus villosus* *Chloris pychnothrix Trin.* *Eucalyptus grandis*
Kibimbiri, Kihihi Kanungu, District 35 M 0804258 9929249 Alt. 1007 m	Homestead Plants / Fallow	*Imperata cylindrica* *Vigna parkeri* *Panicum maximum Jacq.* *Tagates minuta L* *Celosia trigyna L.* *Digitaria ternata* *Ageratum conyzoides L.* *Galisonga parviflora Cav.* *Commelina benghalensis L.*
35 M 0804153 9929238 Alt. 1008 m	Rice garden	*Imperata cylindrica (L.) Beauv. var. africana* *Vigna parkeri* *Senna siamea Lam.* *Sesumum indicum L.* *Solanum nigrum L.* *Panicum maximum Jacq.*
35 M 0804107 9929208 Alt. 1005 m	Fallow land Cabbage (Brassica oleracea L.) Egg plant (Solanum melogena L.) Green pepper (Capsicum sp.) Pumpkin (Cucurbita maxima Lam). Tomatoes (Solanum lycopersicum L.) Tula (Solanum gilo) Amaranthus spp. (Amaranthus hybridus L. subsp. Cruentus). Climbing beans (Phaseolus vulgaris L.) Carrots (Daucas carota L.)	*Imperata cylindrica (L.) Beauv. var. africana* *Panicum maximum Jacq.* *Digitaria abyssinica* *Bidens pilosa L.* *Emilia javanica* *Synedrella nodiflora Gaertn.* *Brachiaria comata (A. Rich.) Stapf* *Senna siamea Lam.* *Cyperus longus L.* *Vigna kirkii (Bak.) Gillett* *Indigofera emerginella A. Rich.* *Desmodium tortuosum* *Albizia coriaria Oliv.*

		Celosia trigyna L. *Commicarpus pedunculosus (A. Rich.) Cuf.* *Vigna parkeri Bak. subsp. maranguensis (Taub.) Verdc.* *Melinis repens (Willd.) Zizka* *Neonotonia wightii (Arnott) J. A. Lackey subsp. wightii var. longicauda (Schweinf.) A. A. Lackey* *Lantana camara L.* *Vernonia lasiopus O. Hoffm.* *Leonotis nepetifolia (L.) Ait.f.* *Ficus sycomorus L.* *Commelina benghalensis L.* *Tephrosia nana Schweinf.* *Blumea alata Sch. Bip.*
35 M 0805230 9928689 Matanda 1	Fallow	*Panicum maximum Jacq.* *Bidens pilosa L* *Ageratum conyzoides L.* *Commelina benghalensis L.* *Eragrostis tenuifolia A. Rich.* *Eleusine indica (L.) Gaert. subsp. Indica* *Persea americana Mill.* *Senna siamea Lam.* *Lantana camara L.* *Leonotis nepetifolia (L.) Ait.f.*
35 M 0805097 9928611 Alt. 1039 m	Eucalyptus Plantation	*Cynodon dactylon (L.) Pers.* *Panicum maximum Jacq.* *Imperata cylindrica (L.) Beauv. var. africana* *Lantana camara L.* *Bidens pilosa L.* *Conyza floribunda H. B. K.* *Mitracarpus villosus (Schumach.) Moss* *Bulbostylis hispidula (Vahl) R. Haines*
35 M 0799534 9920565 Alt. 1081 m Kashozha, Rushoroza	Pasture and Homestead gardens	*Mangifera indica L.* *Albizia coriaria Oliv.* *Imperata cylindrica (L.) Beauv. var. africana* *Panicum maximum Jacq.* *Lantana camara L.* *Urena lobata L.* *Melinis repens (Willd.) Zizka* *Sporobolus pyramidalis Beauv.* *Digitaria abyssinica (A. Rich.) Stapf* *Vigna vexillata (L.) A. Rich,* *Abrus canescens Bak.* *Clerodendrum rotundifolium Oliv.* *Dyschoriste radicans Nees* *Digitaria longiflora (Retz.) Pers.* *Brachiaria comata (A. Rich.) Stapf* *Cyperus longus L.* *Ageratum conyzoides L.* *Triumfetta rhomboidea Jacq.* *Tridax procumbens L.* *Cassia mimosoides L.* *Chloris pychnothrix Trin.* *Ficus natalensis Hochst.*
35 M 0799388 9920641 Alt. 1063 m	Imperata cylindrica grassland	*Imperata cylindrica (L.) Beauv. var. africana* *Cymbopogon nardus (L.) Remdle*

		Sporobolus pyramidalis Beauv. *Digitaria abyssinica (A. Rich.) Stapf* *Brachiaria comata (A. Rich.) Stapf* *Aspilia sp.* *Ageratum conyzoides L.* *Centrocema pubescens Benth.* *Senna siamea Lam.* *Syzygium cuminii (L.) Skeels* *Lantana camara L.* *Digitaria ternata (A. Rich.) Stapf* *Mitracarpus villosus (Sachumach.) Moss* *Sida acuta Burm.f.*
35 M 0797262 9914340 Alt. 1149 m Bihomborwa, Kihihi towncouncil	Homestead plants Banana and Coffee Plantation Bananas, Maize, and Coffee Garden covers 80%	*Musa sp* *Zea mays* *Coffea robusta* *Siegesbeckia orientalis L.* *Tagetes minuta L.* *Bidens pilosa L* *Digitaria ternata (A. Rich.) Stapf* *Acanthospermum hispidum DC.* *Galisonga parviflora Cav.*
35 M 0797160 9914350 Alt. 1149 m	Pasture and Homestead Plants	*Triumfetta rhomboidea Jacq.* *Hyparrhenia filipendula (Hochst.) Stapf* *Phyllanthus nummulariifolius Poir.* *Asystasia gangetica (L.) Andersson* *Melinis repens (Willd.) Zizka* *Lantana camara L.* *Sida rhombifolia L.* *Crotalaria brevidens Benth. var. intermedia (Kotschy) Polhill* *Eleusine indica (L.) Gaertn.* *Urena lobata L.* *Sporobolus pyramidalis Beauv.* *Abrus canescens Bak.* *Stachyrpheta urticifolioa Sims* *Paspalum scrobiculatum L* *Panicum maximum Jacq.* *Digiaria abyssinica (A. Rich.) Stapf* *Vernonia lasiopus O. Hoffm.* *Oryza indicum L.* *Coffea canephora* *Musa paradiasica L.* *Mangifera indica L.* *Gravillea robusta R. Br.*
35 M 0797089 9914354 Alt.1137 m	Homestead Gardens	*Eleusine corona* *Zea mays* *Ipomoea batatus* *Musa sp* *Coffea robusta* *Ficus sur Forssk.*
35 M 0797043 9914360 Alt. 1137 m	Homestead Gardens with scattered tres (Coffea, Cassava, maize and tomatoes)	*Maesopsis eminii Engl.* *Milicia excelsa (Welw.) C. C. Berg* *Coffea robusta* *Manihot esculenta* *Zea mays* *Solanum*

<u>Appendix X: The visual Outlook of Vegetation assemblages of Matanda irrigation scheme are provided in Plate 2 below.</u>

Maize- Finger Millet garden along River Kiruruma

Riverine bushed wooded grassland degraded with Eucalyptus growing and crop cultivation

Riverine wooded bushland degraded with Agro-forestry

Sugarcane garden along River Kiruruma with scattered trees

Sugarcane with a strip of Eucalyptus grandis along river Kiruruma

Finger Millet- maize garden along River Kiruruma

Eucalyptus woodlot within the Project corridor

Riverine bushed woodland (colonizing forest) partly degraded with Eucalyptus growing

Riverine bushed woodland (colonizing forest) partly degraded with Eucalyptus growing

Riverine bushed woodland partly degraded with Cultivation north of the River

Finger Millet-maize- sugarcane garden along the river with a strip of mixed woody vegetation

Coffea robusta plantation

Maize garden within Matanda irrigation scheme site at proposed site for water reservoir tanks

Grassland fallow within the water reservoir tanks area of Matanda irrigation scheme

Grassland fallow at the edge of maize garden dominated by *Imperata cylindrica* and *Urena lobata* within Matanda scheme

Grassland fallow and maize garden with scattered trees within the proposed Matanda irrigation site within Matanda scheme

Eucalyptus-Sugarcane garden along River Kiruruma at Rwangoboka cell

Rice gardens along the River at Nyakasule village

Coofee garden with Nyakasule village

Sweet potato garden continous with Musa garden

Sugarcane plantation within Mitanda scheme

Remnant Bushland patches within the Mitanda scheme

Remant bushland amidst gardens at Bushere cell on 35 M 803510, 9921992.

Rice garden and a strip of riverine bushes dominated by Pennisetum purpureum and Sesbania sesban and Eucalyptus trees

Appendix XI List of Plant Species encountered within The Matanda Project area

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Acanthaceae	*Hewettia sublobata (L. f.) O. Ktze.*	climber	2%	L C	NA
Acanthaceae	*Asystasia gangetica (L.) Andersson*	Forb	25%	L C	NA
Acanthaceae	*Dyschoriste radicans Nees*	Forb	1%	L C	NA
Amaranthaceae	*Achyranthes aspera L.*	Forb	10%	LC	NA
Amaranthaceae	*Amaranthus dubius Thell.*	Forb	2%	L C	NA
Amaranthaceae	*Amaranthus hybridus L. subsp. cruentus (L.) Thell.*	Forb	5%	L C	NA
Amaranthaceae	*Celosia trigyna L.*	Forb	2%	L C	NA
Amaranthaceae	*Cyathura sp*	Forb	4%	LC	NA
Anacardiaceae	*Rhus vulgaris Meikle*	Shrub	5%	L C	NA
Anacardiaceae	*Pseudospondias microcarpa (A. Rich.) Engl.*	Tree	15%	L C	NA
Anarcadiaceae	*Mangifera indica L.*	Tree	10%	LC	NA
Apiaceae	*Centella asiatica*	Forb	25%	LC	NA
Apiaceae	*Daucas carota L.*	Forb	5%	L C	NA
Apocynaceae	*Secamone africana (Oliv.) Bullock*	Climber	5%	L C	NA
Apocynaceae	*Thevtia peruviana (Pers.) Schum.*	Shrub	2%	LC	NA
Apocynaceae	*Funtumia Africana*	Tree	5%	LC	NA
Apocynaceae	*Rauvolfia vomitoria,*	Tree	4%	LC	NA
Araceae	*Colocasia esculenta*	Forb	17%	LC	NA
Araliaceae	*Cussonia arborea A. Rich.*	Tree	1%	L C	NA
Arecaceae	*Phoenix reclinata Jacq.*	Tree	1%	L C	NA
Asteraceae	*Acanthospermum hispidum DC.*	Forb	5%	L C	NA
Asteraceae	*Ageratum conyzoides L.*	Forb	15%	L C	NA
Asteraceae	*Bidens pilosa L.*	Forb	15%	LC	NA
Asteraceae	*Blumea alata Sch. Bip.*	Forb	1%	L C	NA
Asteraceae	*Conyza floribunda H. B. K.*	Forb	6%	L C	NA
Asteraceae	*Emilia javanica*	Forb	1%	L C	NA
Asteraceae	*Galisonga parviflora Cav.*	Forb	15%	L C	NA
Asteraceae	*Helianthus annus L.*	Forb	5%	LC	NA
Asteraceae	*Malenthera scandenns (Schumach. & Thonn.) Roberty*	Forb	1%	L C	NA
Asteraceae	*Siegesbeckia orientalis L.*	Forb	5%	L C	NA
Asteraceae	*Synedrella nodiflora Gaertn.*	Forb	1%	L C	NA
Asteraceae	*Tagetes minuta L.*	Forb	10%	L C	NA
Asteraceae	*Tridax procumbens L.*	Forb	1%	L C	NA
Asteraceae	*Vernonia lasiopus O. Hoffm.*	Forb	1%	L C	NA
Asteraceae	*Microglossa afzeri*	Shrub	3%	NA	NA
Asteraceae	*Vernonia amygdalina Del.*	Tree	5%	L C	NA
Bignoniaceae	*Markhamia lutea K. Schum.*	Tree	30%	LC	NA
Bignoniaceae	*Spathodea nilotica Seem*	Tree	5%	L C	NA

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Boraginaceae	*Cordia milleni Bak.*	Tree	5%	L C	NA
Brasicaceae	*Brassica oleracea L.*	Forb	3%	L C	NA
Bromeliaceae	*Ananas comosus (L) Merr.)*	Forb	7%	L C	NA
Cairicaceae	*Carica papaya L.*	Forb	5%	L C	NA
Capparaceae	*Capparis tomentosa Lam.*	Shrub	5%	L C	NA
Combretaceae	*Combretum molle G. Don*	Tree	5%	L C	NA
Commelinaceae	*Commelina Africana*	Forb	4%	LC	NA
Commelinaceae	*Commelina benghalensis L.*	Forb	10%	L C	NA
Commelinaceae	*Commelina diffusa*	Forb	5%	LC	NA
Commelinaceae	*Commelina sp*	Forb	3%	LC	NA
Convolvulaceae	*Ipomoea cairica (L.) Sweet*	Climber	3%	L C	NA
Convolvulaceae	*Lepistemon owariensis (Beauv.) Hall.f.*	climber	5%	L C	NA
Convolvulaceae	*Ipomoea acuminate*	Climber	5%	LC	NA
Convolvulaceae	*Ipomoea batatas (L.) Lam.*	Climber	55%	LC	NA
Convolvulaceae	*Ipomoea whytei*	Climber	10%	LC	NA
Convolvulaceae	*Merremia pterygocaulis*	Climber	5%	NA	NA
Cucurbitaceae	*Cucurbita maxima Lam.*	climber		L C	NA
Cucurbitaceae	*Momordica foetida Schumach.*	climber	10%	L C	NA
Cucurbitaceae	*Zehneria scabra (Lf.) Sond.*	climber	2%	L C	NA
Cucurbitaceae	*Lagenaria sphaerica*	Climber	3%	LC	NA
Cyperaceae	*Cyperus cyperoides*	sedge	5%	LC	NA
Cyperaceae	*Kyllinga bulbosa*	sedge	10%	LC	NA
Cyperaceae	*Scleria melanophala*	Rush	7%	NA	NA
Cyperaceae	*Bulbostylis hispidula (Vahl) R. Haines*	sedge	1%	L C	NA
Cyperaceae	*Cyperus distans L.f.*	sedge	5%	L C	NA
Cyperaceae	*Cyperus latifolius Poir.*	sedge	10%	L C	NA
Cyperaceae	*Cyperus longus L.*	sedge	1%	L C	NA
Cyperaceae	*Cyperus rotundus*	sedge	3%	LC	NA
Cyperaceae	*Fimbristylis dichotoma*	sedge	1%	L C	NA
Dioscoreaceae	*Dioscorea sp*	Climber	5%	LC	NA
Dracaenaceae	*Dracaena fragrans (L.) Ker-Gawl.*	Forb	10%	L C	NA
Dracaenaceae	*Dracaena steudneri Engl.*	Tree	3%	L C	NA
Euphorbiaceae	*Acalypha bipartita Muell. Arg.*	Shrub	5%	L C	NA
Euphorbiaceae	*Acalypha ornata A. Rich.*	Shrub	10%	L C	NA
Euphorbiaceae	*Manihot esculenta Crantz*	Shrub	45%	LC	NA
Euphorbiaceae	*Alchornea cordifolia Muell. Arg.*	Tree	25%	L C	NA
Euphorbiaceae	*Croton macrostachyus Del.*	Tree	10%	L C	NA
Euphorbiaceae	*Jatropha curcas L.*	Tree	5%	L C	NA
Euphorbiaceae	*Macaranga grandifolia*	Tree	17%	LC	NA
Euphorbiaceae	*Macaranga lancifolia*	Tree	10%	LC	NA

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Euphorbiaceae	*Macaranga schweinfurthii*	Tree	30%	LC	NA
Euphorbiaceae	*Sapium ellipticum (Krauss) Pax*	Tree	1%	L C	NA
Euphorbiaceae	*Shirakiopsis elliptica*	Tree	13%	LC	NA
Fabaceae	*Abrus canescens Bak.*	Climber	1%	L C	NA
Fabaceae	*Centrocema pubescens Benth.*	climber	5%	L C	NA
Fabaceae	*Neonotonia wightii (Arnott) J. A. Lackey subsp.wightii var. longicauda (Schweinf.) A. A. Lackey*	climber	2%	L C	NA
Fabaceae	*Vigna kirkii (Bak.) Gillett*	climber	1%	L C	NA
Fabaceae	*Vigna parkeri*	climber	80%	L C	NA
Fabaceae	*Vigna parkeri Bak. subsp. maranguensis (Taub.) Verdc.*	climber	5%	L C	NA
Fabaceae	*Vigna reticulata Hook.f.*	climber	2%	L C	NA
Fabaceae	*Vigna vexillata (L.) A. Rich,*	climber	10%	L C	NA
Fabaceae	*Cassia mimosoides L.*	Forb	5%	L C	NA
Fabaceae	*Chamaecrista kirkii*	Forb	5%	LC	NA
Fabaceae	*Crotalaria brevidens Benth. var. intermedia (Kotschy) Polhill*	Forb	6%	L C	NA
Fabaceae	*Desmodium adescendens*	Forb	20%	LC	NA
Fabaceae	*Desmodium tortuosum*	Forb	1%	L C	NA
Fabaceae	*Desmodium unicinatum*	Forb	15%	LC	NA
Fabaceae	*Indigofera emerginella A. Rich.*	Forb	5%	LC	NA
Fabaceae	*Indigofera spicata*	Forb	5%	L C	NA
Fabaceae	*Mimosa pudica L.*	Forb	10%	L C	NA
Fabaceae	*Phaseolus vulgaris L.*	Forb	35%	L C	NA
Fabaceae	*Rhynchosia minima*	Forb	3%	NA	NA
Fabaceae	*Tephrosia elata Deflers*	Forb	5%	L C	NA
Fabaceae	*Tephrosia nana Schweinf.*	Forb	2%	L C	NA
Fabaceae	*Tephrosia pumila*	Forb	4%	LC	NA
Fabaceae	*Senna didymobotrya Fresen.*	Shrub	5%	L C	NA
Fabaceae	*Sesbania sesban (L.) Merr.*	Shrub	40%	L C	NA
Fabaceae	*Desmodium salicifolium*	Shrub	4%	LC	NA
Fabaceae	*Acacia hockii De Wild.*	Tree	5%	L C	NA
Fabaceae	*Acacia sieberiana*	Tree	5%	LC	NA
Fabaceae	*Albizia coriaria Oliv.*	Tree	5%	L C	NA
Fabaceae	*Albizia glaberrima*	Tree	4%	LC	NA
Fabaceae	*Albizia grandibracteata Taub.*	Tree	23%	L C	NA
Fabaceae	*Albizia sp*	Tree	5%	LC	NA
Fabaceae	*Albizia zygia*	Tree	3%	LC	NA
Fabaceae	*Erythrina abyssinica DC.*	Tree	5%	L C	NA
Fabaceae	*Piptadeniastrum africanum*	Tree	1%	NA	NA

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Fabaceae	*Senna siamea Lam.*	Tree	10%	L C	NA
Fabaceae	*Senna spectabilis (DC.) H. S. Irwin*	Tree	10%	L C	NA
Lamiaceae	*Leonotis nepetifolia (L.) Ait.f.*	Forb	6%	L C	NA
Lamiaceae	*Leucas martinicensis*	Forb	15%	LC	NA
Lamiaceae	*Ocimum ggratisissimum L.*	Forb	5%	L C	NA
Lamiaceae	*Hoslundia opposita Vahl*	Shrub	5%	L C	NA
Lamiaceae	*Credodendrum jonnistonii*	Shrub	6%	LC	NA
Lauraceae	*Persea americana Mill.*	Tree	3%	LC	NA
Malvaceae	*Sida acuta Burm.f.*	Forb	1%	L C	NA
Malvaceae	*Sida rhombifolia L*	Forb	10%	L C	NA
Malvaceae	*Triumfetta rhomboidea Jacq.*	Forb	5%	L C	NA
Malvaceae	*Urena lobata L.*	Forb	20%	L C	NA
Malvaceae	*Hibiscus diversifolius Jacq.*	Shrub	3%	L C	NA
Malvaceae	*Triumfetta macrophylla K. Schum.*	Shrub	30%	L C	NA
Malvaceae	*Wissandra rostrata (Schumach.) Hookf.*	Shrub	2%	L C	NA
Marantaceae	*Marantochloa purpurea*	Forb	5%	LC	NA
Melastomataceae	*Tristemma mauritianum J. F. Gmel.*	Forb	3%	L C	NA
Meliaceae	*Lovoa swynnertonii Bak.f.*	Tree	3%	**NT**	VU
Menispermaceae	*Tinospora caffra (Miers) Troupin*	climber	1%	L C	NA
Menispermaceae	*Stephania abyssinica*	Climber	5%	LC	NA
Moraceae	*Antiaris toxicaria Leschen.*	Tree	5%	L C	NA
Moraceae	*Artocarpus heterophyllus Lam.*	Tree	30%	LC	NA
Moraceae	*Ficus asperifolia Miq.*	Tree	1%	L C	NA
Moraceae	*Ficus exasperata Vahl*	Tree	5%	L C	NA
Moraceae	*Ficus mucoso*	Tree	5%	LC	NA
Moraceae	*Ficus natalensis Hochst.*	Tree	3%	L C	NA
Moraceae	*Ficus ovata*	Tree	20%	LC	NA
Moraceae	*Ficus sp*	Tree	4%	LC	NA
Moraceae	*Ficus sur Forssk.*	Tree	5%	L C	NA
Moraceae	*Ficus sycomorus L.*	Tree	10%	L C	NA
Moraceae	*Ficus valis-chaude*	Tree	15%	LC	NA
Moraceae	*Milicia excelsa (Welw.) C. C. Berg*	Tree	20%	**NT**	EN
Musaceae	*Musa paradisiaca L.*	Forb	40%	LC	NA
Musaceae	*Musa sapietum L.*	Forb	45%	LC	NA
Musaceae	*Musa sp. - Kawanda hybrid, deep play*	Forb	65%	L C	NA
Myristicaceae	*Pycnanthus angolensis*	Tree	6%	LC	NA
Myrsinaceae	*Measa welwitschii Gilg.*	Tree	2%	L C	NA
Myrtaceae	*Eucalyptus gandis Maiden*	Tree	30%	L C	NA
Myrtaceae	*Psidium guajava L.*	Tree	13%	L C	NA
Myrtaceae	*Syzygium cuminii (L.) Skeels*	Tree	5%	L C	NA

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Oleaceae	*Jasminium eminii*	Climber	2%	L C	NA
Oleaceae	*Jasminium dichotoma Vahl*	Climber	5%	L C	NA
Onagraceae	*Jussiaea abyssinica (A. Rich.) Dandy & Brenan*	Forb	5%	L C	NA
Onagraceae	*Ludwigia abyssinica*	Forb	18%	LC	NA
Pedaliaceae	*Sesumum indicum L.*	Forb	30%	L C	NA
Phyllanthaceae	*Phyllanthus nummulariifolius Poir.*	Forb	2%	L C	NA
Phyllanthaceae	*Flueggea virosa (Willd.) Voigt*	Shrub	5%	L C	NA
Phyllanthaceae	*Phyllanthus ovalifolius Forssk.*	Shrub	5%	L C	NA
Phyllanthaceae	*Bridelia micrantha*	Tree	20%	LC	NA
Phyllanthaceae	*Bridelia scleroneura*	Tree	4%	LC	NA
Phyllanthaceae	*Margaritaria dioscoidea*	Tree	6%	LC	NA
Pinnceae	*Pinus caribaea*	Tree	10%	LC	NA
Plantaginaceae	*Commicarpus pedunculosus (A. Rich.) Cuf.*	Forb	1%	L C	NA
Poaceae	*Brachiaria comata (A. Rich.) Stapf*	Grass	10%	L C	NA
Poaceae	*Chloris pychnothrix Trin.*	Grass	5%	L C	NA
Poaceae	*Coix lacryma-jobi*	Grass	10%	LC	NA
Poaceae	*Cymbopogon nardus (L.) Remdle*	Grass	2%	L C	NA
Poaceae	*Cynodon dactylon (L.) Pers.*	Grass	1%	L C	NA
Poaceae	*Digiaria abyssinica (A. Rich.) Stapf*	Grass	40%	L C	NA
Poaceae	*Digitaria longiflora (Retz.) Pers.*	Grass	1%	L C	NA
Poaceae	*Digitaria ternata (A. Rich.) Stapf*	Grass	10%	L C	NA
Poaceae	*Digitaria veluntina*	Grass	5%	LC	NA
Poaceae	*Eleusine corocona Gaertn.*	Grass	80%	LC	NA
Poaceae	*Eleusine indica (L.) Gaert. subsp. indica*	Grass	5%	L C	NA
Poaceae	*Eragrostis tenuifolia A. Rich.*	Grass	3%	L C	NA
Poaceae	*Hyparrhenia filipendula (Hochst.) Stapf*	Grass	5%	L C	NA
Poaceae	*Hyparrhenia rufa (Nees) Stapf*	Grass	5%	L C	NA
Poaceae	*Imperata cylindrica (L.) Beauv. var. aficana*	Grass	45%	L C	NA
Poaceae	*Leersia hexandra Sw.*	Grass	10%	L C	NA
Poaceae	*Melinis repens (Willd.) Zizka*	Grass	1%	L C	NA
Poaceae	*Oplismenus hirtellus (L.) P. Beauv.*	Grass	1%	L C	NA
Poaceae	*Oryza indicum L.*	Grass	40%	L C	NA
Poaceae	*Panicum deustum*	Grass	5%	LC	NA
Poaceae	*Panicum maximum Jacq.*	Grass	15%	LC	NA
Poaceae	*Paspalidum germinatum*	Grass	15%	LC	NA
Poaceae	*Paspalum scrobiculatum L.*	Grass	15%	L C	NA
Poaceae	*Pennisetum purpureum Schumach.*	Grass	11%	L C	NA
Poaceae	*Saccharum officinarum L*	Grass	50%	L C	NA
Poaceae	*Setaria homonyma (Steud.) Chiov.*	Grass	10%	L C	NA
Poaceae	*Setaria poiretiana*	Grass	14%	LC	NA

Family	Species	Growth Form	Average % cover	IUCN status	WCS Listing
Poaceae	*Setaria sphacelata*	Grass	10%	LC	NA
Poaceae	*Sorghum arundanaceum (Desv.) Alston.*	Grass	2%	L C	NA
Poaceae	*Sorghum bicor*	Grass	20%	LC	NA
Poaceae	*Sporobolus pyramidalis Beauv.*	Grass	20%	L C	NA
Poaceae	*Zea mays L.*	Grass	65%	LC	NA
Polygonaceae	*Persicaria madagascariensis (Meisn.) S. Ortiz & J. A. R. Paiva*	Forb	5%	L C	NA
Polygonaceae	*Persicaria setosula (A. Rich.) K. L. Wilson*	Forb	5%	L C	NA
Proteaceae	*Grevillea robusta R. Br.*	Tree	3%	L C	NA
Rhamnaceae	*Maesopsis eminii Engl.*	Tree	10%	L C	NA
Rubiaceae	*Mitracarpus villosus (Schumach.) Moss*	Forb	3%	L C	NA
Rubiaceae	*Coffea canephora Froehner*	Tree	80%	LC	NA
Rubiaceae	*Mitragyna stipulosa*	Tree	5%	**VU**	VU
Rubiaceae	*Psydrax schimperiana*	Tree	3%	NA	NA
Rutaceae	*Clausena aniseta*	Shrub	4%	LC	NA
Sapindaceae	*Paullinia pinnata*	Climber	3%	NA	NA
Sapindaceae	*Allophyllus macrobotrya Gilg.*	Shrub	10%	L C	NA
Sapindaceae	*Blighia unijugata Bak.*	Tree	5%	LC	NA
Sapotaceae	*Bequaertiodendron oblanceolatum*	Tree	10%	NA	NA
Sapotaceae	*Manilkara dawei*	Tree	5%	LC	NA
Scrophulariaceae	*Cycnium herzfeldianum (Vatke) Engl.*	Forb	1%	L C	NA
Solanaceae	*Capsicum sp.*	Forb		L C	NA
Solanaceae	*Solanum dasyphyllum Schum. & Thonn.*	Forb	1%	L C	NA
Solanaceae	*Solanum gilo*	Forb	20%	L C	NA
Solanaceae	*Solanum lycopersicum L.*	Forb	23%	L C	NA
Solanaceae	*Solanum nigrum L.*	Forb	10%	L C	NA
Solanaceae	*Solanum melogena L.*	Shrub	15%	L C	NA
Solanaceae	*Solanum mauritianum*	Shrub	10%	NA	NA
Sterculiaceae	*Cola gigantean*	Tree	5%	NA	NA
Sterculiaceae	*Dombeya sp*	Tree	5%	NA	NA
Sterculiaceae	*Pterygota mildbraedii*	Tree	4%	NA	NA
Sterculiaceae	*Sterculia dawei*	Tree	3%	LC	NA
Ulmaceae	*Trema orientalis Blume*	Tree	5%	L C	NA
Urticaceae	*Pouzotzia parasitica (Forssk.) Schweinf.*	Forb	5%	L C	NA
Verbenaceae	*Stachyrpheta urticifolia Sims*	Forb	1%	L C	NA
Verbenaceae	*Clerodendrum rotundifolium Oliv.*	Shrub	3%	LC	NA
Verbenaceae	*Lantana camara L.*	Shrub	1%	LC	NA
Vitaceae	*Cayratia ibuensis (Hook.f.) Suesseng.*	climber	5%	L C	NA
Vitaceae	*Cissus petiolata*	climber	3%	L C	NA

APPENDIX F REPORT ON THE BATWA: VULNERABLE AND MARGINALIZED GROUPS' FRAMEWORK (VMGF)

Vulnerable Groups and ethnic minorities: Indigenous group – the Batwa

The Batwa also known as the Twa are an indigenous group of people who originally lived in the ancient Bwindi forest in Uganda for more than 300 years and were known as the "Keepers of the forest" until it was gazetted as a National park in 1991.

Within the command area, the Batwa mainly inhabit areas of Kihembe adjacent to the Bwindi Impenetrable Forest National Park. However, few of them are also scattered in various parts of the district like Kanyanshande, Kayonza, Butogota, Byumba, Mukongoro and Mpungu, among others. Outside Kanungu district, the Batwa are also found in areas of Kabaale, Kisoro and Rwanda.

A model village was set up in Mgahinga in Kihembe Parish, Kanyantorogo Subcounty by Bwindi Mgahinga Conservation Trust (BMCT), a trust that was established under the Uganda Trust Act in 1994, as a registered Conservation Trust Fund mandated to support conservation of Mgahinga Gorilla National Park (MGNP) and Bwindi Impenetrable National Park (BINP) and contribute to uplifting the livelihoods of the people in communities adjacent to these national parks.

A total of 24 families reside in this model village and by the time of the study, a project of construction of houses for these families that started in 2017 by BMCT was still ongoing.

BATWA SOCIAL ORGANIZATION SETUP

Majority of Batwa are no longer able to hunt/gather from the forest and this traditional form of livelihood has had an impact on their form of social organization. In a discussion held with some of the Batwa living in the model village, they mentioned that the main challenge is that they were disconnected from their traditional food e.g wild meat, wild fruits, tubes and wild berries which they long for. During the consultation meeting at the model village, some members mentioned they believe that the common local food e.g cassava, beans etc., is among the reasons why many of them are dying. They mentioned certain activities brought them together for example collecting of shrubs known to them as "Entangamiizi" from which they would turn into mattresses. However, such activities have since ceased.

To better understand the quality of life of the Batwa residing in the Model Village in Mgahinga, 12 out of the 24 household heads in the model village were subjected to structured questionnaires that were administered by trained survey assistants that were well conversant with Lutooro; a dialect close to Lutwa and understood by the Batwa. This number (12 respondents) was based on availability and willingness to respond to the questions.

A. Education

Education attainment among the Batwa is still very low. None of the household heads that participated in the survey had ever attended school, however, their children go to Kihembe Primary School. In addition, a pre-primary school has been set up in the camp where young ones go to before they attend Primary school. The pre-school has got only one teacher and she does not reside in the village but rather commutes from Kihembe village.

Figure: Room used as pre-school

Figure: Children play area

B. Religious affiliations

Consultations revealed that the Batwa originally believed in a supreme being known as “Imaana” who was believed to provide food, bless hunters with catch, wealth and protection. However, many of them mentioned that they had adopted Christianity and during the survey, 6 of the respondents mentioned that they were Protestants (Anglican) whereas others were catholic and Pentecostals. However, a few of them still practice the old religion.

C. Livelihood sources

The main source of livelihood for the Batwa in Kihembe is mainly farming, at a subsistence level. A few of them own very little agricultural land, and the least productive, (one acre or less per household), in designated locations in hard-to-reach hilly terrain near the forest obtained from development agencies such as the Adventist Development and Relief Agency, BMCT (Bwindi Mgahinga Conservation Trust) and AICM (African International Christian Ministry). The main crops grown include beans, bananas, ground nuts, maize and cassava among others. The Batwa mainly depend on rain to water their crops. Much of their produce is consumed at home, whereas some is sold at the trading center. Possibly because they are originally hunters, the Batwa in the model village do not rear animals. During consultations they revealed that they prefer wild meat to that from domestic animals.

Figure: Banana growing in the model village

Figure: Beans and maize growing in the model village

D. Water

The village is connected to NWSC. Households access water from yard taps. However, when water bills accumulate and they fail to pay, the Batwa resort to a protected spring close to the camp. The constructed houses were provided with water harvesting facilities and so these provide an alternative to NWSC where water is harvested and stored during the rainy seasons for use during the dry seasons.

Figure: Some of the constructed houses in the model village

Figure: Rain water harvesting in the model village

E. Health

All the household heads reported to have a member of their household that had suffered an illness in the past 6 months and Malaria was reportedly the common illness among the Batwa in the model village. Other illnesses included Typhoid and intestinal worms. Among other reasons, high rate of spread of malaria could be attributed to the lack of insecticide treated mosquito nets. 8 out of the 12 household heads mentioned that they do not have mosquito nets in their houses. Health services are accessed from Kihembe H/C, Kihihi H/C III, Mburamaize Barracks H/C II and Samaria Health centre. Average distance travelled to access these health facilities was 1.5 – 2.5 km. regarding immunization, 10 out of the 12 household heads mentioned that their under 5 children had bee immunized.

F. Sanitation

During the household survey, 10 out of the 12 household heads, had pit latrines whereas 2 shared with other households and occasionally practiced open defecation. Only 3 had hand washing facilities whereas the 9 did not.

Most of the toilets were constructed as under the house construction project by BMCT that is still ongoing.

Figure: One of the toilet facilities within the model village

G. Energy

The only source of energy for cooking was firewood which is collected from the Surrounding wood lots. Kerosene was the main source of energy for lighting since the village was not yet connected to the national grid at the time of the study. However, during consultation, they mentioned that their children are constantly burnt by kerosene lamps, additionally, purchasing Kerosene every other day has become costly to them.

H. Gender roles

Gender roles do not defer among the Batwa. Both the men and women are engaged in farming activities and casual labour. However, women have got in unique music, drama, art and crafts. During a discussion held with the women, they expressed the need for training in handcraft especially in making baskets and mats to economically harness the talents and establish a sustainable livelihood.

VULNERABLE & MARGINALISED GROUPS' FRAMEWORK/VMGF FOR MATANDA IRRIGATION SCHEME IN KANUNGU DISTRICT

The presented Vulnerable and Marginalized Groups' Framework (VMGF) below was drafted in May 2019 as the ESIA study was ongoing.

A. Rationale for the VMGF

The VMGF is prepared to ensure that the irrigation schemes' development process fully respects the dignity, human rights, economies and the culture of VMGs and that the project has a broad community support from the affected VMGs. The VMGF also provides procedures to ensure that the impacts are mitigated and that the Batwa's benefit from the project.

B. Purpose and Objectives of the VMGF

The World Bank's OP 4.10 on Indigenous Peoples and VMGs aims to avoid adverse impacts on VMGs and to provide them with culturally appropriate benefits. Therefore, this VMGF is prepared to ensure that the World Bank's OP 4.10 on VMGs is applied to Matanda Irrigation Scheme. It aims to develop measures to:

i) Avoid potentially adverse impacts on VMGs;
ii) Where avoidance is not feasible, minimize, mitigate and compensate such effects;
iii) Ensure that VMGs receive social and economic benefits that are culturally appropriate as well as gender sensitive; and
iv) Guarantee the full participation of VMGs in the entire scheme cycle.

C. AN UNDERSTANDING OF INDIGENOUS PEOPLES IN UGANDA

i) Indigenous Peoples

Literature indicates a lack of a universally accepted definition of "Indigenous Peoples". Indigenous Peoples may be referred to in different countries by such terms as "Indigenous ethnic minorities," "aboriginals," "hill tribes," "minority nationalities," "scheduled tribes," "first nations," or "tribal groups." In Uganda, the term "ethnic minorities" is used to refer to VMGs. For purposes of this framework, the World Bank's criterion for identifying VMGs will be used to distinguish them from the 65 ethnic groups in Uganda: that is, *those people who have historically suffered, and continue to suffer disempowerment and discrimination on economic, social and cultural grounds*. The term "Indigenous Peoples" is used in a generic sense to refer to a distinct social and cultural group possessing the following characteristics in varying degrees:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;

- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; or
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

It is noted that, although the Ugandan Constitution does not expressly recognize indigenous peoples it makes provision for addressing some of the negative effects arising from ethnic imbalances. The Constitution, in the section on National Objectives and Directive Principles of State Policy, provides that every effort shall be made to integrate all peoples while at the same time recognizing the existence of, amongst others, their ethnic, religious and cultural diversity. In this regard, the Constitution requires that everything necessary be done to promote a culture of co-operation, understanding, appreciation, tolerance and respect for each other's customs, traditions and beliefs.

ii) Ethnic Minority Groups in the Project Area

It is possible to argue endlessly about the meaning of the term 'minority' in the Ugandan context (and sub-Saharan Africa) and whether a particular group of individuals form a separate minority (MRG, 2001). Similarly, no definition of the term 'minority' has proved universally acceptable. However, the UN Human Rights Committee came up with a working definition as: *"any disempowered group, regardless of its numerical size could be considered a minority"* (Ibid) typically defining Banyabutumbi (Indigenous ethnic minorities).

iii) Marginalised Groups

The term "Marginalization" generally describes the overt actions or tendencies of human societies whereby those perceived as being without desirability or function are removed or excluded (i.e., are "marginalized") from the prevalent systems of protection and integration, so limiting their opportunities and means for survival.

iv) Vulnerable Groups

Vulnerability refers to the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. A vulnerable group is therefore a population with specific characteristics that put it at a higher risk of falling into poverty than others living in project areas. Vulnerable groups thus include the elderly, disabled people, HIV/AIDS infected and affected individuals and households, women, and orphans and vulnerable children (girl child, street children, children from extremely poor households, HIV/AIDS infected and affected children, children with disabilities, children living with elderly or disabled parents, and children in paid employment). This definition also includes the three groups described above. On average, the Batwa are recognized as vulnerable, marginalized and poor.

v) Recognising VMGs in Uganda

Uganda does not have an official definition of VMGs neither does it have a criterion for their identification. According to Uganda's 1995 Constitution, there are 65 ethnic groups referred to as its indigenous communities as from the date of 1st February 1926. Ethnic diversity plays a major role in shaping the behaviours and ways of life of people as their cultural and social life differ from one ethnic group to another. The term 'indigenous' as referred to in the Constitution is used to describe the different ethnic groups that have historically resided within Uganda's borders. This understanding differs markedly from the manner in which the term is used by international and regional organizations and by experts on VMGs' issues. Uganda uses ethnic minorities, to the exclusion of other factors, as the only method of identifying VMGs.

The African Commission on the 3rd periodic report (concluding observations) on the Republic of Uganda, observed that one of the factors restricting the enjoyment of the rights enshrined in the African Charter on Human and Peoples' Rights (ACHPR, 2009) is the apparent lack of political will to take measures to realize the rights of VMGs especially the *Batwa* as guaranteed under the Charter. The commission recommended that Uganda adopts measures to ensure the effective protection of the rights of VMGs especially of the *Batwa* people as guaranteed under the Charter by establishing laws that protect land rights and natural resources of VMGs (ibid). These groups are not recognized as VMGs by the GoU which prefers to call them vulnerable and Marginalized groups or Ethnic Minorities.

vi) The Vulnerable and Marginalized Groups of Uganda

A number of ethnic minority groups in Uganda have been identified according to the World Bank's OP 4.10 on the identification of VMGs. They include traditional hunters and gathers' communities of:

- ***Batwa***, also known as *Twa or Pigmies* who live primarily in south-western Uganda;
- ***Ik,*** who live on the edge of the Karamoja - Turkana region along the Uganda - Kenya border in Kaabong district, Karamoja;
- ***Benet,*** also known as *Ndorobos,* are 20,000 in number and live in Kween district on the margins of and inaccessible parts on the slopes of Mt. Elgon in the north-eastern part of Uganda, and
- ***Tepeth****,* also referred to as the *Soo*. They live in Mount Moroto and neighbor the Turkana and the Pokot of Kenya. They are also said to have been the original people of Moroto but due to ethnic wars with the Karimojong they were driven up the top of mount Moroto.

The VMGs of Uganda are commonly characterised by:

- Historical and continued suffering, disempowerment and discrimination on economic, social, cultural and political grounds;
- Reliance on their land and environment to sustain themselves both physically (in terms of food, fuel and habitat) and culturally;

- Threatened livelihoods mainly due to dwindling access to land and natural resources on which they depend as hunters and gatherers;
- Their economic systems exist separately from that of the mainstream or dominant community, and tend to have minimal interaction (if any) with the socio-economic and legal systems of national governments;
- Much lower health and education indicators than those of the dominant community, often due to difficult access. This means that they are particularly vulnerable to changes in their socio-economic and physical environments; and
- Social exclusion, deprivation from mainstream government services, lack of participation in development processes that affect them, and in most cases uncertainty of land and natural resource tenure.

vii) Key Challenges faced by the Batwa

- Landlessness - although the Batwa had no concept of land ownership before 1992, they were comfortable in the forest which was 'owned' by none except themselves. From the forest that provided them with all their basic living requirements without any threats, they were resettled in camps located in Kengoma and Kanyashande cells, Kanyantorogo subcounty where they are now impoverished in a state of landlessness (since they own now small plots) and lack of resources;
- Loss of a culture/identity - transition from forest life to the 'outside, open and dry life' is one of the Bwata's biggest challenges. The culture outside the forest is alien, demanding and does not enable *Batwa* carry out activities previously undertaken in the forests. On resettlement, many could not sleep in the Iron roofed houses since they were not familiar with the rain drop sound on the iron roof in relation to their former grass hatched house or sleeping under trees. The Batwa leaders lost all cultural sites in the forest from which they used to perform rituals, worshiping of their gods and settling family disputes. This has affected teaching and learning of indigenous knowledge to the young generation and thus a steady loss of their culture;
- The threat of extinction - some *Batwa* in the sub region are faced with the threat of extinction due to stigmatization and 'integration'. The VMGs remain 'silent' and 'hidden' in the dominant community because they are ashamed of revealing their identity. Through the various myths in the Kengoma and Kanyashande cells and surrounding communities about, "HIV/AIDS healing through sexual intercourse with a Mutwa Woman," has exposed many in these designated camps to the disease. Exposure to the outside community has fueled intermarriages with the Batwa.
- High non-school attendance, school dropouts and low completion rates at both primary and secondary levels. There are very few *Batwa* children in secondary schools.
- Joblessness – With the small sized plots of land the Batwa acquired, they cannot practice commercial farming unlike their fellow non marginalized counterparts (the community that existed in these cells), hence they have been left to rent out their small plots to the community for agricultural practice and restored to selling their labour to earn a living. They are now characterized as beggars in the community.

Idleness attracts vices like alcoholism and 'prostitution' making them susceptible to diseases particularly HIV/AIDS.

- Poor hygiene and eating habits – characterized with poverty, many cannot afford two meals a day, this does not only affect their health status but also affects their children's school attendance as they skip school because they are hungry or/and are dirty in which case they are teased at school.

viii) Key Challenges Common to VMGs in Uganda

The non-recognition and identification of VMGs by the GoU is a major cause of their neglect and violation of their rights. According to the International Work Group for Indigenous Affairs (IWGIA), dispossession of traditional lands and territories is one of the major problems of VMGs in Africa. Dominating development paradigms in Africa perceive VMGs' modes of production (pastoralist, hunting, and gathering), as primitive, non-productive and unaligned with today's modernization aspirations of African States. Therefore, many development policies are either directly or indirectly unfavourable to VMGs' modes of production. In addition, IWGIA notes that only a few African States recognize and protect the basic collective rights of VMGs in their constitutions or national legislation. Indigenous Peoples suffer from weak political representation, discrimination, and stereotyping from the mainstream society. Some of the major challenges and concerns faced by indigenous groups in Uganda are:

- Uganda's constitution does not express protection for VMGs, though it does provide for affirmative action in favor of marginalized groups (IWGIA, Update 2011);
- The Land Act of 1998 and the National Environment Statute of 1995 protect customary interests in land and traditional uses of forests. However, these laws also authorize the government to exclude human activities in any forest area by declaring it a protected forest, thus nullifying the customary land rights of VMGs. Nevertheless, the National Land Policy 2013 seeks to address the issue of dispossession of VMGs' ancestral lands as will be seen in the next section;
- Political participation of VMGs remains limited and their socio-economic rights are ignored by the State and society; and
- Eviction from their homelands has limited Uganda's VMGs' access to natural forest food, herbal medicine, and shelter leaving some of them plagued by starvation and sickness;
- Eviction from homelands (Natural Forests) has limited the vulnerable/marginalized Peoples' access to food, medicine, and shelter. As a result, some of them are plagued by starvation, sickness and exposure. For instance, the Batwa in Bundibugyo District numbering less than 200 are on the verge of total extinction due the HIV/AIDS, which they have acquired due to the integration with other communities who believe that one can get cured of the infection after sleeping with a Mutwa woman.

The International Work Group for Indigenous Affairs (IWGIA) and the Working Group on Indigenous Issues of the Commission have argued that: the issue of VMGs revolves around the assertion that certain marginalized groups are discriminated against in particular ways because of their particular culture, mode of production and subordinate position within the State and that State legal and policy frameworks have been impotent at addressing these challenges. This is a form of discrimination which other groups within the State do not suffer from. It is legitimate for the marginalized groups to call for the protection of their rights in order to alleviate this particular form of discrimination**.**

The international work group for indigenous affairs and the working group on indigenous issues is triggered in this project due to impacts likely to occur to the Batwa if no clear consideration is undertaken. The report emphasized that there is need to protect the Batwa, involve them in every preparation stage and above all offer them work during construction.

D. NATIONAL LEGAL FRAMEWORK APPLYING ALONG WITH OP 4.10

The table below presents the national legal framework applying along with OP 4.10 guiding this VGMF.

Legal framework	Relevance to the proposed VGMF
Constitution of the Republic of Uganda, 1995	**OP4.10 >** Under paragraph 10. *Consultation and Participation*. Where the project affects Indigenous Peoples, the borrower engages in free, prior, and informed consultation with them. **Constitution >** the Batwa defined as key stakeholder were prior consulted (Batwa leaders) and will be consulted at large during the Social Assessment with the aim of disclosing the proposed project scope and activities in line with Objective XXVII (i) of the constitution , "awareness."
	OP4.10 > Under paragraph 3. *Identification*. Because of the varied and changing contexts in which Indigenous Peoples live and because there is no universally accepted definition of "Indigenous Peoples," this policy does not define the term. Indigenous Peoples may be referred to in different countries by such terms as "indigenous ethnic minorities," "aboriginals," "hill tribes," "minority nationalities," "scheduled tribes," or "tribal groups." **Constitution >** According to Uganda's 1995 Constitution, there are 65 ethnic groups referred to as its indigenous communities as from the date of 1st February 1926. The term 'indigenous' as referred to in the Constitution is used to describe the different ethnic groups that have historically resided within Uganda's borders. Uganda uses ethnic minorities, to the exclusion of other factors, as the only method of identifying VMGs like the Batwa under Third Schedule article 10(a). **Gap >** Uganda's constitution has no express protection for VMGs, though it does provide for affirmative action in favor of marginalized groups like; • Equality and freedom from discrimination; without prejudice to clause (1) of this article, a person shall not be discriminated against on the ground of ethnic origin or tribe.

Legal framework	Relevance to the proposed VGMF
	• Right to culture and similar rights; every person has a right as applicable to belong to, enjoy, practice, profess, maintain and promote any culture, cultural institution, language, tradition in community with others. • Protection of rights of minorities; Minorities have a right to participate in decision-making processes, and their views and interests shall be taken into account in the making of national plans and programmes
National Water Policy, 1999	**OP4.10 >** Under paragraph 18. *Commercial Development of Natural and Cultural Resources*. If the project involves the commercial development of natural resources such as water on lands or territories that Indigenous Peoples traditionally owned or occupies. The borrower includes in the IPP arrangements to enable the Indigenous Peoples to share equitably in the benefits to be derived from such commercial development. **Policy >** Under section 5.2.2, *Financing, Subsidies 'and Tariffs*. It calls for Subsidies to enable the disadvantaged sections of the community access to basic services and improvements in their quality of life, hence a project service inclusion of the Batwa.
National Irrigation Policy, 2017	**OP4.10 >** Under paragraph 22(i). *Indigenous Peoples and Development*. It facilitate partnerships among the government, IPOs, CSOs, and the private sector to promote Indigenous Peoples' development programs. **Policy >** Under Section 6; *Implementation Framework and Strategic Partnerships,* It calls for contact and inclusion with appropriate institutions / farmer organizations at local/scheme level for sustainable management of irrigation schemes. **Policy >** Under Section 3; *Policy Priority Areas and Strategic Interventions*, Priority 4 of the policy encourages equitable access to irrigation production opportunities for the marginal and vulnerable groups like the Batwa livelihood development program at the camps.
National Gender Policy, 2007	**OP4.10 >** Under paragraph 22(d). *Indigenous Peoples and Development*. It address the gender and intergenerational issues that exist among many Indigenous Peoples, including the special needs of indigenous women, youth, and children **Policy >** Under Section 6; *Gender and Governance,* specific strategies (d) calls for Promoting social protection interventions for poor and vulnerable women and men; and (e) developing strategies to eradicate the child labour incidence with emphasis on the exploitation of the girl child.
Uganda National Land Policy, 2013	**OP4.10 >** Under paragraph 16. *Lands and Related Natural Resources*. (a) the customary rights of the Indigenous Peoples, both individual and collective, pertaining to lands or territories that they traditionally owned, or customarily used or occupied, and where access to natural resources is vital to the sustainability of their cultures and livelihoods; (b) the need to protect such lands and resources against illegal intrusion or encroachment;

Legal framework	Relevance to the proposed VGMF
	Policy > Under Section 4.8; *Land Rights of Ethnic Minorities,* Paragraph 58; (a) Government of Uganda shall, in its use and management of natural resources, recognize and protect the right to ancestral lands of ethnic minority groups;(b) Government of Uganda shall pay prompt, adequate and fair compensation to ethnic minority groups that are displaced from their ancestral land by government action. It was on basis of this section that the Camp for the Batwa in Kengoma and Kanyashande cells, Kanyantorogo subcounty, Kunungu district near the Matanda command area were established. The policy provides for affirmative action in favor of marginalized groups current settlement through establishment of regulations by Statutory Instrument to:(a)Recognize land tenure rights of minorities in ancestral lands; (b)Document and protect such de fact occupation rights against illegal evictions or displacements;(c)Consider land swapping or resettlement or compensation in the event of expropriation of ancestral land of minorities for preservation or conservation purposes;(d)Set terms and conditions for displacement of minorities from their ancestral lands in the interest of conservation or natural resources extraction.
Uganda National Culture Policy, 2006	**OP4.10 >** Under paragraph 2. The Bank recognizes that the identities and cultures of Indigenous Peoples are inextricably linked to the lands on which they live and the natural resources on which they depend. At the same time, the Bank recognizes that Indigenous Peoples play a vital role in sustainable development and that their rights are increasingly being addressed under both domestic and international law. **Policy >** Under Section 2.3.1; *Uganda's Indigenous Communities,* it recognizes the existence of indigenous minorities that are marginalized of which are faced with loss of identity, which threatens their existence. **Policy >** Under Section 7.3; *Development and promotion of Indigenous knowledge,* it recognizes Indigenous Knowledge (IK) as a vital sub-system of culture being a key factor in social and economic development as well as cultural transformation. In addition, there is recognition of the important role of local communities in contributing their indigenous knowledge systems to enhance the sustainability of development programmes.
	OP4.10 > Under paragraph 4. *The term "Indigenous Peoples*". A group that has lost "collective attachment to geographically distinct habitats or ancestral territories in the project area." **Policy >** Relates indigenous ethnic groups that are marginalized to status unequal to that of the dominant groups. Their rights including access to justice, equality, dignity, identity are belittled or ignored compared to those of other groups. It explicitly identifies the Batwa as part of the Uganda Indigenous Communities.

E. POTENTIAL IMPACTS OF ICRP PROJECT ON AFFECTED VMGs

i) Key Issues

It is evident from the consultations that the collective relationship that VMGs have with their land, territories and resources is both multi-faceted and profound. It has dimensions which are material, social, cultural, economic, political, psychological and spiritual in nature. This relationship is intergenerational and critical to the identity, economic sustainability and survival of the VMGs as distinct cultural communities with their own world view and spirituality. Denial or restriction of access to their lands, territories and resources can threaten their physical and cultural survival as well as social organisation. Therefore, a number of risks relevant for the Matanda Irrigation Scheme are worth noting:

- Indigenous Peoples' rights - Particular rights of VMGs are recognized in international agreements and for World Bank-supported projects by the Bank's own policy. Such rights, and especially access to their land, are also recognized in the National Land Policy, 2013. Wheareas during the RAP implementation no Batwa land was affected, special attention should be taken to ensure that their interests are protected. The implementation process of the Matanda Irrigation Scheme will have to identify and recognize these rights to ensure that activities do not infringe on such rights.
- Wheareas their land or interests are relatively far away, approximately 48 km south of the Matanda Irrigation Scheme command area, specifically in Kengoma and Kanyashande cells, Kihembe Parish Kanyantorogo subcounty, the project has put in place a deliberate system, through a Vulnerable and Marginalised Groups' Plan (VMGP) to ensure there is close collaboration with their community regarding the project. For example, employing them on the project, recognising their existence, involving them in project development, providing them both clean drinking water and water for production, and any corporate incentives their community should benefit from, among other livelihood interventions.
- Loss of culture and social cohesion - Given VMGs' distinct cultures and identities and their frequent marginalization from the surrounding society, Matanda Irrigation Scheme interventions may run the risk of imposing changes to or disruption of their culture and social organization, whether inadvertently or not. While these indigenous communities may welcome and seek change, they can be vulnerable when such change is imposed from external forces and when such change is rushed. Moreover, since many indigenous communities' culture and social organization are intertwined with their land and natural resource use practices, changes to these practices may result in undesired changes in the culture and social organization which may lead to social disruption and conflicts within and between communities and other stakeholders.

ii) Potential Positive Impacts

Potential Positive Impacts

<table>
<tr><th>Project Components</th><th>Potential Positive Impacts on VMGs</th></tr>
<tr><td colspan="2"><u>Component 1.</u> Irrigation and Drainage Service Development
Most of the settlements of the VMGs are in areas hindered by inadequate rains terrain that exposes them to water scarcity. This has contributed to poor agricultural produces for those that have tried to practice farming. And for those that have managed to be resettled near surface water sources, they have been exposed to flood risks due to poor catchment management practices characterized by their illiteracy in environmental protection. This component will construct new large-scale irrigation schemes for constant agricultural water supply but will also have the VMGs participate in the development and implementation of integrated catchment management interventions. To ensure protection of vulnerable groups, a comprehensive VMGP covering risk areas for VMGs has been developed and included under Volume 1.</td></tr>
<tr><td>Sub-component 1.2 Infrastructure Development
▪ Construction of associated head works (weirs), irrigation networks (pipes, canals, electro-mechanical equipment), drainage networks, access and scheme roads, scheme offices, sanitation facilities, and weather stations</td><td>• Creation of employment opportunities for the VMGs' in the project area to the extent possible, depending on the level of skills required visa-vié skills available from the VMGs.
• Construction of access and scheme roads in the VMGs' areas (project area) will increase their access to quality social and economic services like markets, health centres and schools.
• Construction of on-farm irrigation works and equipment will not only expose the VMGs' to modernized methods of farming, but enable them bear capacity to carry out modern framing for better agricultural production as a better economic alternative.
• Improved VMGs' attitude towards employment and agriculture, hence making it a priority for many. VMGs that currently had tried agriculture with no success may gradually change their negative attitudes towards agriculture when they bear good productions and sales.
• A reduction of beggars among the VMGs better agricultural avenues would have been introduced with a high labour force expectation. The plan to ensure protection of VMGs has been included.</td></tr>
<tr><td>▪ Technical assistance for preparation of feasibility studies and detailed designs for irrigation schemes, monitoring and control of works, O&M of irrigation schemes, environmental audits and implementation of the Environmental and Social Management and Monitoring Plan (ESMMP)</td><td>• Prior inclusion of the VMGs during the preparation of feasibility studies and detailed designs for irrigation schemes will enable them to understand the project scope and nature, accept, and own up the project.
• Monitoring and control of works by expert team will create assurance to the VMGs as regards to their inclusion in project works and respect of their rights in the entire scheme cycle.
• Implementation of the project developed Environmental and Social Management and Monitoring Plan will not only trigger implementation of mitigation measures attributed to the VMGs but also improve their interaction with the environment and society as a whole in a sustainable manner.
• Project environmental and social audits will enable checking if the social and economic benefits delivered for VMGs are culturally</td></tr>
</table>

Project Components	Potential Positive Impacts on VMGs
	appropriate and gender sensitive. To ensure that all aspects necessary for protecting them are covered under the Vulnerable and Marginalised Groups' Plan (VMGP), which was developed along this report.
Sub-component 1.2: Integrated Catchment Management	• Through trainings, workshops, dissemination of information to the VMGs, a knowledge gap will be closed.
<u>Component 2</u>. Support services for agricultural production and value-chain development Having provided water for agriculture to the various VMGs' gardens, strengthening of VMGs' farmers groups in marketing, finance, and organizational management will be provided by MAAIF with the aim of facilitating them to access quality inputs and appropriate technologies and practices with the aim of improving production and productivity; and support value chain development and market (domestic and regional) linkages to increase the value of traded items for better economic gains.	
Subcomponent 2.1: Farmer Organizational Capacity Enhancement and Support	• The project will encourage establishment and strengthening of vulnerable and marginalised farmers groups (VMFGs) that will contribute to social cause of the groups. • VMFGs will be trained in various agricultural aspects aimed at improving production and productivity, hence enhancing VMFGs' capacity. • All these measures are comprehensively covered in the VMG plan covering aspects aimed at protecting vulnerable groups.
Sub-component 2.2: Production and Productivity Improvement	• An increased access to inputs like seeds, fertilizers and agro-chemicals. • Access to good agricultural practices, sustainable land management practices, integrated pests and disease management knowledge through trainings.
Sub-component 2.3: Value Addition and Market linkages including	• Increased assess to technical assistance for support of value chain actors aimed at improvement of post-harvest handling and agro-processing. • Improved access to financing services. • Improved access to markets and market information. • Improved access to processing tools, equipment and machinery.
<u>Component 3.</u> Institutional Strengthening and Implementation Support	• Through technical assistance for institutional strengthening of MWE and MAAIF, these in turn will enable transcending of capacity building to the VMFGs. The Project Implementation Team (PIT) comprised of MWE, MAAIF, Kanungu District Local Government has been established and is responsible for capacity needs assessment, training planning and training of VMGs. This will be funded under the project budget. The PIT will be responsible eligibility assessment of the Trainees. • The VMGF includes a comprehensive plan designed to ensure that vulnerable farmers will access benefits of the irrigation scheme. A template of the VMGP has been incorporated as Section G of the VGMF.

iii) Potential Negative Impacts

Matanda Irrigation Scheme is likely to have minimal impact negative impact on the VMGs as the irrigation activities are mostly located relatively out of their occupied areas. Some envisigad impacts are illustrated in the table below Table PI: Negative impacts envisaged from the construction of Matanda irrigation scheme on VMGs **Impacts**	**Description**	**Mitigations**
Loss of residual grezzing land	**The Batwa predominantly been grezzing beyond their land area. These once taken up by the irrigation activities would be out of bounds for them affecting their way of life.**	**Oprtimization of their individual plots for grezzing. The project should aim at not extending into batwa land during construction to limit further**
Loss of Private land	**During RAP studies in the project area, no land owned or used by the Batwa was encountered.**	**The contractors should limit all the operations within the already established project corridor.** In case of impact on Batwa land, MWE shall carry out a culturally sensitive RAP that will be subjected to World Bank and CGV review and approval
Loss of access to communal resources	**Some corridor mapped out for irrigation works/infrastructure have been used as communal grounds for both the general community but also the vulnerable groups. Charcoal trees, figrewood, medicininal herbs, food gathering areas, water points**	**Undertaking thorough engegements and enhancing batwa participation the project cycle.** **Createtion of alternative access points by the contractor** **Implement resources sharing for all community groups**

		Undertaking community capacity development
Impact on Health	**Influx of people into the project area may put pressure on already weak health public health system within the project area resulting into suffering of the vulnerable person** **The influx may also led to spreading of diseases such as HIV if not handled well.**	**Limitation of influx of masses into the project area.** **Continuous sensitization about STIs and HIV/AIDS prior to project implementation and after shall be carried out to prevent VMGs and vulnerable groups from contracting/spreading STIs/HIV/AIDS.**
Loss of hunting ground	**A permanent boundary is going to be established around the national park limiting access to once an important ground for hunting among the batwa.**	**Sensitization on diversification of food/ meat sources to avoid an already declared illegal activity of hunting wild animals .**

Other impacts envisigad from the irrigation was within the matanda irrigation scheme includes the following,

Air quality impacts; It is expected that project vehicular traffic will emit exhaust emissions, chiefly oxides of sulphur (SOx), nitrogen (NOx) and those of carbon (CO_2 and carbon monoxide, CO). Others are particulates, unburned fuel (VOC) and ground-level ozone. Emissions quantities generated will depend on volume of traffic, travel distances, type and age of vehicles/ equipment, fuel type and quantities. Road dust generated by project traffic on earth roads and material handling (loading and tipping operations). These will temporarily affect the VMGs in short-term only manifesting during the construction phase. This impact may be mitigated through encouraging dust suppression by watering wherever necessary and ensuring regular servicing of equipment for high operational efficiency.

Disturbance due to noise pollution and vibrations; At construction sites (irrigation networks, drainage networks, and access and scheme roads), noise and vibrations will be generated from; construction vehicles and machinery movement, civil works like mixing concrete and offloading and loading of equipment and materials at construction sites. Excessive offsite noise will also impact surrounding settlements of VMGs. As a mitigation, the proposed works will only be scheduled during day and machines will be turned off when not in use.

Insecurity/theft; The influx of new people (workers) in the project area comes with all sorts of vices including theft. Such unscrupulous people may indulge in theft of the little accumulated VMG's wealth (crops, reared animals, domestic property, personal belongings, ritual antiquities, cultural symbols) or involve the unemployed or project employed VMGs' in their activities, which in the long run might affect their social image. Background check-ups on all people before employment will be conducted and security concerns shared with the community at large, including the VMGs.

Improper management of project generated waste; Vegetation waste from site clearance, excavated materials from earthworks, general construction waste (e.g. wood, scrap metal, concrete, empty cement bags); and municipal wastes generated by site workers (plastic bottles, mostly drink/water bottles, paper, cloths, food scraps, sewage) all are anticipated to be generated during the project construction phase. Visual impact of heap of collected rubbish, associated bad odour, harbour disease causing vectors like flies may expose the VMGs to health related risks. Implementation of the project waste management plan developed under the project ESIA component will help prevent or minimize this exposure.

Soil Erosion and Degradation; The area in which the VMGs would likely be resettled under this project delineation is highly characterized with steep slopes, that may increase the risk of soil erosion from the loose soils being eroded from the construction site during site clearance and excavations to downstream gardens of the VMGs hence affecting crop productivity. Clearance of vegetation should be limited to areas that will be required for construction of the components.

Impact on Gender; Participation of women in construction is a desired gender-related benefit but this may be constrained by the fact that most construction sites in Uganda are predominantly male dominated which disadvantages women involvement in provision of labor. At the same sites, equal employment opportunity for vulnerable women, paid an equal living wage, utilizing gender sensitive sanitary facilities and use of gender-sensitive language such as: "Go Slow, Work in Progress" instead of "Go Slow, Men at Work" will be encouraged.

iv) Matanda Irrigation Scheme Intervention Risks' Analysis

Some of the social risks of Matanda Irrigation Scheme interventions include, but are not limited to:

- ✓ The Batwa are formerly reknowned as forest-dwelling hunter-gatherers who became squatters living on the edges of society on establishment of the Bwindi and Mgahinga National Parks and Queen Elizabeth National Park. The Batwa are still challenged with land issues especially productive land for commercial agriculture. Small acreage subsistence farming practice by the VMGs implies that they a currently bearing less produce, aimed at hand-to-mouth with no saving for sale. Therefore, it would be risky to implement such a scheme in VMG areas without careful consideration of their ability to make a meaningful production. The schemes should not only consider current acreage of production but ability and attitude to future production. This will encourage development of VMFGs with a cause of appropriate land distribution and combined commercialized crop production. The VMGP shall include aspects of protection of this group in ensuring land protection and allocation in the irrigatable grounds.
- ✓ Most of the relocated settlement areas of the Batwa are on boarders of the renowned national parks in the delineated project area. These have relied on water sources within the national park competing for water with wildlife and have always faced attacks. Therefore, provision of agricultural water will improve their access to water for agricultural production but also for unintended domestic use such as drinking water for them and their animals, increasing the risk of ingesting contaminated water bearing animal's fecal matter, upstream fertilizers use, and sedimentation. Basing on the same case, the proximity of their gardens to the parks makes their produces more vulnerable to destruction by wild animals (like elephants and monkeys).
- ✓ The ICRP Project Implementation Team will coordinate with the Kanungu District Local Government and other on-going government programs to ensure that supply of drinking water for human use is prioritized for communities at Matanda Irrigation Scheme, including the VMGs.
- ✓ Best practices emphasize that projects should be demand-driven and encourage grassroots participation to ensure community ownership especially for the established infrastructure as a lack of it can result in 'white elephants'. Infrastructure investments completed without meaningful local community input face a risk of poor use and maintenance. To mitigate this challenge, the project shall ensure active participation and inclusion of this group into project implementation. A VMGP including assessment of their needs has been intergrated in this report.
- ✓ Apart from meeting agricultural needs, the irrigation scheme could have a direct impact on various socio-economic development indicators among the VMGs. For example, the expansion of cultivated and irrigated areas once the irrigation scheme is up and running may limit access to natural resources and cause encroachment on forests. Similarily, due to expension of irrigation system there is a likelyhood of restricted use of resources and leakage of resources extraction to the Queen Elizabeth National Park. To prevent this, the QENP is implementing a protective mechanism to install an electric fense across their border during second half of 2024.

v) Mitigation Measures

To avoid or minimize adverse impacts and, at the same time, ensure benefits for the VMGs, an understanding shall be reached between MWE and the community to, in principle, apply the following basic principles in the selection of feasible designs of irrigation scheme for Matanda:

- Ensure that VMG communities in general and their organizations/local leaders are not excluded by any means in activities of project beneficiary selection, design, and implementation processes.
- Provide full information on the project scope and nature to the VMGs at all stages of the project cycle.
- To ensure appropriate utilization of provided water, MWE shall provide alternative water sources to the VMG communities for domestic consumption like standpipes or a water harvest program.
- To ensure that VMFGs' are encouraged, MWE in conjunction with MAAIF shall establish irrigated demonstration farms in the VMGs community to act as demonstration farms for the VMGs.
- MWE shall ensure that VMGs in the project areas get a fair share of the Matanda irrigation scheme within VMGs community to encourage interactions with the wider community and be mindful of the potential harm caused by gaps in service provision to prevent such gaps.
- MWE shall carry out specific assessments of the impact of proposed Matanda irrigation scheme on the economic and social development of VMGs as an integral part of the project cycle, through a transparent process with free and informed participation of the affected communities. MWE has to ensure that the Matanda irrigation scheme interventions do not unnecessarily and unintentionally exacerbate factors outside the scope of the planned impacts.
- To ensure protection of the VMGs and other vulnerable groups, a deep assessment on top of what has been undertaken through stakeholder engagement using the MVGs assessment tool, MWE shall ensure resources for risk and impact management necessary for the Matanda project are available for implementation. Where alternatives are not feasible and adverse impacts on VMGs are unavoidable, MWE together with the affected VMGs and other knowledgeable of VMG culture and concerns shall make an immediate assessment of the key impact issues and the most opportune compensatory measures.
- MWE shall undertake effective consultation and collaboration with existing NGOs with experience in VMGs to ensure there is a holistic protection system and that the VMGs benefit from the project and the necessary tasks are taken to adopt appropriate mitigation measures. The most important in this respect is efficient consultation with the VMGs communities, community elders/leaders, CSOs/NGOs and other actors with experience in working with VMGs.
- MWE should undertake Sexual Exploitation and Abuse (SEA) as a form of Gender-Based Violence (GBV) assessments/ surveys in the area including the Batwa camps in conjunction with department of Labour under Ministry of Gender Labour and Social Development (MGLSD) and, prepare and implement a preventive action plan based on the results as pertinent.

vi) Strategies for VMGs Participation

VMGs are usually excluded from accessing basic services because they are not sufficiently positioned to tap vital development opportunities. Below are the strategies identified for the project to ensure their inclusion and participation in the Matanda Irrigation Scheme.

Guidelines for including VMGs include:

- Identify subgroups (VMGs) among the poor, especially those at risk of exclusion;
- Structure project rules such as related with employment opportunities of the vulnerable groups, inclusion in discussions and decision making, and assessment of key VMG needs within the project;
- Develop and carry out a deliberate plan that ensures that VMGs are actively participating in the project implementation process. For example, the Batwa must be institionally given a slot in every meeting, the budgets shall include facilitation of their movement and allocation of irrigation water and land shall cover the VGMs;
- Ensure that intermediaries (CSOs/NGOs/CBOs, etc.) working with communities have expertise in working with these groups and using participatory techniques;
- Ensure that allocation of water and irrigatable land is more responsive and inclusive of these groups e.g., securing more fertile land for VMGs with the aim of increasing cultivated acreage and the yield per acreage; and
- Include specific indicators related to these groups in monitoring and evaluation systems and involve VMGs in monitoring and evaluation.

Consultation and Mobilization

Matanda irrigation scheme must be designed in such a way that all segments of the community have a voice in decision-making and management. In order to enhance the positive benefits of the project, there should be adequate consultation and participation of VMGs during project design and implementation to ensure that the project adequately deals with the needs, priorities and preferences. Emphasis should also be put on mobilizing communities to manage and sustain the project infrastructure and services so as to encourage ownership of these investments. Focus should also be put on providing access to information that will enable all community members not only to know their rights, demand for services and hold leaders accountable but also fulfill their duties and responsibilities as project stakeholders. The project will involve the training of local agricultural groups (farmers, suppliers, that should work together with the respective District Community Development Officers, CDOs) and the CSOs/NGOs to mobilize VMGs to participate in the Matanda irrigation scheme.

Working with stakeholders

The degree to which MWE will be able to collaborate, share information, and synthesize efforts will determine, to some extent, the success of Matanda irrigation scheme. Engaging stakeholders will help MWE to:

- Identify and prioritize community development needs and opportunities for integration in design of Matanda irrigation scheme;
- Identify potential positive or negative impacts that the scheme may further leverage or help to mitigate;
- Encourage community member involvement in project design, implementation, and monitoring;
- Identify and evaluate potential partners to implement the project;
- Monitor project impacts and ensure that the project meets community expectations;
- Obtain feedback from the VMG communities; and

- Obtain support and ownership from them.

Experience of already existing NGOs and other agencies in the project areas will be invaluable to MWE. The presence of NGOs like Bwindi Mgahinga Conservation Trust (BMCT) and the United Organisation for Batwa Development in Uganda (UOBDU) has helped in addressing some of the underlying social and economic barriers. Therefore, MWE should consider tapping experiences from these CSO/NGOs during project implementation and ensure there is collaboration with existing NGOs within the project area.

APPENDIX G NATIONAL AIR QUALITY STANDARDS

POLLUTANT	AVERAGING TIME FOR AMBIENT AIR	EXAMPLES TO WHICH STANDARDS ARE APPLICABLE TO	STANDARD FOR AMBIENT AIR	STANDARD FOR EMISSIONS (POINT SOURCES)
Acid mist	24 hr	Acid manufacture, battery manufacture and acid changing, chemical stores and labs	100 µgNm^{-3}	
Ammonia	24 hr	Refrigeration, chemicals stores and labs, fish processing Combustion processes, boilers or any process involving sulphur burning	200 µgNm^{-3}	50 mg/Nm^3
Asbestos	24 hr	Construction industry, garages/car repairs, asbestos manufacture	0.01 fibres ml^{-1}	
Baggase	24 hr	Sugar processing plants	200µNgm^{-3}	
Carbon dioxide	8 hr	Breweries, soft drink industries, burning processes	9.0 ppm	
Carbon monoxide	8 hr	Combustion processes, boilers	9.0 ppm	
Cement	24 hr	Cement industries, construction	200 µgNm^{-3}	50 mg/Nm^3
Ceramics	24 hr	Tile and brick industries, ceramic industries, construction	200 µgNm^{-3}	
Chlorine	24 hr	Water treatment, fish processing, chemical stores and labs	200µg Nm^{-3}	< 3mg/Nm^3
Cobalt	1 month	Cobalt processing, copper mining	1.0 µgNm^{-3}	
Coffee dust	24 hr	Coffee processing and trading	200 µg Nm^{-3}	
Cotton fibres	24 hr	Cotton farming, ginning and export, textile manufacture	200 µgNm^{-3}	
Copper dust	1 month	Copper mining and processing, metal works and fabrication	1.0 µgNm^{-3}	0.5 mg/Nm^3
Electrode manufacture emissions	24 hr	Electrode manufacture, garages/car repairs, welding, metal fabrication	150 µgNm^{-3}	20 mg/Nm^3
Grain dust	24 hr	Grain milling, bakeries, feed mills, breweries, agriculture	200µgNm^{-3}	
Hydrocarbons	24 hr	Chemical stores and labs, fuel depots and stations	5 mgm^{-3}	
Hydrogen Sulphide	24hr	Waste water treatment, tanneries	15 µgNm^{-3}	15 mg/Nm^3
Lead	1 month	Battery manufacture and repair metal fabrication	1.0 µgNm^{-3}	0.5 mg/Nm^3

POLLUTANT	AVERAGING TIME FOR AMBIENT AIR	EXAMPLES TO WHICH STANDARDS ARE APPLICABLE TO	STANDARD FOR AMBIENT AIR	STANDARD FOR EMISSIONS (POINT SOURCES)
Lime	24 hr	Lime and cement industries, agriculture, construction	200 µgNm^{-3}	
Nitrogen oxides (NO_x)	24 hr 1 year Arithmetic mean	Combustion processes, welding	0.10 ppm	300 mg/Nm^3
Ozone	1 hr		0.10 ppm	
Pesticides	24 hr	Pest control and plant protection		
Phosphates	24 hr	Fertiliser manufacture, soap and detergents industry	200 µgNm^{-3}	50 mg/Nm^3
Silica	24 hr	Construction industry, detergent and manufacture, quarries	200 µgNm^{-3}	
Smoke	Not to exceed 5 min. in any one hour	Industry, trade or nay combustion process	Ringlemann scale No.2 or 40% observed at 6m or more	
Soot	24 hr	Combustion, charcoal and brick making, boilers	500 µgN m^{-3}	
Sulphur dioxide	24 hr	Combustion processes, boilers or any process involving sulphur burning	0.15 ppm	400 mg/Nm^3
Sulphur trioxide	24 hr	Sulphur burning, sulphuric acid manufacture	200µgNm^{-3}	
Synthetic fibres	24 hr	Synthetic textiles manufacture	0.01fibres ml^{-1}	
Tea dust	24 hr	Tea processing and manufacture	200 µgNm^{-3}	
Tobacco dust	24 hr	Cigarette manufacture including tobacco curing, tobacco farming	200µgN m^{-3}	
Total suspended particles/ particulate emissions	24 hr	Industries (e.g. cement, lime), quarries, grain milling, coffee processors, pharmaceuticals and any other trade	300 µgN m^{-3}	<50mg/Nm^3
Wood dust	24 hr	Saw mills, timber works and furniture making, construction	1 mgNm^{-3}	20mg/Nm^3
VOCs	24 hr	Breweries, fuel depots and stations	6 mgNm^{-3}	20mg/Nm^3

Beaufort scale of wind speed

Beaufort scale number and description	Wind speed equivalent at a standard height above flat ground		Specifications for estimating speed over land
	m/s	Km/hr	
0 Calm	0 – 0.2	< 1	Calm; smoke rises vertically
1 Light air	0.3 – 1.5	1 – 5	Direction of wind shown by smoke-drift but not wind vanes
2 Light breeze	1.6 – 3.3	6 – 11	Wind felt on face; leaves rustle; ordinary vanes moved by wind
3 Gentle breeze	3.4 – 5.4	12 – 19	Leaves and small twigs in constant motion; wind extends light flag
4 Moderate breeze	5.5 – 7.9	20 – 28	Raises dust and loose paper; small branches are moved
5 Fresh breeze	8.0 – 10.7	29 – 38	Small trees begin to sway, crested wavelets form on inland waters
6 Strong breeze	10.8 – 13.8	39 – 49	Large branches in motion; whistling heard; umbrellas used with difficulty.
7 Near gale	13.9 – 17.1	50 – 61	Whole trees in motion; inconvenience felt when walking against the wind
8 Gale	17.2 – 20.7	62 – 74	Breaks twigs off trees; generally impedes progress
9 Strong gale	20.8 – 24.4	75 – 88	Slight structural damage occurs
10 Storm	24.5 – 28.4	89 – 102	Seldom experienced inland; trees uprooted; considerable structural damage occurs
11 Violent Storm	28.5 – 32.6	103 – 117	Very rarely experienced; accompanied by structural damage
12 Hurricane	32.7 and over	118 and over	Widespread damage

APPENDIX H NATIONAL NOISE STANDARDS

Regulation 6(1)

Maximum Permissible Noise Levels for General Environment

Column 1	Column 2	
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 : 6.00 a.m - 10.00p.m.

Night : 10.00p.m - 6.00a.m

SOIL AND TOPOGRAPHICAL SURVEYS FOR IRRIGATION DEVELOPMENT IN KANUNGU DISTRICT

TECHNICAL REPORT

PREPARED FOR

Ministry of Water and Environment/Arrvee Associate Architect Engineer

BY

Moses Ojara (PhD Fellow), David Akodi (MSc.) & Denis Ekakoro (MSc.)

3rd – 13th November 2018

Soils & GIS Unit
National Agricultural Research Laboratories (NARL), Kawanda

1.0 INTRODUCTION

1.1 Background

There exists a dual need of making more profitable use of agronomic research and proper utilization of each acre of agricultural land found on earth. This involves the efficient production of crops and maintaining future productivity. A soil survey is one of the techniques that can be used to profitably use the available soils on earth. Soil survey involves determining the pattern of the soil cover and dividing this pattern into homogeneous units, and mapping their distribution and characterizing them (Deckers *et al*., 2004). It further involves the technique and practice of soil classification; it is the act of describing, identifying, and mapping the different soils in an area, the recording of other research, chemical, and physical data is a part of the program. It also involves the interpretation and use of the completed maps and reports. The information obtained from soil surveys is important in planning for agriculture and other land uses and management (Dent *et al*., 1994; Deckers *et al*., 2004). It enables better predictions about specific uses of the land. Soil survey also allows useful statements to be made with respects to land use potential and behavior towards different management practices (Kaaya *et al*., 1994). Soil survey and effective land classification and planning based on a thorough understanding of the soil conditions are generally accepted essential preliminaries to investment in irrigation development which helps to checks the hazardous of salinization, waterlogging and lowered fertility.The purpose of the study was to contribute to the understanding of the physical, chemical and morphological characteristics of soils in Kanungu district for irrigation development in order to improve crop production. The survey was conducted from 3rd - 13th November 2018. It is important that complimentary soil surveys are undertaken as part of the agronomy extension services prior to commissioning of the scheme to ensure that the beneficiary farmers access initial soil analysis of their parcel(s) as part of the initial capacity building on improved productive practices.

1.2 Objectives

The main objective of this study was to characterize the physical and chemical properties of the soils of Matanda and Enengo and evaluate their potentials for dam construction, irrigation development and ultimately crop production. Specifically;

- ✓ record each pit/profile location with a GPS device and photograph each location and record any visual or olfactory observations,
- ✓ identify the soil horizons at each location and the depth and physical condition of the top soil layer, describe and classify the soils,
- ✓ investigate physio-chemical properties of the soils, to identify their geographic distribution and to evaluate land suitability for irrigation, and
- ✓ Determine fertility status of the area and make the best recommendation for the envisaged development based on soil test data.

1.3 Scope of the study

This study focused on soil and topological properties that could have contributed to the development of soil properties and functioning of the soils in this area. Other socioeconomic and political factors are included in this report. The study employed a free survey technique to assess up to a depth of 100 cm of soils, determining some of the physical soil properties at the site and collecting soil sample for further laboratory analysis. The standard soil physical and chemical analysis was done at the laboratory on soil samples collected for routine and other specialized analysis including; textural class analysis, permanent wilting point, field capacity, and Bulk density (PWP, FC, & BD).

2.0 Methods and Materials

2.1.1 Geology and geomorphology

The geological formation of the districts indicates rocks formed between 3,000 and 6,000 million years ago (pre-Cambrian era) which makes them very old. The districts are characterized by undulating hills with steep slopes and U shaped valleys. The hilltops continually rise to over 1,864 m above sea level.

2.1.2 Land use and vegetation

The vegetation in the districts is comprised of forests, woodland, bushland, farmland, and open water. Eucalyptus and pine species constitute the biggest percentage of the plantation forests. Most area is comprised of Subsistence farmland.

2.1.3 Human activities

Agriculture is the main economic activity in Kanungu and Rukungiri districts. The few pockets of fertile soils and climate allow for adequate produce for home consumption and surplus that are sold. Because of the mountainous terrain, taking produce to the market becomes a challenge and a constrained to increased agricultural production. Crops grown in the districts include coffee; bananas (Matooke) maize, beans, rice, potatoes, cassava, sorghum, sweet potatoes. Many people in these districts keep livestock on a subsistence level, primarily for milk production. Milk is part of the local diet and it is a requirement for some households.

3.0 Soil survey methods

Soil mapping units were identified with the help of topographic maps and through ground-truthing to confirm the identified units. Vegetation types and the color of soils also helped in the delineation of mapping units. The locations at which the profile pits were to be dug were predetermined randomly with each mapping unit. This was done to enable us to confirm if that soil mapping unit contained the same soil type. Soil profiles were excavated within each mapping unit to a depth of 0.8-1 m with dimensions of 1 m wide and 1.5 m long to allow for sufficient examination and description of the different horizons. Before the actual soil description, some relevant information related to the registration and identification of the soil to be described was noted. The general site information/characteristics were also recorded. The site characteristics noted include; location (district/sub-county/parish/village and GPS coordinates), profile number, elevation, authors, map sheet number, weather information, topography, slope, microrelief, rock outcrops, soil drainage class, human influence, vegetation, land use etc. Some of this information was necessary for easy referencing and retrieval of the soil description from data storage systems.

The description of soil and the coding of attributes were generally based on the guidelines for soil description according to (FAO, 1990). The soil description was done horizon by horizon, starting with the uppermost one and the main diagnostic horizons, diagnostic properties and diagnostic materials for each of the profiles were identified and recorded. The soil was given a field classification based on the FAO (IUSS Working Group, 2014) systems. Information and data were recorded on a field data collection form for each site. The field classification was later combined with laboratory results to make a final soil classification.

3.1 Soil sample preparation and laboratory analysis

The standard soil physical and chemical analysis was done at the laboratory on soil samples collected for routine and other specialized analysis including; textural class analysis, Permanent wilting point (PWP), field capacity (FC), and Bulk density (BD). Soil pH was measured potentiometrically in a 2.5:1 water to soil suspension, using a combined glass electrode pH meter, texture using the hydrometer method, BD was determined as a ration of oven-dry soil to its volume. SOC was determined using the wet oxidation method and available P by Olsen method.

3.2 Laboratory handling and analysis methods employed

The samples were air dried at about 25^{o}C for 5 days to eliminate the moisture. They were ground using a porcelain pestle and mortar and then sieved through a 2-millimeter sieve to remove debris and other non-soil materials including stones and roots. The sieved soil samples were repackaged, clearly labeled and analyzed from the Soil, Plant and Water analytical Laboratory at the Department of Agricultural and Environmental Sciences - Makerere University.

A broad spectrum of agronomy related parameters including soil pH, organic matter, total nitrogen, available phosphorus; exchangeable Ca, Mg, Na, K, Bulk density, sums of basic cations (CEC), saturated hydraulic conductivity and soil texture and other physical parameters mentioned in (3.1) were analyzed.

3.3 Analytical methods

The individual soil properties were specifically analyzed by particular analytical methods and procedures as indicated below:

First; the two mineral cations; Calcium and Magnesium were analyzed by the atomic absorption spectrophotometer on a mehlich 1 extract. Further; Potassium and Sodium were analyzed using the Flame photometer on the same mehlich 1 extract, Available phosphorus was analyzed using the Bray 1 method based on the soil pH, it is Bray 1 method recommended for slightly acidic to acidic soils. Soil pH was measured in a soil-water solution at a ratio of

1:2.5 by the help of a pH meter, while the Total Nitrogen (N) determined calorimetrically following digestion using concentrated sulphuric acid and Selenium powder plus Salicylic acid. Soil organic matter (O.M) was determined using the Walkley and Black method following wet oxidation using concentrated Sulphuric acid and Potassium Dichromate.

Soil texture was analyzed using the hydrometer method (Bouyoucous method). All analyses were performed using the routine procedures outlined by Okalebo et al., (2002) and other standard operating procedures (SOPs) that are internationally recommended.

Saturated hydraulic conductivity was determined from the laboratory on the core samples that were collected. The cores were first covered with a piece of cloth at the base, placed in water to circulation (water oozing out at the top of the core). Using cell tape, an empty core is inserted on top of the circulated core tightly and the pair clumped on a stand. Using a siphon placed above the empty core supplied water at a constant supply and the water that percolates through the system is determined or collected for example at the 60 min interval. This procedure is repeated three times and an average cultivated.

Finally; the soil bulk density (BD) was determined from the core samples which were dried in an oven at 105^{O}c for overnight to eliminate moisture. Thereafter, the dry weight was determined and divided by the volume of the core.

3.4 Land suitability evaluation for irrigation

Land evaluation is the selection of suitable land and suitable cropping, irrigation, and management alternatives that are physically and financially practicable and economically viable. The land suitability evaluation was done using the principles of the FAO Framework (FAO, 1976) for land evaluation and the FAO Guidelines on land evaluation for rain-fed agriculture (FAO, 1984).

Land classes for surface irrigation are attributed according to the methods used for the crop specific evaluation for rain-fed agriculture; this can include; definition according to the maximum limitation method, definition according to number and intensity of limitation levels and definition according to a parametric method. Subclasses deal with the kind of limitation. The maximum limitation method was used for determining the suitability of the surveyed area for irrigation. This method considers only the most limiting land characteristic(s) when determining the land suitability class. Eight land characteristics were used to evaluate the suitability for irrigation. They included; drainage, flooding, soil erosion risks, soil depth, soil texture for both top and subsoil, soil structure, gypsum, $CaCO_3$, stoniness, water table, Ksat, and available water capacity. The justification for using some of the mentioned land characteristics are detailed below:

3.4.1 Topography

The dominant topographic factor that influences the irrigation suitability of an area concerns slope and microrelief. The application of basin flush irrigation requires horizontal basins, while for basin furrow irrigation a slight slope of the basins is permitted. We consider that a slope up to 2% can be leveled for basin-flush irrigation. At the other hand slopes of 6% can be considered as marginal for basin furrow irrigation as leveling and grading are ordinary management practices up to slopes of 6%.

3.4.2 Drainage

The effect of drainage depends on the depth and quality of a possible groundwater table. Impeded drainage conditions are limiting, particularly when saline groundwater is present.

3.4.3 Soil texture

The most common surface irrigation system is furrow irrigation. Long-furrow irrigation is a logical development of the short furrow method used in small holdings. Since hand labor, necessary for irrigation management, has become scarce the long furrow method was introduced in mechanized farming. The long furrow method requires land leveling and grading. It saves in effort and waste of land, but water is still wasted through deep percolation, surface evaporation, and runoff. The length of furrow should depend on soil texture and slope of the furrow. Therefore there is a need to increase the furrow slope when the texture is coarse.

3.4.4 Soil depth

The soil depth is defined as the thickness of the loose soil above a limiting layer, which is impermeable for roots and/or percolating water. The most common types in arid areas are: an unconsolidated gravely or stony horizon with at least 75 % by volume coarse elements, a continuous, consolidated calcium carbonate layer with a minimum thickness of 30 cm and more than 60% calcium carbonate, a continuous gypsiferous layer with more than 25% gypsum and a minimum thickness of more than 30 cm and a continuous hard rock, or hardpan of more than 10 cm thick.

3. 5 Land Suitability Classification for Irrigation development

The ratings of land use requirements for the various land utilization types have been compiled and summarized in (Tables 1). The land qualities of the different mapping units were matched with some of the above-mentioned requirements. Each of the land characteristics is given a suitability class based on the characteristics obtained from each of the profiles representing the mapping unit for each soil type. The final suitability was got by determining the most limiting factor for irrigation. This gives the suitability class.

The scheme (Baldaccini and Vacca 2009) used for this assessment indicates the general criteria for the evaluation of the suitability for irrigation according to topographic, hydrological and pedological factors (Table1).

Table : Suitability classes for the different land characteristics for Irrigation

Suitability classes	S1	S2	S3	N1	N2
Slopes	Slope 0-5%	6-10%	11-20%	21-30%	>30%
Microrelief	none or very weak low	low	moderate	strong	very strong
Soil erosion risk	None	low	moderate	High	Very High
Inundation occurrence	none	very rare	rare	likely	almost certain
Drainage	well	moderately well	somewhat poorly drained or somewhat excessively drained	poorly drained or excessively drained	very poorly drained or excessively drained
Water table depth	> 2 m	2-1.2 m	1.2-0.75 m	0.75-0.50 m	< 0.50 m
Rock outcrops	0%	< 2%	2-10%	10-25%	>25%
Stoniness	<0.1%	0.1-3%	3-15%	15-50%	>50%
Soil depth (m)	>1	1-0.75	0.75-0.5	0.5-0.25	<0.25
Topsoil texture	From SL to CL	From SiL to perm. C	From LS to mod. perm. C	From S to slightly perm. C	From S to slightly perm. C
Subsoil texture	from SL to CL	from SiL	Topsoil texture	from SL to CL	from SiL
Soil structure	granular; fine and medium subangular blocky	coarse sub-angular blocky, fine and medium angular blocky	coarse angular blocky; fine, medium and coarse prismatic	very coarse angular blocky and prismatic	single grain and massive
Infiltration rate (cm/h)	0.8-3.5	0.2-0.8 3.5-11	0.1-0.2 11-12.5	0.1-0.2 11-12.5	<0.1 >12.5
Hydraulic conductivity	moderately low or moderately high	moderately low or moderately high	low or high	very low or very high	very low or very high
AWC (g/kg)	>150	115-150	75-115	<75	<50

4.0 RESULTS

4.1 Location of the soil profiles, general properties of the soil and their classification

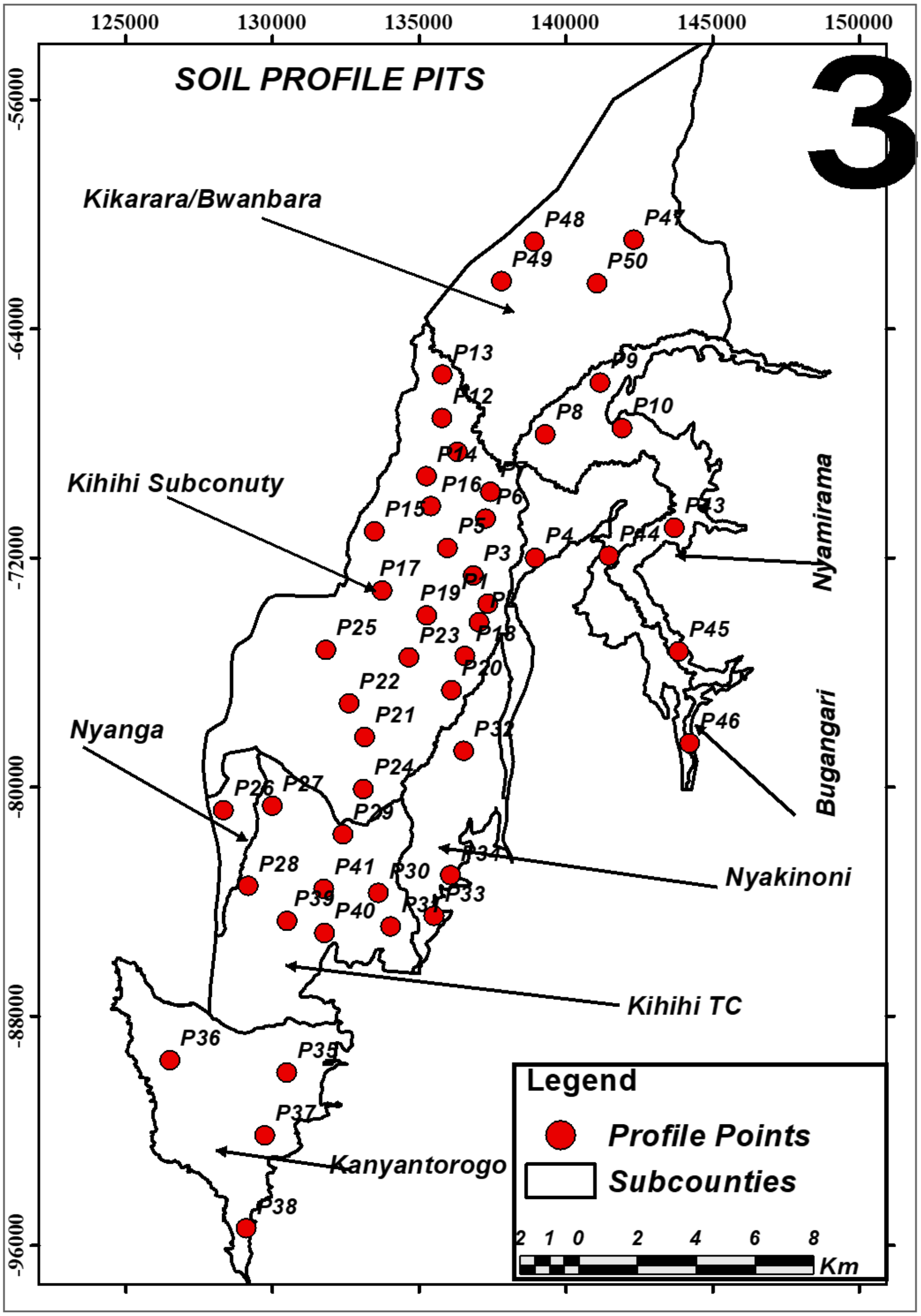


Fig: Location of the sampled points/Profile Pits

Table : Location and the corresponding soil unit and soil type in the surveyed area

Profile Number	Long	Lat	Elevation (Meter)	Soil Drainage	Erosion hazard	Soil Type	Soil Unit
SU001	127310.8	-73521.3	969	Well drained	None	Haplic Ferralsols	2
SU002	137014.6	-74202.5	1098	Well drained	Moderate	Haplic Ferralsols	2
SU003	136836.9	-72544.0	1054	Well drained	Moderate	Skeletic Leptosols	8
SU004	138939.8	-71921.9	1017	Poorly drained	None	Skeletic Leptosols	8
SU005	135918.7	-71596.1	1016	Well drained	None	Arenosols	3
SU006	137221.9	-70589.0	1016	Imperfectly drained	None	Arenosols	3
SU007	137429.3	-69611.6	983	Imperfectly drained	None	Gleyic Vertisols	6
SU008	139265.6	-67686.3	974	Imperfectly drained	None	Gleyic Vertisols	6
SU009	141131.6	-65850.0	1004	Imperfectly drained	None	Gleyic Vertisols	6
SU010	141872.1	-67419.8	1019	Moderately drained	None	Gleyic Vertisols	6
SU011	136224.5	-68249.1	966	Well drained	None	Gleyic Vertisols	6
SU012	135770.6	-67064.3	958	Well drained	None	Gleyic Vertisols	6
SU013	135859.5	-65553.8	955	Imperfectly drained	None	Gleyic Vertisols	6
SU014	135267.1	-69078.4	971	Well drained	None	Arenosols	3
SU015	133430.0	-71003.7	975	Well drained	None	Arenosols	3
SU016	135474.4	-70174.3	976	Well drained	None	Arenosols	3
SU017	133697.3	-73077.0	1010	Well drained	None	Arenosols	3
SU018	136570.3	-75357.7	1105	Well drained	None	Haplic Ferralsols	2
SU019	135267.1	-73936.0	1059	Well drained	None	Rhodic Ferralsols	7
SU020	136096.4	-76572.1	1121	Well drained	None	Haplic Ferralsols	2
SU021	133164.1	-78171.5	1084	Well drained	None	Haplic Ferralsols	2
SU022	132571.7	-76980.7	1061	Well drained	None	Haplic Ferralsols	2
SU023	134615.5	-75387.3	1063	Well drained	None	Rhodic Ferralsols	7
SU024	133075.3	-79978.2	1112	Well drained	None	Haplic Ferralsols (Rh)	2
SU025	131801.6	-75150.3	1009	Well drained	None	Haplic Ferralsols (Ar)	5
SU026	128188.1	-78586.2	1053	Well drained	None	Rhodic Ferralsols	7
SU027	129935.6	-80570.6	1047	Well drained	None	Haplic Ferralsols	2
SU028	129135.9	-83384.4	1075	Well drained	None	Haplic Ferralsols	2
SU029	132364.4	-81577.7	1143	Well drained	None	Haplic Ferralsols	2
SU030	133608.4	-83651.0	1163	Well drained	None	Skeletic Leptosols	8
SU031	133963.8	-84806.2	1156	Well drained	None	Acric Ferralsols	1
SU032	136511.1	-78675.0	1111	Well drained	None	Acric Ferralsols	1
SU033	135504.0	-84450.7	1191	Well drained	None	Plinthosols	4
SU034	136096.4	-82999.4	1183	Well drained	None	Plinthosols	4
SU035	130498.4	-89989.5	1178	Well drained	None	Acric Ferralsols	1
SU036	125966.7	-88093.9	1069	Well drained	None	Acric Ferralsols	1
SU037	129698.7	-92092.4	1154	Well drained	None	Acric Ferralsols	1
SU038	129106.3	-95320.9	1123	Well drained	None	Acric Ferralsols	1
SU039	130439.2	-84628.4	1137	Well drained	None	Skeletic Leptosols	8
SU040	131772.0	-85013.5	1185	Well drained	None	Skeletic Leptosols	8

Profile Number	Long	Lat	Elevation (Meter)	Soil Drainage	Erosion hazard	Soil Type	Soil Unit
SU041	131742.4	-83473.3	1161	Well drained	None	Skeletic Leptosols	8
SU043	143601.5	-70794.7	994	Well drained	None	Haplic Ferralsols	2
SU044	141519.7	-71751.2	998	Imperfectly drained	None	Gleyic Vertisols	6
SU045	143770.3	-75183.4	1006	Imperfectly drained	None	Gleyic Vertisols	6
SU046	144220.4	-78390.5	1063	Well drained	None	Gleyic Vertisols	6
SU047	142307.4	-60723.2	1064	Well drained	None	Arenosols	3
SU048	138931.5	-60835.8	969	Well drained	None	Planosols	4
SU049	137693.6	-62186.1	954	Well drained	None	Planosols	4
SU050	141069.5	-62242.4	1040	Well drained	None	Arenosols	3

SU = Uganda soil, Lat = Latitude, Long = Longitude and Elev = Elevation, **(Rh=Rhodic),** ***(Ar=Arenic).***

4. 2 Morphological observations and classification of soils from the different profile pits

A brief description of the soils in terms of color, structure, horizons and soil type are given in Table 3.

Table : Description of soils at Matanda and Enengo Area in Kanungu and Rukungiri Districts

Profile number	A brief description of soils of Kanungu and the corresponding soil type
SU001	Deeply weathered black colored soil (5YR 2.5/1) well-drained sandy clay loam with agranular structure in the first 0-30 cm and yellowish brown color (5YR 4/6) in the B-horizon extending from 30 cm and beyond the depth of 100 cm. ***Haplic Ferralsols.***
SU002	Dark brown (7.5YR 3/2) clay loam horizon with a sub-angular blocky structure overlying a red (2.5YR 4/6) clay loam horizon with a sub-angular blocky structure. All the horizons had a strong microstructure development. ***Haplic Ferralsols.***
SU003	Black sandy loam horizon (5YR) with a sub-angular blocky structure. The lower horizon had a lot of small rocks which covers about 70% of the profile. ***Skeletic Leptosols.***
SU004	Very gravelly sandy loam in the top 0-20 cm over gravelly sandy clay loam having more than 70% by volume of coarse fragments starting at a depth of 20 cm and extends beyond 70 cm which is typical of ***Skeletic Leptosols.***
SU005	Dark greyish brown (10YR 4/2) sandy horizon over a brown (7.5YR 4/4) sandy horizon. The soil structure was single grains in both horizons. The major soil diagnostic property is arenic. ***Arenosols (Humic).***
SU006	Dark greyish brown (10YR 4/2) sandy horizon from 0-20 cm over brown (7.5YR 4/4) sandy horizon between 20 and beyond 100 cm depth. The soil structure was single grains in both horizons. The major soil diagnostic property is arenic typical of ***Arenosols (Humic).***
SU007	Very dark sandy clay horizon overlying grey clayey horizon. A horizon had sub-angular structure and B horizon had blocky structure. ***Gleyic Vertisols.***
SU008	Black silty clay horizon overlying a greyish brown clayey horizon. Strong brown and black Fe and Mn concretions in the lower parts of the B horizon. The upper horizon had sub-angular block structure and the lower horizon had a blocky structure. ***Gleyic Vertisols.***
SU009	Black sandy clay horizon overlying a greyish brown clayey horizon. The upper horizon had sub-angular block structure and the lower horizon had a blocky structure. ***Gleyic Vertisols.***
SU010	Black sandy clay horizon overlying very dark grey sandy clay horizon. Yellowish red Fe concretions in the B horizon. All the horizons had sub-angular blocky structure. ***Gleyic Vertisols.***
SU011	Very dark greyish (10YR3/1) sandy clay horizon overlying a greyish brown (10YR5/2) clayey horizon. The upper horizon had sub-angular block structure and the lower horizon had a blocky structure. ***Gleyic Vertisols.***

Profile number	A brief description of soils of Kanungu and the corresponding soil type
SU012	Very dark grey (2.5Y3/1) clay horizon overlying a greyish brown clayey horizon. Strong brown and black Fe and Mn concretions in the lower parts of the B horizon. The upper horizon had sub-angular block structure and the lower horizon had a blocky structure. ***Gleyic Vertisols***.
SU013	Very dark grey (2.5Y3/1) sandy clay horizon overlying a greyish brown clayey horizon. All the horizons had sub-angular blocky structure. ***Gleyic Vertisols***.
SU014	Dark grey (10YR 3/1) loamy sand overlying a dark reddish brown ((10YR3/6) sandy horizon. ***Arenosols (Humic).***
SU015	Very dark grey (2.5Y3/1) horizon overlying a brownish grey (10YR 6/2) horizon. The texture in all the horizons was sandy. A***renosols (Humic).***
SU016	Very dark grey (2.5Y3/1) sandy horizon overlying dark reddish brown (10YR3/6) loamy sand horizon. All horizons had sub-angular blocky structure. A lot of sand in both horizons. ***Arenosols (Humic).***
SU017	Dark grey (10YR 3/1) loamy sand in the top 0-20 cm overlying brownish grey (10YR 6/2) sandy textured horizons. All the horizons consist of single grain structures. ***Arenosols (Humic).***
SU018	Dark grey (10YR 3/1) loamy sand in the top 0-20 cm overlying brownish grey (10YR 6/2) sandy textured horizons. All the horizons consist of single grain structures. ***Arenosols (Humic).***
SU019	Very dusky red (2.5YR2.5/2) horizon overlying dark reddish brown (2.5YR2.5/4) horizon. Loamy sand and sub-angular blocky structure in both horizons. ***Rhodic Ferralsols.***
SU020	Dark brown (7.5YR 3/2) clay loam horizon from 0-20 cm sitting on red (2.5YR 4/6) clay loam horizon extending from 20 and beyond the depth of 70 cm. All the horizons had a sub-angular blocky structure with strong microstructure development. ***Haplic Ferralsols***.
SU021	Dark brown A horizon over brown B horizon. The color codes for A and B horizons were 7.5YR3/2 and 7.5YR4/4 respectively. The soil textures in all the horizons were sandy loam. There was a sub-angular blocky structure in all the horizons. ***Haplic Ferralsols.***
SU022	Dark brown (10YR4/2) sandy loam horizon overlying dark greyish brown (7.5YR3/3) sandy loam horizon. All the horizons had sub-angular block structure. Fe concretions in the B horizon. ***Haplic Ferralsols.***
SU023	The upper horizon (Ap) had very dusky red color (2.5YR2.5/2) with loamy sand texture and B was dark reddish brown (2.5YR2.5/3) with loamy sand. Soils in all the horizons had sub-angular blocky structure. A lot of sand in both horizons. Some Arenic properties in all the horizons. ***Rhodic Ferralsols.***
SU024	Reddish black (2.5YR2.5/1) A horizon on top of yellowish red (5YR4/6) B horizon. Sandy clay loam and loamy sand in A and B horizons respectively. Sub-angular blocky structures in all the horizons. ***Haplic Ferralsols.***
SU025	Dark greyish brown (10YR4/2) sandy loam horizon overlying dark brown (7.5YR3/3) sandy loam horizon. All the horizons had sub-angular blocky structure. Stones starting from 100 cm. ***Haplic Ferralsols.***
SU026	Dark reddish brown (5YR2.5/2) sandy loam horizon overlying yellowish red (5YR4/6) sandy loam horizon. All the horizons had sub-angular blocky structure. ***Rhodic Ferralsols.***
SU027	Dark brown (10YR4/2) sandy loam horizon overlying dark greyish brown (7.5YR3/3) sandy loam horizon. All the horizons had sub-angular block structure. Fe concretions in the B horizon. ***Haplic Ferralsols.***
SU028	Deep dark reddish grey (2.5YR3/1) sandy loam horizon with sub-angular blocky structure overlying brown (7.5YR4/4) sandy clay loam horizon with sub-angular blocky structure. ***Haplic Ferralsols.***
SU029	Dark reddish brown (5YR 3/2) sandy clay loam horizon in the top 0-20 cm overlying yellowish red (5YR 4/6) sandy clay loam horizon. All the horizons had sub-angular blocky structure. Field classification is given as a ***Haplic Ferralsols.***
SU030	Very gravelly sandy loam in the top 0-20 cm over gravelly sandy clay loam having more than 70% by volume of coarse fragments starting at a depth of 20 cm and extends beyond 70 cm which is typical of ***Skeletic Leptosols.***
SU031	Very dark grey (5YR3/1) horizon overlying strong brown (7.5YR4/6) horizon. The two horizons had sandy loam and clay loam textures respectively. All the horizons had sub-angular blocky structure. ***Acric Ferralsols.***
SU032	Very dark grey (5YR3/1) sandy loam horizon overlying strong brown (7.5YR4/6) clay loam horizon. All the horizons had sub-angular blocky structure. ***Acric Ferralsols.***
SU033	Very dark grey (2.5Y3/1) sandy loam horizon over a horizon with a lot of stones. A horizon had sub-angular blocky structure. ***Plinthosols.***

Profile number	A brief description of soils of Kanungu and the corresponding soil type
SU034	All the three horizons had dark reddish brown (5YR 2.5/2) soils with distinct indurations in the lower two horizons (plinthic material). Granular structure in the A and B2 horizon and sub-angular blocky structure in the B1 horizon. Soil displays typical characteristic of ***Petric Plinthosols.***
SU035	Dusky red (2.5YR3/1) clay loam Ap horizon overlying dark yellowish brown (10YR3/4) clay loam B horizon. Ap horizon had blocky structure and B had sub-angular blocky structure. Dark (10R3/6) Fe mottles in the B horizon. Increased concentration of Fe mottles with an increase in soil depth. ***Acric Ferralsols.***
SU036	Dusky red (2.5YR3/1) clay loam horizon with a blocky structure overlying dark yellowish brown (10YR3/4) clay loam B horizon with a sub-angular blocky structure. ***Acric Ferralsols.***
SU037	Deep yellowish red (5YR4/6) overlying brown (7.5YR5/3) horizon. All the horizons had silty loam texture and sub-angular blocky structure. Red (2.5 YR4/6) Fe mottles in the A horizon. ***Acric Ferralsols.***
SU038	Deep yellowish red (5YR4/6) overlying brown (7.5YR5/3) horizon. All the horizons had silty loam texture and sub-angular blocky structure. Red (2.5 YR4/6) Fe mottles in the A horizon. ***Acric Ferralsols.***
SU039	Black (10YR2/1) silty loam Ap horizon overlying dark brown (7.5YR3/3) silty loam B horizon. Both horizons had sub-angular blocky structures. ***Skeletic Leptosols.***
SU040	Black (5YR2.5/1) sandy loam horizon with sub-angular blocky structure over a horizon consisting of a lot of gravels. Leptic and skeletic properties. ***Skeletic Leptosols.***
SU041	A thin black (5YR2.5/1) sandy loam horizon with sub-angular structure overlying a gravelly horizon with many small rocks. The rocks more than 70% of the total soil volume in the lower horizon. ***Skeletic Leptosols.***
SU042	Very dark grey (5YR3/1) sandy loam horizon over a gravelly horizon. ***Skeletic Leptosols.***
SU043	Black (5YR2.5/1) Ap horizon overlying very dark grayish (brown horizon. Sub-angular blocky structures and silty loam texture in both horizons. ***Acric Ferralsols.***
SU044	Black (5YR2.5/1) Ap horizon overlying very dark grayish brown horizon. Sub-angular blocky structures and silty loam texture in both horizons. ***Acric Ferralsols.***
SU045	Dark grey sandy loam horizon overlying grayish clay loam horizon. All the horizons had sub-angular blocky structures. ***Fluvisols.***
SU046	Black (5YR2.5/1) sandy loam horizon over dark grey (7.5YR4/1) sandy clay loam. The third horizon consisted of brown (7.5YR4/2) clay horizon. The soil structure was columnar in the upper horizon. The lower two horizons had sub-angular blocky structure. Mn concretions within Bt1 and Fe mottles in the Bt2 horizon. ***Gleyic Vertisols.***
SU047	Dark grey loamy sand overlying brownish grey sandy textured horizons. All the horizons consist of single grain structures. ***Arenosols (Humic)***.
SU048	Greyish sandy loam horizon with sub-angular blocky structure overlying sandy clay horizon with a sub-angular blocky structure. **Gleyic *Planosols.***
SU049	Dark Grey sandy loam horizon overlying a horizon with a sandy clay texture. All the horizons had a very weak structure. **Gleyic *Planosols.***
SU050	Very dark grey sandy loam horizon overlying brown sandy horizon. All the horizons had single grain structure**.** ***Arenosols (Humic).***

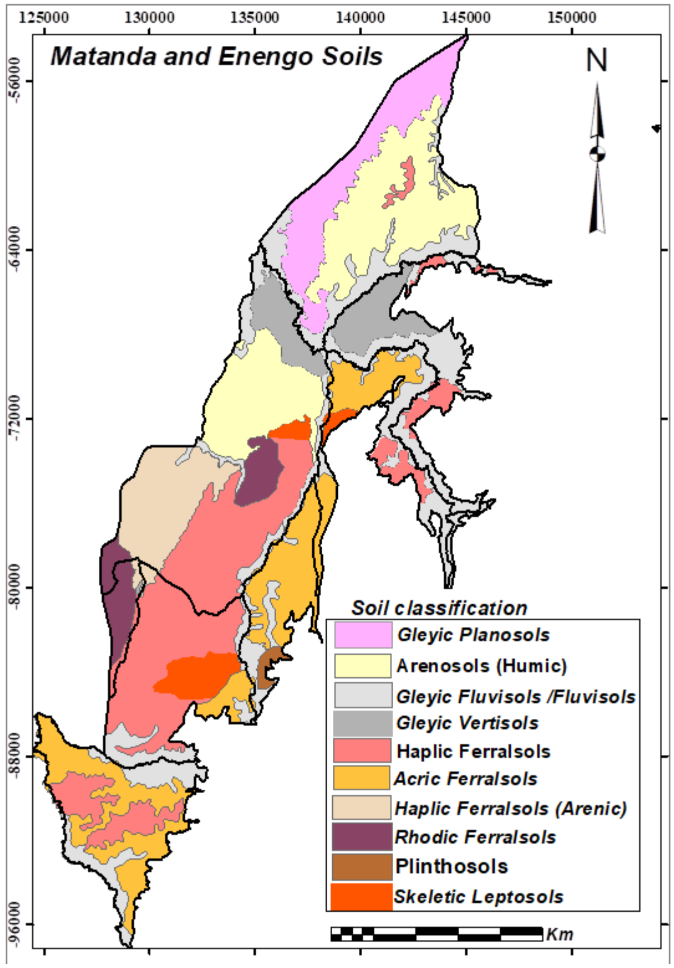


Fig : Soils of Matanda and Enengo

4.3 Areal extent of different soils of Matanda and Enengo in Kanungu and Rukungiri district

Table 4 indicates that Acric Ferralsols, Haplic Ferralsols, Arenosols (Humic), and Fluvisols covered the greatest part of the survey area with 19.4%, 17.3%, and 18.7% respectively. Plinthosols covered a small percentage (0.4%) of the surveyed area.

Table : Area covered by each of the soil types/Sub-types

Soil code	WRB 2014 Classification	Area(ha)	Coverage (%)	Rank
1	Acric Ferralsols	6140.5	19.4	1
2	Arenosols (Humic)	5475.9	17.3	4
3	Gleyic Fluvisols/Fluvisols	5898.6	18.7	3
4	Gleyic Vertisols	1690.6	5.3	7
5	Haplic Ferralsols	5900.4	18.7	2
6	Haplic Ferralsols (Arenic)	2026.6	6.4	6
7	Gleyic Planosols	2296.2	7.3	5
8	Plinthosols	141.8	0.4	10
9	Rhodic Ferralsols	1148.7	3.6	8
10	Skeletic Leptosols	884.1	2.8	9
	Total area (ha)	**31603.5**	**100**	

4.4 Characteristics of major soils identified in Kanungu and Rukungiri District

Generally, the characteristics of soils in the tropics are yellow or red in color, old and strongly leached. They are deep, fine textured, contain no more than traces of weatherable minerals, have low-activity clays and have less than 5 percent recognizable rock structure and gradual soil boundaries. These features are general but different soil types have different morphological characteristics. The major soils identified in the study area included Haplic/Rhodic/Acric Ferralsols, Plinthosols, Gleyic Planosols, Fluvisols, Skeletic Leptosols, Gleyic Vertisols and Arenosols (Humic) as presented in (Fig 3). These soils had different visible features as detailed below.

1. **Soil type 1: Ferralsols:**

The reference soil group of the Ferralsols holds the classical deeply weathered, red or yellow soils of the humid tropics. Ferralsols group all strongly weathered soils having a ferralic horizon. Internationally Ferralsols are known as Oxisols. In an undisturbed state, these soils are known for their excellent physical properties mainly great soil depth, good permeability to water and air, high content of clay-size particles, the stable microstructure that makes them less susceptible to erosion. These soils are well drained and easy to work on when moist.

Detail studies of the different types of Ferralsols in the area revealed 19.4% of Acric Ferralsols, 18.7% of Haplic Ferralsols, Haplic Ferralsols (Arenic) 6.4% and Rhodic Ferralsols 3.6%. In all, Ferralsols occupy about 48.1% of the total coverage of the two command areas. Physically, Ferralsols are most common in the Kihihi Subcounty, Kihihi Town council and some patches in other sub-counties. They occupy most of the gentle slopes in the areas. The most common crops observed in these soils include: Banana-Coffee intercropped, Maize-Beans intercrop, Rice, potatoes, cassava, sorghum, and sweet potatoes etc

2. Soil Type 2: Vertisols:

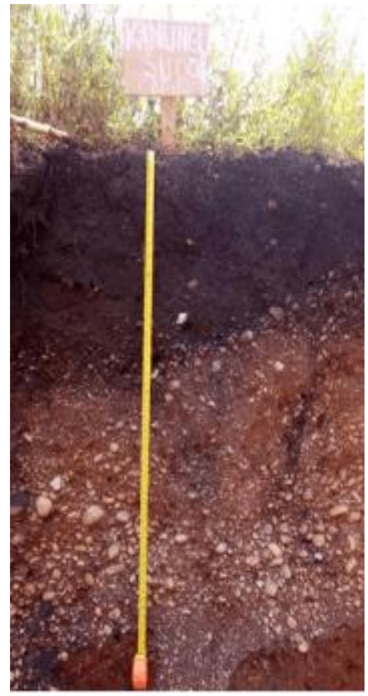
Vertisols are clay soils that shrink and swell upon changing soil moisture conditions. The clay minerals adsorb water and increase in volume when wet and then shrink as they dry, forming large, deep wide cracks downwards. Surface materials fall into these cracks and are incorporated into the lower horizons when the soil becomes wet again. As this process is repeated, the soil experiences a mixing of surface materials into the subsoil that promotes a more uniform soil profile. Vertisols exhibit unique morphological properties such as the presence of slikensides, wedge-shaped aggregates, gilgai and they are usually very dark in color, with widely variable organic matter contents.

For the project area; the vertisols have a deep top layer of approximately 40-60 cm. Typical of Profiles 7, Profile 8, Profile 9 and Profile 10. They are well located towards the Northern end of Kihihi Subcounty in Kanungu and Bwambara sub-county is Rukungiri District. The total coverage of these soils is approximately 5.3% of the total coverage. The lower layer of soil is deep clay mixed with brown mottles which increase with depth. Some agricultural activities including the growing of crops such as Maize, Beans, Bananas, coffee, and fruit trees such as mangoes is being done. Other activities include: Cattle grazing and commercial tree growing.

3. Soil Type 3: Plinthosols:

Plinthosols are soils having a petroplinthic or a plinthic horizon starting within 50 cm from the surface of the soil. They are defined by a subsurface layer containing an iron-rich mixture of clay minerals and silica that hardens on exposure into ironstone concretions known as plinthite. Internationally these soils are known as groundwater laterite soils. Formation of plinthite is associated with level to gently sloping areas with fluctuating groundwater. Plinthite have high contents of sesquioxides i.e. oxides of aluminum and iron. They are also found in patches like skeletic Leptosols. Typical of Profile 33 and Profile 34 located at Kalubeizi area in Nyakinoni sub-county. This supports the growth of trees as the thick forest is observed in the area. A lot of murram mining for construction is done from these soils. The coverage of these soils is about 0.4% of the total command area combined.

4. Soil type 4: Leptosols:



Leptosols in the World Reference Base for Soil Resources is a very shallow soil over hard rock or highly calcareous material or a deeper soil that is extremely gravelly or stony. They are young soils and evidence of soil formation is normally limited to the thin A-horizon over an incipient B-horizon or directly over the unaltered parent material. They have more pronounced morphological features; their dark brown or black calcareous organo-mineral surface soil. At the base of the soil profile, there is an abrupt change to the underlying rock. They should typically remain under natural vegetation being especially susceptible to erosion, desiccation or waterlogging. These are in patches in the study area. They form a very minor coverage in the command area approximately 2.8% only. In the Matanda command area, they exist as a bridge between the Ferralsols from Kihihi Sub-county and Arenosols near the Refugee camp. Such patches can be used for tree planting or animals grazing where its coverage is large enough. However shallow rooted crops can be grown successfully.

5. **Soil Type 5: Arenosols (Humic):**

The reference soil group of the Arenosols consists of sandy soils, both soils developed in residual sands, in situ after weathering of old, usually quartz-rich soil material or rock, and soils developed or recently deposited sands. The surface horizon or horizons are normally light in color and have soft consistency when dry. Their A-horizon is shallow and contains poorly decomposed organic matter. These soils are generally low in organic matter and lack significant profile development. The organic carbon contents of well-drained Arenosols are normally less than 1 percent. These soils are marked by their ease of cultivation, rooting and harvesting of root and tuber crops.

Arenosols are mainly located after the ridge skeletic Leptopsols starting Matanda Refuge settlement camp and moving Northward to approximately 0.7 kilometers along Kihihi town council to Queen Elizabeth National Park and in the North in the Enengo extended in Kikarara area bordering the park. The total coverage of Arenosols is about 17.3% of the total command area. The main crop seen on sites is millet, maize and cassava. Millet is seen to perform very well as it has fibrous roots system to absorb surface water after rains. Typical profiles include: profile 5, Profile 6, and Profile 14- Profile 17 in Enengo command area and in Profile 48- Profile 49 in the extension of Enengo at Kikarara

Shows the maize-millet intercrop field at Matanda Refugee camp on Arenosols.

6. Soil type 6: Gleyic Planosols:

A Planosol in the World Reference Base for Soil Resources is a soil with light colored, a coarse-textured surface horizon that shows signs of water stagnation and slow permeability in the sub-soils. It is characterized by a surface layer of clay accumulation. They occur typically in wet low lying areas. The characteristic clay-rich layer can form from a downward translocation of clay particles under the action of percolating water from the burial of a clay-rich layer by over-washed coarse materials or from seasonal destruction and translocation of clay.

7. Soil Type 7: Fluvisols:

They are genetically young soils in alluvial deposits. They occur in river sediments, lacustrine and marine deposits. These soils can also be found on alluvial plains, river fans, and valleys. In these soils, horizons are weakly developed with a distinct topsoil horizon.

Common crops observed in these soils include vegetables, rice, millet, sorghum, beans, and maize. These soils are common in Rukungiri at Bugangari and Bwambara as well. And it covers approximately 18.7% of the total combined command area.

Table : Land use systems and soil types

Land system	Land Units (description)	Current Land use	WRB 2014 Classification	Area (ha)	Coverage (%)	Rank
Alluvial terraces	High alluvial terraces (>15 m above the river), flat or gently sloping	Maize, cassava and beans, Bananas, Coffee, Millet, Soybean, beans, and maize	Acric Ferralsols	6140.5	19.4	1
		Maize, cassava and beans, Bananas, Coffee, Millet, Soybean, and maize	Haplic Ferralsols	5900.4	18.7	2
		Maize, cassava and beans, Bananas, Coffee, Millet, Soybean, and maize	Haplic Ferralsols (Arenic)	2026.6	6.4	6
		Maize, cassava and beans, Bananas, Coffee, Millet, Soybean, maize	Rhodic Ferralsols	1148.7	3.6	8
	Undulated middle alluvial terrace remnants	Maize, cassava beans, Bananas, and Millet Rice	Gleyic Vertisols	1690.6	5.3	7
	Low terrace slopes,	Maize. Rice, beans, Millet	Gleyic Fluvisols/Fluvisols	5898.6	18.7	3
Hills	Gently sloping hill foot slopes	Beans, cassava, Coffee, Fruit trees, Bananas, Eucalyptus	Gleyic Planosols	2296.2	7.3	5
	Gently sloping hill foot slopes	Maize, Groundnuts	Skeletic Leptosols	884.1	2.8	9
	Gently sloping hill foot slopes	Coffee and maize, Banana,	Plinthosols	141.8	0.4	10
Flood plains and Valley	Gently sloping, well-drained valley floors	Groundnuts, Millet, Maize, Sweet Potatoes, Sorghum, Maize, Yams, and Beans.	Arenosols (Humic)	5475.9	17.3	4

The alluvial terraces are the most common land system widely distributed in the study area, covering 22805.5 Ha of the total area. This is basically flat or gently sloping area currently being used for mixed cultivation of crops such as maize, cassava and beans, bananas, coffee, millet, soybean, and beans. The hills are in isolated patches being utilized for tree planting and growing of fruit crops such as Jackfruit, Mangoes. Marrum mining is also common in areas occupied by Plinthosols and Skeletic Leptosols. The Arenosols were found to be not totally in lower parts of the floods, on gentle sloping and are well drained. This can be mistaken for other soil types if not of the high sand content in the soils. They are being use for crop cultivation such as millet, maize, and beans.

4.5 Soil physical and chemical properties

4.5.1 Soil physical properties

The soil physical indicators are mainly concerned with the physical arrangement of the solid particles and pores and include texture, BD, porosity, aggregate strength and stability, soil crusting, soil compaction, and topsoil strength, and water holding or available water capacity. Soils are considered physically poor when it shows a low infiltration rate, enhanced surface runoff, poor cohesion, low aeration, and root density, and difficulty for mechanization. The results of the soil physical properties are presented in Table 6.

1) Effective Rooting Depth

The effective soil depth of the surveyed area is characterized as moderately deep to very deep. The low lying areas have rooting depth more than 100 cm. These are areas especially containing Vertisols, Ferralsols, Fluvisols, and Arenosols. These soil depths are suitable for most crops and the soil depth will not be a constraint for the present irrigation development project. The areas with Patches of Plinthosols and Skeletic Leptosols might have a limitation with rooting depth. For all Project sites i.e Matanda and Enengo command areas, the lowland areas have soil depth more than 100 cm while high gently slopes have a varying depth between 40cm-100cm. Areas with Leptosols is constrained with the rooting depth but is limited to small patches.

2) Surface stoniness and soil drainage

The cover of the surface in the proposed project area is having few to none coarse fragments and it may not be a problem for irrigated development. The depth of groundwater of the survey area is very deep and the drainage is imperfect for lowland areas while well drained for gentle slopes in both project sites at Matanda and Enengo in Kanungu-Rukungiri district. The drainage of lowland parts of the Enengo command area may require slight improvement.

3) Elevation, slopes and soil erosion hazard

Most of the project areas lie in lowland-gently slopes areas with the approximate altitude of 955 meters above sea level (msl) to a high of 1200 meters above sea level and the slope of a range of one (<2%). For Matanda command area in Kanungu and Part of Rukungiri, elevation ranged between 1020 to 1200 msl, and the gentle slope of >5%. The sign of soil erosion hazard was rarely seen in all the two sites. This moderate slopes could be useful in aiding the flow of water by gravity in Matanda command Area.

4) Soil texture

Soil texture is one of the most stable soil properties and it is independent of soil use and management. It is one of the properties useful in the determination of the agricultural potential of a soil. It is an important factor affecting the balance between water and gases, water intake rate, water storage in the soil, organic matter (OM) retention and decay, ease of tillage and soil fertility. Most soils in the surveyed area had sandy loam textures which are good for crop production. Only soils under Arenosols and Gleyic Vertisols had a lot of sand and clay respectively.

- **Soil type1/Sub-types:** Ferralsols; including Haplic Ferralsols, Acric Ferralsols, Rhodic Ferralsols, Haplic Ferralsols (Ar) have Sandy Clay Loam, Sandy Loam and Loam soils. These textures are generally good for agriculture as it is easy to use. These classes occupy the largest area of Matanda command area and some portion of the Enengo command area in the North of Mantanda

- **Soil type 2: Gleyic Vertisols/Vertisols**. The textural class of these soils varies; in that, the top soils have Loamy texture, followed by Clay loam and Clay in the last layers. The average percentage of Sand, Clay, and Silt is approximately 50%:30 %: 20%, this means that soils can also be easily utilized for agricultural activities not typical of pure sticky clay vertisols of Karamoja in North Eastern Uganda. But the concentration of Clay increases with the depth of the profile. This is typical of Profile 8, Profile 9, Profile10 and Profile 11.
- **Soil Type 3: Plinthosols**. The texture of these soils is either Loamy Sand or Sandy Clay Loam.
- **Soil Type 4; Skeletic Leptosols:** Samples were taken from the top layer only (0-35cm) as the sub-layer could not easily be sample. These top layers have Sandy Loam textural Classes. This is typical of Profile 3 and Profile 4.
- **Soil Type 5: Arenosols (Humic)**: Typical Arenosols is Sand/Sandy. This is typical of Profile 6, Profile 14, Profile 16, Profile 17 in Matanda command area, and Profile 47 Profile 50 in Kikarara in Enengo command Area. The single grain structure of Arenosols does not hold water for long after rains or Irrigation, making it difficult for plants to access moisture for growth and development. But in this area some humic property have been observed in the soils, hence the reason for support crop growth in the area. Better suited crops for these soils should be carefully selected and appropriate irrigation method selected to manage the effects of nutrients and water loss after rains or irrigation water application.

5. **Bulk density (BD)**

Bulk density is an indicator of soil compaction. To measure bulk density of the soils, undisturbed soil samples were taken by using pF core sampling cylinder and sent to Soil Laboratory. If the value of soil bulk density exceeds 1.65 g cm^{-3} compaction is expected. It is calculated as the dry weight of soil divided by its volume. BD and total porosity can represent the effects of soil use and management on the water and air relationships better than other soil physical properties such as texture. Generally, increased soil BD and decreased total porosity may indicate a trend towards lower soil quality. The average bulk densities of different soil types are described as:

- **Soil type 1: Ferralsol.** The range between 1.10g cm^{-3} and 1.68g cm^{-3} and an average of 1.53g cm^{-3}, which does not limit the growth of crops.
- **Soil type 2: Gleyic Vertisols**. The bulk densities range between 1.10g cm^{-3} to 1.63g cm^{-3} and an average of 1.36gcm^{-3}.
- **Soil Type 3: Arenosols (Humic)**: The bulk densities range between 1.29gcm^{-3} to 1.61g cm^{-3} and an average of 1.50gcm^{-3}.
- **Soil Type 4: Skeletic Leptosols**: The bulk densities range between 1.23gcm^{-3} to 1.55g cm^{-3} and an average of 1.42gcm^{-3}.
- **Soil Type 5: Plinthosols**: Shows an average bulk density of 1.224g cm^{-3}.

On average; the bulk densities of all the soil types in all the command area does not show that compaction is expected. The mentioned BD's, presented in Table : Laboratory results for the selected soil physical properties, are below the critical values and therefore, all the project sites are suitable for growing crops.

6. Soil structure

Soil structure as one of the physical soil indicators is the arrangement of the primary soil particles (sand, silt, and clay). Granular structure is considered the most suitable for plant growth, allowing for a better balance between macro and microspores, and consequently, between the air/water proportion. Most of the soils in the survey area had sub-angular blocky and blocky structures except Arenosols and lower parts of Plinthosols and Leptosols. Such structures are good for crop production.

7. Available water capacity

The available water capacity (AWC) defines the amount of water in a soil that is available for plant growth. The upper limit is defined by the water content at field capacity (FC) and the lower limit is the value of water content at wilting point (PWP).

The available water capacity is the portion of water that can be absorbed by plant roots. By definition it is the amount of water available, stored, or released between field capacity and the permanent wilting point water contents. The soil types with higher total available water content are generally more conducive to high biomass productivity because they can supply adequate moisture to plants during times when rainfall does not occur. Sandy soils are more prone to drought and will quickly (within a few days) be depleted of their available water when evapotranspiration rates are high. For example, for a plant growing on fine sand with most of its roots in the top foot of soil, there is less than one inch of readily available water. Soils at Matanda command area (Ferralsols) on average have more water available for plants (0.07-0.129 cm cm^{-3}) with an average of 0,10 cm cm^{-3}. The Gleyic Vertisols of the two command area have average values of 0.07 - 0.12 cm cm^{-3} with an average of 0.11 cm cm$^{-3.}$ Arenosols on the other end showed the AWC range between 0.074-0.091cm cm^{-3}) and an average of 0.090 cm cm^{--3}. The remaining minor soils; Plinthosols and Skeletic Leptosols showed an average AWC of 0.08 cm cm^{-3} and 0.091 cm cm^{-3}respectively. The AWC of both Ferralsols and Gleyic Vertisols are two better AWC for crop production, the remaining soils have the AWC values that are marginally suitable for crop production.

8. Field capacity

Field capacity is the amount of water remaining in the soil a few days/ hours after having been wetted and after free drainage has ceased. The larger pores drain fast by gravity drainage, if not restricted, may only take hours, whereas in clay soils without macropores; gravity drainage may take two to three days. In general, the average water content for soils in Ferralsols ranges between 0.151cm cm^{3}-0.35 cm cm^{-3} and on average of 0.172cm cm^{3}. Vertisols showed relatively uniform FC values ranging between 0.21-0.351cm cm-^{3}, on average of 0.285cm cm^{-3} and slightly higher than that of Ferralsol. Similarly; Arenosols showed similar FC values within the range of 0.132-0.219cm cm-^{3}, showing an average of 0.177cm cm-^{3}. Skeletic Leptosols showed average FC values of 0.214cm cm-^{3} while Plinthosols showed an average FC value of 0.155cm cm-^{3}.

9. Permanent wilting point

Permanent wilting point is the water content of a soil when the plants growing in that soil wilt and fail to recover their turgor upon rewetting. The matric potential at this soil moisture condition is commonly estimated at -15 bars. Most agricultural plants will generally show signs of wilting long before this moisture potential or water content is reached (more typically at around -2 to -5 bars) because the rate of water movement to the roots decreases and the stomata tend to lose their turgor pressure and begin to restrict transpiration. This water is strongly retained and trapped in the smaller pores and does not readily flow. The water content at PWP for average Ferralsols (0.17 cm cm^{-3}), while the PWP for Gleyic Vertisols is 0.20cm cm^{-3}, and for Arenosol was 0.081 cm cm^{-3}. For the top layer of Skeletic Leptosol, the average PWP values were 0.10 cm cm^{-3} slightly less than that of Plinthosols (0.114 cm cm^{-3}).

10. Saturated hydraulic conductivity

Saturated hydraulic conductivity (Ksat) is one of the hydraulic properties of the soil. It is the measure of the soil's ability to transmit water when submitted to a hydraulic gradient. Ksat strongly depends on BD, organic carbon content and land use. Ksat ranged between 2 and 13 mm/hr with the exception of profile SU009 which had extremely high Ksat value (52.6 mm/hr). Generally, with the exception of profile SU009, Ferralsols and Gleyic Vertisols had lower Ksat values compared to other soil types. This could be attributed to higher BD and fewer macropores in the soil.

Ferralsols showed a Ksat values ranges of 2.2-8.8mm/hr with an average value of 5.2mm/hr. The highest Ksat Values of 8.8mm/hr is obtained in the Ferralsols with Arenic nature as expected. The highest Ksat values of 52.6 mm/hr are obtained in Gleyic Vertisols, which seems to be an outlier, the rest of the Vertisols shows Ksat values ranging from 2.5mm/hr to 16.8mm/hr, with an average Ksat value of 7.3mm/hr**.** Arenosols nearly showed uniform Ksat values for most profiles, ranging from 16.0mm/hr-22.0mm/hr with an average Ksat Values of 19.8mm/hr. The top layer of skeletic Leptosols showed an average Ksat value of 9.9mm/hr while Plinthosols showed and average Ksat values of 8.7mm/hr.

In general; the Ksat values for Ferralsols, Planosols, Fluvisols, and that of Leptosols is highly suitable for irrigation (S1), Similarly; the Ksat is Ksat for Arenosols and Gleyic vertisols are marginally suitable (S3), while Plinthosols showed moderately suitable Ksat values (S2) (see table 8 below).

Table: Laboratory results for the selected soil physical properties

Profile No	Depth (cm)	Soil Classification (WRB 2014)	BD (g/cm^3)	PWP (cm3/cm^3)	FC (cm3/cm^3)	AWC (cm3/cm^3)	Ksat (mm/hr)	Texture (%) Sand	Clay	Silt	Textural Class
SU001	0-40	Haplic Ferralsols	1.7	0.152	0.244	0.09	6.6	76	16	8	Sandy Loam
SU001	40-100	Haplic Ferralsols	1.7	0.065	0.151	0.09	6.4	68	26	6	Sandy Clay Loam
SU003	0-20	Skeletic Leptosols	1.4	0.151	0.241	0.09	17.0	82	8	10	Loamy Sand
SU006	0-40	Arenosols (Humic)	1.3	0.065	0.139	0.07	19.5	90	6	4	Sand
SU006	40-100	Arenosols (Humic)	1.5	0.090	0.178	0.09	21.2	84	12	4	Sand
SU007	0-30	Gleyic Vertisols	1.6	0.128	0.241	0.11	4.7	68	20	12	Sandy Loam
SU007	30-100	Gleyic Vertisols	1.1	0.200	0.291	0.09	2.4	58	34	8	Clay Loam
SU009	0-40	Gleyic Vertisols	1.3	0.170	0.289	0.12	5.2	50	30	20	Clay Loam
SU009	40-120	Gleyic Vertisols	1.4	0.241	0.344	0.10	52.6	44	44	12	Silty Clay
SU011	0-20	Gleyic Vertisols	1.3	0.172	0.280	0.11	16.8	40	38	22	Clay Loam
SU012	0-40	Gleyic Vertisols	1.2	0.164	0.283	0.12	6.4	56	28	16	Loam
SU012	40-80	Gleyic Vertisols	1.6	0.115	0.211	0.10	13.0	56	34	10	Loam
SU014	0-50	Arenosols (Humic)	1.6	0.102	0.192	0.09	22.0	76	16	8	Sand
SU014	50-100	Arenosols (Humic)	1.6	0.064	0.155	0.09	19.0	80	14	6	Sand
SU015	0-70	Arenosols (Humic)	1.5	0.064	0.132	0.07	21.0	88	4	8	Sand
SU016	0-50	Arenosols (Humic)	1.5	0.091	0.184	0.09	18.9	86	6	8	Sand
SU016	50-100	Arenosols (Humic)	1.6	0.123	0.214	0.09	16.0	80	16	4	Sand
SU017	0-40	Arenosols (Humic)	1.5	0.100	0.198	0.10	22.0	86	6	8	Sand
SU017	40-100	Arenosols (Humic)	1.4	0.106	0.199	0.09	19.0	82	12	6	Sand
SU018	0-50	Haplic Ferralsols	1.7	0.077	0.162	0.09	6.1	86	8	6	Sand
SU018	50-100	Haplic Ferralsols	1.4	0.091	0.180	0.09	5.2	82	12	6	Sandy Clay Loam
SU019	35-100	Rhodic Ferralsols	1.6	0.211	0.351	0.14	3.6	70	24	6	Sandy Clay Loam
SU021	0-400	Haplic Ferralsols	1.6	0.076	0.171	0.10	8.6	84	10	6	Sandy Clay Loam
SU021	40-100	Haplic Ferralsols	1.5	0.133	0.224	0.09	6.2	76	20	4	Sandy Clay Loam
SU023	0-400	Rhodic Ferralsols	1.6	0.122	0.206	0.08	5.0	86	8	6	Sand
SU023	40-100	Rhodic Ferralsols	1.6	0.114	0.198	0.08	5.3	76	18	6	Sandy Loam
SU025	0-50	Haplic Ferralsols (Ar)	1.4	0.144	0.234	0.09	8.8	68	18	14	Sandy Loam
SU043	50-100	Haplic Ferralsols (Ar)	1.5	0.182	0.267	0.09	6.7	70	22	8	Sandy Clay Loam

SU026	0-30	Rhodic Ferralsols	1.5	0.114	0.212	0.10	3.8	76	12	12	Sandy Loam
SU026	30-80	Rhodic Ferralsols	1.4	0.166	0.251	0.09	5.0	76	16	8	Sandy Loam
SU028	0-60	Haplic Ferralsols	1.5	0.182	0.283	0.10	3.4	72	16	12	Sandy Loam
SU028	60-90	Haplic Ferralsols	1.1	0.081	0.160	0.08	2.7	62	30	8	Sandy Clay Loam
SU032	0-40	Acric Ferralsols	1.5	0.136	0.243	0.11	3.8	66	22	12	Sandy Clay Loam
SU032	40-80	Acric Ferralsols	1.5	0.157	0.223	0.07	3.9	62	30	8	Sandy Clay Loam
SU033	0-40	Plinthosols	1.2	0.077	0.155	0.08	8.7	68	26	6	Sandy Clay Loam
SU036	0-500	Acric Ferralsols	1.3	0.250	0.346	0.10	8.3	50	30	20	Clay Loam
SU036	50-100	Acric Ferralsols	1.6	0.173	0.279	0.11	4.6	44	44	12	Silty Clay
SU037	0-100	Acric Ferralsols	1.6	0.139	0.234	0.10	4.2	52	28	20	Sandy Clay Loam
SU037	100-140	Acric Ferralsols	1.5	0.115	0.199	0.08	4.1	62	22	16	Sandy Clay Loam
SU039	0-40	Skeletic Leptosols	1.5	0.104	0.197	0.09	6.6	72	14	14	Sandy Loam
SU039	40-80	Skeletic Leptosols	1.2	0.112	0.201	0.09	6.0	74	14	12	Sandy Loam
SU043	60-100	Haplic Ferralsols	1.4	0.155	0.284	0.13	4.5	68	24	8	Sandy Clay Loam
SU043	0-60	Haplic Ferralsols	1.3	0.136	0.210	0.07	2.2	56	22	22	Loam
SU045	0-20	Gleyic Vertisols	1.4	0.212	0.341	0.13	2.5	44	38	18	Clay Loam

***BD = bulk density, Ksat = saturated hydraulic conductivity, FC = field capacity, PWP = permanent wilting point, AWC = plant available water capacity**.*

4.2.2 Soil chemical properties

Soil chemical properties

Soil chemical properties of the surveyed sites are presented in Table 7. Soil chemical indicators refer to chemical properties and processes that are important to plant growth and environment. Soil chemical attributes are correlated with the capacity of the soil to provide nutrients for plants and/or retaining chemical elements or compounds harmful to the environment and plant growth. Soil pH, soil OM, total N, pH, cation exchange capacity (CEC), exchangeable bases, and plant available nutrient reserves are the main attributes considered when assessing the capacity of the soil to support high crop yields.

Soil pH

Soil pH is a measure of acidity and alkalinity in soils. Knowing soil acidity is useful in evaluating soils because pH exerts a very strong effect on the solubility and availability of many nutrients and it influences nutrient uptake and root growth. The pH values ranged from 5.0 to 6.6. This indicates that pH values for most of the profiles are favorable for crop growth. Most of the crops grow well in soils with pH ranging between 5.5 and 6.5.

Organic matter (OM)

Organic matter contains an acid that can make plant roots more permeable, improving their uptake of water and nutrients, and can dissolve minerals within the soil, leaving them available for plant roots. Carbon is the main element present in soil organic matter, on average making up 58% by weight. The organic matter content of soils varied from 1.0% to 11.9% with an average value of 3.4% indicating that the study area had low to very high contents of OM. Profile SU016 had a very low content of OM and Profiles SU045 and SU011 had very high of OM. The very high contents of OM in profiles SU045 and SU011 could be attributed to histic conditions. The plant leaves and grasses could not be decomposed easily due to anaerobic conditions.

Available phosphorus (P)

Available phosphorous is the amount of phosphorus readily available for absorption by plant roots. Three different phosphorus ions are formed by ionization of one, two, or all of the three hydrogens from phosphoric acid (H_2PO_4) to form (HPO^{2-}). The predominance of one or another of or PO_4 is the one most readily absorbed by the concentration of the HPO_4 ion increases at high pH value because it becomes the dominant ion in solution above pH 7.2. The distribution of P in the study area varied from one sampling point to another with some profiles having very low values of P and other high P values. The overall available phosphorus content of the soil of the study ranged from 0 ppm to 40.8 ppm with an average value of 10.4 ppm. On average, P was very low in all the profiles in the surveyed area except profiles; SU006, SU009, SU017, SU039, SU044, and SU045, which had relatively higher values of P.

Total nitrogen

Nitrogen is an essential element for tissue development both in plants and animals. All organisms need nutrients such as N for growth and reproduction but it is one of the nutrients that is always lacking in the ecosystems. Nitrogen contents ranged from 0.1% to 0.4% indicating low to high values of N in the survey area.

Exchangeable cations

The level of the exchangeable cations in soil indicates the existing nutrient status and can be used to assess balance among the cations. Many effects on soil structure and nutrient uptake by crops are influenced by the relative concentration of cations as well as by their absolute levels. The exchangeable bases looked at were potassium, magnesium, and calcium. Calcium is an essential element of the plant cell wall. It forms calcium pectate compounds which give stability to cell walls and bind cells together. It also helps the movement of carbohydrates from one part of the plant to the other and for helping to regulate sap acidity. The exchangeable calcium of the soils ranged from 5.9-7.7 cmol (+)/kg soil indicating moderate values of Ca in the study area. Magnesium is the building block of the chlorophyll that makes leaves appears green. The exchangeable magnesium ranged from 0.8 cmol (+)/kg soil to 1.7 cmol (+)/kg soil. These values indicate a low to moderated levels of Mg. Potassium ranged from low to high levels (0.03-1.22 cmol (+)/kg soil).

Table: Laboratory results for selected soil chemical properties

Profile No.	Depth	pH	O.C (%)	OM (%)	P (mg/kg)	N (mg/kg)	C:N	K (cmol/kg)	Na (cmol(kg)	Ca (cmol/kg)	Mg (cmol/kg)	CEC (cmol/kg)
SU009	0-40	5.91	2.14	3.69	20.79	0.23	9.3	0.50	0.24	6.65	1.34	8.7
SU009	40-120	5.55	1.12	1.93	9.70	0.15	7.4	0.08	0.10	6.56	1.16	7.9
SU007	0-30	5.81	1.77	3.05	6.27	0.20	8.8	0.13	0.12	6.84	1.54	8.6
SU007	30-100	5.52	1.40	2.41	7.70	0.17	8.2	0.20	0.14	6.45	1.12	7.9
SU006	0-40	5.78	1.12	1.93	19.74	0.13	8.6	0.08	0.05	6.77	1.23	8.1
SU006	40-100	5.92	0.65	1.12	15.96	0.09	7.2	0.14	0.07	7.03	1.66	8.9
SU018	0-50	5.89	2.23	3.85	7.28	0.22	10.2	0.15	0.10	6.87	1.28	8.4
SU018	50-100	5.77	1.02	1.77	5.99	0.13	7.9	0.07	0.05	6.92	1.38	8.4
SU021	0-40	5.58	5.77	9.95	6.62	0.36	16.0	0.07	0.05	6.88	1.44	8.4
SU021	40-100	5.65	1.49	2.57	5.92	0.17	8.8	0.06	0.05	6.79	1.43	8.3
SU012	0-40	5.27	3.17	5.46	12.08	0.28	11.3	0.42	0.12	6.66	1.21	8.4
SU012.	40-80	6.35	1.02	1.77	8.82	0.13	7.9	0.08	0.05	7.45	1.66	9.2
SU014	0-50	5.08	1.77	3.05	6.69	0.19	9.3	0.08	0.05	6.44	1.07	7.6
SU014	50-100	5.35	2.14	3.69	6.62	0.21	10.2	0.06	0.02	6.62	0.99	7.7
SU017	0-40	6.44	1.68	2.89	0.00	0.20	8.4	0.29	0.02	7.67	1.68	9.7
SU017	40-100	6.04	1.68	2.89	27.20	0.21	8.0	0.32	0.07	7.29	1.4	9.1
SU039	0-40	6.10	3.54	6.10	18.31	0.30	11.8	0.14	0.05	7.44	1.35	9.0
SU039	40-80	6.29	0.65	1.12	7.60	0.08	8.1	0.10	0.07	7.56	1.45	9.2
SU028	0-60	5.37	1.49	2.57	6.02	0.18	8.3	0.06	0.02	6.56	1.05	7.7
SU028	60-90	5.20	1.77	3.05	4.10	0.19	9.3	0.04	0.02	6.63	1.22	7.9
SU023	0-40	5.71	2.14	3.69	5.81	0.23	9.3	0.15	0.05	6.82	1.37	8.4
SU023	40-100	5.37	1.30	2.25	5.64	0.15	8.7	0.06	0.05	6.56	1.16	7.8
SU001	0-40	5.54	1.21	2.09	6.44	0.14	8.6	0.03	0.02	6.83	1.34	8.2
SU001	40-100	5.34	0.74	1.28	5.92	0.11	6.8	0.06	0.05	6.66	1.08	7.8
SU016	0-50	5.62	0.84	1.44	8.33	0.10	8.4	0.13	0.05	6.77	1.21	8.2
SU026	0-30	6.08	0.74	1.28	9.66	0.09	8.3	0.42	0.07	7.44	1.45	9.4
SU026	30-80	5.87	1.49	2.57	5.88	0.17	8.8	0.07	0.05	6.56	1.05	7.7
SU033	0-40	5.34	0.74	1.28	5.92	0.10	7.4	0.06	0.05	6.51	0.95	7.6
SU003	0-20	6.00	2.05	3.53	25.90	0.21	9.8	0.11	0.10	7.33	1.4	8.9

Profile No.	Depth	pH	O.C (%)	OM (%)	P (mg/kg)	N (mg/kg)	C:N	K (cmol/kg)	Na (cmol(kg)	Ca (cmol/kg)	Mg (cmol/kg)	CEC (cmol/kg)
SU019	35-100	5.14	1.86	3.21	6.72	0.18	10.3	0.07	0.05	6.44	0.98	7.5
SU011	0-20	6.37	6.89	11.9	9.45	0.38	18.1	1.18	0.14	7.46	1.36	10.1
SU036	0-50	5.12	2.23	3.85	4.69	0.23	9.7	0.08	0.07	6.55	1.11	7.8
SU036	50-100	5.08	2.14	3.69	3.50	0.22	9.7	0.06	0.05	6.27	0.87	7.2
SU037	0-100	5.03	1.49	2.57	6.06	0.19	7.8	0.07	0.05	5.87	0.79	6.8
SU037	100-140	5.33	1.86	3.21	5.71	0.20	9.3	0.08	0.05	6.25	1.06	7.4
SU016	50-100	6.02	0.56	0.96	7.07	0.07	8.0	0.11	0.38	7.45	1.38	9.3
SU025	0-50	5.86	1.86	3.21	6.83	0.22	8.5	0.08	0.05	6.89	1.17	8.2
SU026	50-100	5.16	2.42	4.17	6.30	0.24	10.1	0.08	0.05	6.44	1.22	7.8
SU032	0-40	5.61	2.33	4.01	5.78	0.25	9.3	0.03	0.05	6.65	0.89	7.6
SU032	40-80	5.49	1.30	2.25	6.55	0.17	7.7	0.13	0.12	6.45	1.04	7.7
SU043	0-60	5.73	2.79	4.82	10.89	0.27	10.3	0.28	0.07	6.69	1.23	8.3
SU043	60-100	6.03	2.05	3.53	8.93	0.20	10.2	0.06	0.05	7.23	1.45	8.8
SU044	0-70	6.37	2.61	4.49	40.81	0.25	10.4	0.20	0.10	7.67	1.24	9.2
SU045	0-20	6.61	4.38	7.54	16.98	0.30	14.6	1.22	0.91	7.66	1.31	11.1
SU002	0-35	5.5	1.558	2.68	4.96	0.14	11.13	0.02	0.10	1.88	0.95	4.35
SU002	35-110	5.6	0.983	1.69	trace	0.10	10.24	0.01	0.05	3.54	1.15	6.11
SU008	0-30	5.1	1.459	2.51	13.28	0.12	12.47	0.02	0.14	2.35	0.12	4.39
SU008	0-90	4.7	0.532	0.92	17.53	0.10	5.36	0.01	0.07	2.69	0.25	5.25
SU022	0-40	5.5	1.403	2.41	15.32	0.13	11.22	0.03	0.24	4.99	0.52	7.04
SU022	40-100	5.7	3.053	5.25	39.78	0.23	13.45	0.00	0.05	3.04	0.21	4.55
SU047	0-45	6.1	0.766	1.32	1.22	0.09	8.71	0.00	0.05	3.90	0.31	5.10
SU047	45-100	5.7	1.017	1.75	150.54	0.11	9.59	0.00	0.37	1.07	0.00	2.34
SU048	0-50	5.7	4.49	7.72	34.01	0.30	14.97	0.08	0.05	10.92	1.43	13.73

4.3 Land suitability evaluation for irrigation

Table 8 indicates the suitability of the surveyed areas for irrigation. The overall suitability was based on the maximum limitation in each of the soil types.

Table : Suitability for irrigation for the different soil mapping units (soil type) based on selected important parameters

Land characteristic	**Suitability class**								
	Haplic Ferralsols	**Acric Ferralsols**	**Rhodic Ferralsols**	**Gleyic Vertisols**	**Arenosols (Humic)**	**Fluvisols**	**Planosols**	**Leptosols**	**Plinthosols**
Drainage	S1	S1	S1	S3	S1	S1	S1	S1	S1
Flooding	S1	S1	S1	S3	S1	S1	S1	S1	S1
Slope	S1	S1	S1	S1	S1	S1	S1	S3	S3
Water table	S1	S1	S1	S2	S1	S1	S1	S1	S1
Soil depth	S1	S1	S1	S1	S1	S1	S1	S3	S3
Soil erosion risks	S1	S1	S1	S1	S1	S1	S1	S1	S1
Top-soil texture	S1	S1	S2	S2	S3	S3	S3	S2	S1
Sub-soil texture	S1	S1	S2	S2	S3	S3	S2	S2	S2
Soil structure	S1	S1	S1	S3	S3	S2	S2	S1	S1
Ksat	S1	S1	S1	S3	S3	S1	S1	S1	S2
Gypsum	S1	S1	S1	S1	S1	S1	S1	S1	S1
CaCO3	S1	S1	S1	S1	S1	S1	S1	S1	S1
Overall suitability (code)	S1()	S1()	S2(t)	S3(t,ks)	S3(t,ks)	S3(t,)	N1(t,)	N2(sd,t)	S3(sd,S)
Overall suitability class	**Highly Suitable**	**Highly Suitable**	**Moderately suitable**	**Marginally suitable**	**Marginally suitable**	**Marginally suitable**	**Marginally NOT suitable**	**Not currently Suitable**	**Marginally suitable**

S1 = highly suitable, S2 = moderately suitable, S3 = marginally suitable. N1 = marginally not suitable, N2= Not currently Suitable and $CaCO_3$ = calcium carbonate, ks = saturated hydraulic conductivity, s = soil structure, sd = soil depth, t = texture and S=slope

Note: The table 8 above show the overall suitability of the soils taken as an average of the soil profile pits. For example; Haplic Ferralsols in the first column, the suitability of given as S1(), this means that the soils is highly suitable, as per no known limitation ().

4.3.1 General Suitability for Irrigation

Haplic Ferralsols and Acric Ferralsols were highly suitable for irrigation with no major limitation and Rhodic Ferralsols showed moderately suitability with limitation due to textural class (S2(t). Very high and low values of K_{sat} are not favorable for irrigation. The high values can lead to a loss in water due to percolation and the low values can result in huge volumes of runoff and erosion. K_{sat} is an important soil property to many soil water-related investigations such as water conservation, irrigation design, drainage and general transport phenomena in soils. Ferralsols have high structural stability. The relatively low Ksat can be attributed to the formation of stable micro-aggregates. The topsoil macro-aggregates can be subjected to degradation due to human activities such as tilling which decreases K_{sat}.

Arenosols (Humic) S3(t,ks), Gleyic vertisols S3(t,ks), Fluvisols S3(t,) were also marginally suitable and Gleyic Planosols N1(sd,S) is marginally Not suitable. The first two soils; Arenosols (Humic) and Gleyic vertisols S3(t,ks), had a soil texture, and Ksat limitation. On the same note; Fluvisols S3(t,) had limitation due to texture S3(t,) while Gleyic Planosols N1(sd,S) was limited due soil depth (sd) and slope(S). Texture determines the rate at which water should be applied, how much should be applied and how often irrigation should occur. For the case of Gleyic Vertisols which contains much more clay than other soil types, water will infiltrate slowly and applying large volumes quickly will lead to a runoff. However, they can store a large volume of water and therefore requires less frequent irrigation. Good soil structure allows for improved infiltration and drainage. It also enhances root growth. Poor structure reduces infiltration and water holding capacity and will make irrigation more difficult to manage.

Leptosols are Not suitable due to a soil depth limitation (sd). Soil depth determines the potential rooting depth of plants to be grown and any restrictions within the soil that may hinder rooting depth. Any discontinuities in the soil from layers of sand, gravel or even bedrock physically limit rooting depth and hinder irrigation. It can also create problems when using irrigation.

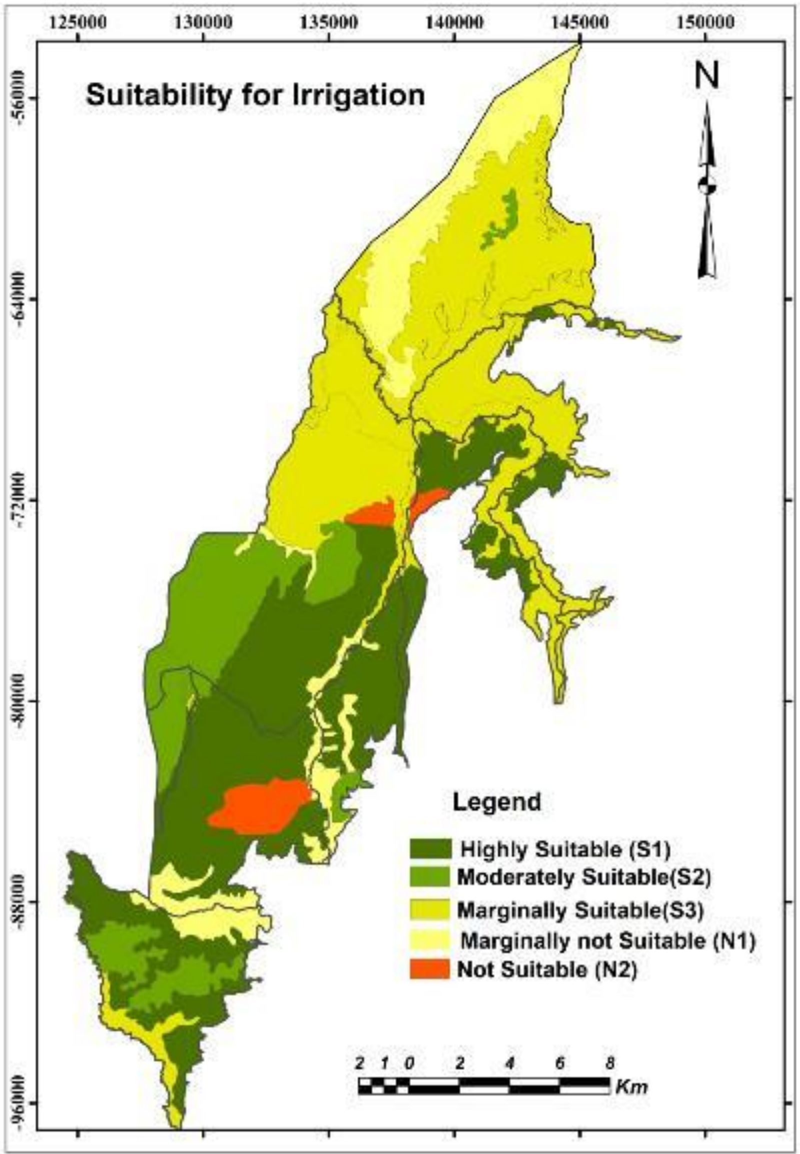


Figure: Shows the map of general land Suitability for Irrigation

4.3.2 Assessing the meaning of each Land Suitability Class

The common limitations in the surveyed area are the inability of the soil to hold nutrients due to the coarse texture of topsoil of the mapping unit. The soils have acidic pH which is not suitable for rice production; these soils can be corrected by liming at the appropriate rate.

Class S1 Highly Suitable: Land having no significant limitation or only have minor limitations to sustain a given land utilization type without significant reduction in productivity or benefits and will not require major inputs above an acceptable level.

Class S2 Moderately Suitable: Land having limitations which in aggregate are moderately severe for sustained application of the given land utilization type; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciable compared to that expected from Class S1 land.

Class S3 Marginally Suitable: Land having limitations which in aggregate are severe for sustained application of the given land utilization type and will so reduce productivity or benefits, or increase required inputs, that any expenditure will only be marginally justified.

Class N1 Marginally Not Suitable /or Not currently Suitable: Land having limitations which may be surmountable in time, but which cannot be corrected with existing knowledge at currently acceptable cost; the limitations are so severe as to prevent successful sustained use of the land in the given manner.

Class N2 Not currently Suitable as the range of inputs required is unjustifiable.

4.4 Soil Fertility and land management under irrigation

Soil fertility refers to the inherent ability of soils to provide sufficient and right quantity vital nutrient to plant for their most favorable growth and it is one of the key components to determine productivity. Nitrogen is only second to water affecting the yields of most of the crops. The interaction between nitrogen and irrigation water has a significant effect on crop yields.

Soil nutrient status of the project site is varied from point to point and depth to depth as expected. N showed 50% of the sample having moderate values and 40% low levels of N and the remaining 10% high in N content. The soils are low in available P with almost 80% of the samples below the critical values and the remaining 20% ranging between medium-high levels of P in the soils. K levels in the soil range from very low to medium. In exception of few cases; the level of Ca in the soils is moderate/medium. For increased and sustainable crop yields supplementary nitrogen and phosphorus fertilizer and organic manures might be required with the experience of other irrigation schemes in Uganda.

Therefore, field trial experiments for calibration of nutrient requirements for crops by agricultural researchers and adaptation trials on farmer’s plots are required. The soil tests should be calibrated by correlating them with the yield results of a field experiment. The continuous field experiment in the specific area provides the basis for fertilizer recommendation.

In this paragraph, we suggest the following fertilizer rate for rice crop that has been grown in many irrigation schemes in Uganda based on different National Agricultural Research Institutes’ and JICA recommendations.

Apply 25 kg of DAP (18-46-0) and 25 kg of Urea (46-0-0) before final harrowing. Apply 25 kg of urea at panicle initiation stage (65-70 days after sowing) as a top dressing. After top-dressing, irrigate the field and keep 2-3 cm standing water and keep water in the field for one week to avoid fertilizer runoff.

After transplanting keep the shallow depth of water around 2 cm for one week and keep the field at saturation up to maximum tillering and keep 3 to 5 cm of standing water in the field till hard dough stage of the seed and stop irrigation/drain the water a week before harvest.

Supplying of optimum quantities of nutrient N, P and K with farmyard manure have beneficial effects on the physical and biological situations of the soils. In order to manage & maintain soil fertility in the project area, organic manure and inorganic fertilizers should be utilized together. The application of nitrite-containing fertilizers for crops grown under surface irrigated agriculture and water-logged soils results in a considerable amount loss of N due to its denitrification. Therefore, nitrogen fertilizers must be given a split application depending on the critical growth stage of the crop. Application of green-manure increases utilization of phosphorus by the crop not from the added fertilizers but also from the reserve supplies of soil phosphorus. The application of organic matter also improves the CEC of the soil.

4.4.1 Agricultural value, land use, and management

Different crops might have a particular type of soil that they grow best on. The right crop management decision for a smallholder farmer is to select the right crop for a given soil condition and or type paying attention also to the climate of that particular area. For a large scale farmer, there is need to select the right choice of a crop for a particular soil and correct limitations associated with that particular soil in order to maximize returns. The texts below highlights the agricultural value and management options for the different soils identified in Kanungu and Rukungiri Districts.

Plinthosols

Plinthosols with continuous ironstone at shallow depth are generally unsuitable for favorable uses, because of limited rootable soil volume. Soft plinthite is dense and obstructs deep percolation of water and penetration of plant roots. The impenetrability of the hardened plinthite layer as well as fluctuating water table that produces it restricts its use to grazing or forestry. Though food crops and tree crops can be planted on them, they suffer from drought, especially during the dry seasons. Civil engineers have a different application of these soils. It is valuable for making bricks and the hardened plinthite layer has value as subgrade material for roads.

Plinthosols come with considerable management problems of poor soil fertility, water logging in the bottom slopes and drought on shallow soils. Many Plinthosols have a shallow, continuous petroplinthitic layer which limits their rootable soil volume to the extent that arable farming is no longer possible. The stoniness of many Plinthosols is another problem implying low storage of nutrients and water.

Haplic, Rhodic and Acric Ferralsols

In its natural state Ferralsols often maintains high productive and diverse ecosystems that are dependent on efficient resource utilization. These soils rely heavily on soil organic matter to recycle nutrients from the soil through the plant and hence back to the soil through plant debris. Soil organic matter (SOM) in this case act as a slow release nutrient delivery system that mediates the cycling of nutrients and chemical attributes of the soil. However, if the natural ecosystems are disturbed especially through continuous cultivation, the productivity of these soils decline rapidly due to loss of SOM, accelerated acidification and reduction in cation exchange capacity thereby limiting the ability of the soil to hold basic cations.

These soils can be used for subsistence farming with cassava, maize, sweet potatoes, beans, bananas, millet, and sorghum. Coffee can also be grown on these soils but with an annual application of mulch. After 3 to 4 years of cropping, a grass fallow is recommended to regenerate the soil fertility. Intensive cultivation of these soils with annuals is possible on condition that adequate fertilizers are used after annulations of the phosphorous fixation capacity and aluminum saturation. There is a need also to prevent surface soil erosion by use of cover crops and mulch.

Arenosols

All Arenosols have a coarse texture which makes them generally have a high permeability. They have low water and nutrient storage capacity. Limitations associated with these soils are low coherence, low nutrient storage capacity and high sensitivity to erosion. These soils can be used for the production of annual crops such as groundnuts, millet, maize, Sweet Potatoes, sorghum, maize, yams, and beans. Most of these crops have been observed in the current land use (see table 5 and Plate 6). These soils can also be left under forest to produce timber. Permanent cultivation of annual crops would require frequent addition of the right quantities of organic matter. Irrigation is also required in order to realize good yields of small grains and fodder crops. Drip irrigation combined with the correct dosage of fertilizers may remedy the above challenges.

Gleyic Vertisols

Vertisols are among the most fertile soils on earth. Most of them have a high cation exchange capacity and base saturation. They can be used for smallholder and commercial production of post-rainy season crops; millet, sorghum, cotton, rice, chickpea, wheat, and barley. Cotton is well known to perform well in these soils due to the vertical nature of its roots that is not severely damaged by the cracking of the soil especially during dry periods. These soils can also be used for extensive grazing.

Though these soils have a considerable agricultural potential due to their high chemical fertility, their physical soil characteristics and especially their difficult water management cause a problem. Adapted management is a precondition for sustained production on these soils. Fallow periods of 1 to 4 years are needed to restore organic matter. Application nitrogen (N) and phosphorous (P) fertilizers are recommended to increase on the N and P contents. There is a need to improve on organic matter contents by addition of animal manures and green manures. During rainy seasons there is a need to evacuate excess surface water by using broad beds and furrows. Micro dams can also be used to store excess water and control soil erosion during the rainy season.

Skeletic Leptosols

Leptosols are unattractive soils for arable cropping because of limited rooting depth, a low water holding capacity and their nutrient supply is confined to what is available in the shallow top layer. These soils are very susceptible to erosion. They have the potential for tree crops and are good for grazing animals. Leptosols for appropriate use should be left for forestry.

Planosols

Planosols are poor in plant nutrients and the high clay contents lead to both seasonal waterlogging and drought stress. They can be cultivated for rice, wheat or sugar beet. They support either grass or open forest vegetation. Principally, these soils should be used for grazing animals. Fertilizers are needed for good yields on Planosols.

Fluvisols

Fluvisols have good natural fertility. They are cultivated for dryland crops such as soybean, maize, and rice. The amount of water on these soils should be controlled in order to increase its agricultural value. Animals can also be grazed on these soils especially in the dry seasons.

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The consultant carried out soil survey in Kanungu and Rukungiri District between the 3rd and 13th November 2018. The main objective of the survey was to characterize the physical and chemical properties of the soils, classify these soils into different types and evaluate the land for crop production and irrigation suitability.

Results indicated that most soils in the survey area are deep soil with exceptions of few profiles that had a limited depth due to laterites, plinthite and rocks. Areas with soil types; Leptosols and Plinthosols had limited by rocks and stones respectively. Soil depth plays a major role in influencing crop growth and yield. When crops are grown on shallow soils, their roots will be restricted and as a result, the root volume will be smaller than their normal volume and therefore crops cannot store enough nutrients and water.

Most of the soil types had textures good for crop production except soil types with sandy textures (Arenosols, Planosols, and Fluvisols). Sandy soils are associated with poor fertility in that they cannot store enough water due to large pore spaces and increased water drainage. The soil structures were good enough since most of the soils in the surveyed areas had sub-angular blocky structures.

The soil pH values were within the optimum range for crop production. Soils that were imperfectly drained e.g. Gleyic Vertisols had considerable amounts of OM. Generally, Arenosols had lower contents of OM, N and P. Ferralsols had moderate amounts of exchangeable Ca and Mg and low K contents.

Generally, most of the soils in the study area were suitable for irrigation with few limitations. The limitations that were found included, shallow soil depth especially under Skeletic Leptosols and heavy textured soils under Gleyic Vertisols, and finally single grain textures under Arenosols, Planosols, and Fluvisols.

5.2 Recommendations

Most of the crops are suitable for most of the soils identified. However, appropriate management is required for all the soil types and more attention should be paid to soils with serious limitations. A summary of management options is detailed below.

- Application of manure and inorganic fertilizers applied at guideline rates based on the crop type and crop physiological stage in all the soil types. In sandy soils, fertilization with organic manures is very essential. Application of organic manures can supply nutrients in slowly available forms and improve soil physic-chemical properties.

- Controlled application of irrigation water. Drip irrigation is essential because the large pore spaces in sandy soils can lead to a loss in the large volumes of irrigation water.

- Increase the slope for furrow irrigation on sandy soils (Arenosols, Planosols, and Fluvisols) so that water can move a long distance before it completely infiltrates in a short distance.

- Applying a moderate amount of water and in a slow paste especially on clayey soils (Gleyic Vertisols) due to its high water holding capacity and low infiltration rates.

- Use of broad beds especially on clayey soils (Vertisols) because these soils are prone to waterlogging especially in the rainy seasons.

- Organic matter levels need to be improved and maintained especially under Arenosols by addition of organic manures, use of cover crops and leguminous crops.

- Tree planting and animal grazing especially for shallow soils; Plinthosols and Leptosols.

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APPENDIX J AGRO-ECONOMIC REPORT

AGRO-ECONOMIC FEASIBILITY STUDY OF MATANDA IRRIGATION SCHEME

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FOR

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EXECUTIVE SUMMARY

The farmers in Matanda practice subsistence agriculture. For Matanda, the main typologies are Rice, Cereal/legume (Field Crops), and Coffee/Banana dominated fields. Land tenure system is mainly customary in both schemes across all typologies. In Matanda, the percentages of farmers with customary land are 79.2%, 75.9%, and 71.8% for rice, cereals and perennials.

The major crops grown by the farmers in the command area include rice, maize, beans, groundnuts, millet, coffee, and banana. Besides, sweetpotato, cassava, tomatoes, watermelon, cabbages and sugarcanes are also grown but by very few farmers. Both crop rotation and intercropping are dominant cultural practices applied in Matanda and across the different farm typologies. Nevertheless, the cropping pattern is sometimes not well sequenced as in some cases, crops in the same family are intercropped or rotated following each other such as beans with groundnuts. Consequently, farmers do not generally enjoy the benefits of intercropping and crop rotation.

Overall, the cropping calendars for the crops grown follow the rainfall regimes in Matanda. However, these calendars reveal poor adoption of Good Agronomic Practices (GAPs). For instance, they are characterized with: weeding only once in the entire crop production cycle; rarely are pests and disease managed; there is very limited use of productivity enhancing technologies particularly fertilizers; and although improved seed is used, most of it is recycled from the previous season.

Relatedly, productivity for all crops across all farmer categories is low compared to the potential yields. This is attributed to several factors including poor cultural practices, as well as decreasing soil fertility coupled with inadequate access to and use of productivity enhancing technologies such as fertilizers and pesticides constrain productivity. Similarly, except for tarpaulins, there is very low use of Post-Harvest Handling technologies such as threshers and shellers; and ultimately low-quality products are produced under the different value chains. Furthermore, apart from rice processing, value addition to the different commodities within the area is minimal.

Inadequate access to production and post-harvest handling technologies is partly attributed to high costs associated with these technologies and yet farmers have limited capital; moreover, access to credit is constrained by high Interest Rates (IRs) not affordable by most of the smallholder farmers who are the majority in the area. For instance, the annual IRs from the commercial banks is at least 24%, while for other lending associations, it stretches to over 36%. According to the key informants.

Economic analysis revealed that most of the major crops grown (maize, beans, and groundnuts) are neither market oriented nor economically viable except rice, coffee, tomatoes, watermelon and cabbages. Trading arrangements for both inputs and output markets are largely informal and based on mutual trust among the actors, although for rice, close to 10% of the farmers sell on credit to the processors. Producers mainly sell as individuals to traders and processors (in case of rice). Normally, the produce is collected by the trader from the farmers premises; and the former sell it to various customer categories within and outside the project area including exporting to countries like Rwanda and DRC.

Gender disparity is generally high under both schemes as most production activities such as planting and weeding are undertaken by women except tomatoes were the enterprise is youth dominated. In contrast, marketing and land allocation activities are mainly conducted by the men.

Institutional support is weak although there are a number of constraints requiring interventions such as capacity building in group strengthening and governance, gender mainstreaming, financial literacy, Good Agronomic and Post-Harvest Handling Practices, among others.

In terms of enterprises for promotion and streamlining in irrigation scheme the team recommends in Matanda irrigation command area; rice, coffee, groundnuts, tomatoes, green pepper, watermelons, cabbages and carrot are recommended.

1.1 Farm characteristics

1.1.1 Farm typologies in the command area

Farm typologies were defined based on the area under production of the dominant crops in each irrigation scheme. For Matanda, the typologies established were those dominated with Rice, Cereals/Legumes and Coffee/Banana production are the dominant fields were those planted with Rice, Millet and Coffee. The classifications were determined as in Table (1).

Table: Criterea for classification of the command area into typologies

Typology	Description/ Criteria	% response
Rice dominated fields	• Rice field ≥ 0.5 acres in at least one season • No coffee/banana fields with ≥ 0.5 acres in a season	11.8
Field Crops (other Cereals and Legumes)	• Fields with cereals of any acreage • Rice acreage ≤ 0.5acres in at least a season • Coffee and or banana acreage ≤ 0.5acres	77.2
Coffee/Banana dominated fields	• Coffee and or banana field ≥ 0.5 acres in at least one season	11.0

In the Matanda Irrigation Scheme, most of the farmers are under the typology of field crops production (77.2%) while for rice and coffee/banana typologies, the respective responses are 11.8 and 10.0.

1.1.2 Soil types under the different farm typologies

The farms in Matanda are generally characterized by Ferralsols across the typologies i.e., 83.0%, 89.3% and 94.5% for the rice, Cereal/Legume and Coffee/banana dominated fields, respectively.

Table: Percentage of farmers with farms under the different soil types

Soil type	Rice	Cereal/Legume	Coffee/Banana
Ferralsols	83.0	89.3	94.5
Vertisols	0.0	0.0	0.0
Plinthosols	0.0	0.0	0.0
Leptosols	13.0	10.7	2.6
Arenosols	0.0	0.0	0.0
Planosols	0.0	0.0	0.0
Fluvisols	0.0	0.0	0.0

Typical sandy loam soils on hilslope under subsistance production of sweetpotato and coffee in Mashaku 2 village, Mashaku parish

1.1.3 Land tenure system

Land tenure system is mainly customary in both schemes across the typologies. In Matanda, the percentages of farmers with customary land are 79.2%, 75.9%, and 71.8% for rice, cereals and Coffee/banana (perennials), respectively.

Table: Land tenure system in the two Irrigation Schemes

Land tenure system	Rice	Cereal	Coffee/Banana
Customary	79.2	75.9	71.8
Freehold	11.3	13.3	25.6
Hired	5.7	4.9	0.0
Bought	3.8	5.9	2.6

1.2 Existing crops and cropping pattern in project command area

1.2.1 Existing crops

The major crops grown by the farmers in the command area include rice, maize, beans, groundnuts, millet, coffee, and banana (Tables 5). Besides, sweetpotato, cassava, tomatoes, watermelon, cabbages and sugarcanes were reported to be grown but by very few respondents. Rice is grown as sole crop. In contrast, other crops i.e., maize, beans, groundnuts, coffee and millet are cultivated as both sole and as intercrops within the various typologies in the two schemes. Generally however, sole crops registered higher yields compared to when they are grown as intercrops. Nevertheless, for both sole and intercrop systems, the productivities for all crops across all the farm typologies in Matanda are very low compared to the potential yields. For instance, the potential yields (Mt/ha) are over 2.4 for groundnuts and for beans, 4.5 for rice and for coffee, 3.5 for open pollinated maize variety-Longe 5, and over 6.0 for hybrid maize. The low productivities can be attributed to several factors including limited adoption of Good Agronomic Practices (GAPs) such as use of appropriate rotations, recommended weeding regimes and pests and disease control; decreasing soil fertility coupled with inadequate use of productivity enhancing technologies such as fertilizers, pesticides and improved seed.

In Matanda, average land size is highest under sole bean production (1.0 acre) within the rice dominated fields. However, the average cropped area (ha) is highest under the rice fields (476.9). For the coffee/ banana dominated typology, both the highest average household land size (1.65 acres) and the biggest area under crop production (369.4 ha) are for the coffee intercropped with banana fields (Table 5).

Table: Common crops by typology grown in Matanda scheme

Cropping system	Average household acreage (acres)	Total area (Ha)	Yield of main crop (ha)	Yield of main intercrop (ha)
Rice Dominated Typology				
Rice	0.73	476.9	2,137.3	NA
Beans	1.0	67.2	1,086.8	NA
Beans/maize	0.52	128.7	679.3	649.9
Maize/Beans	0.83	56.0	1,235.0	691.6
Fallow land	0.77	188.1	-	-
Sub Total		**916.8**		
Coffee/Banana Dominated Typology				
Coffee	1.0	44.8	988.0	NA
Beans/Maize	0.53	82.8	633.3	548.8
Coffee/Banana	1.65	369.4	1,294.3	639.2
Coffee/Beans	1.0	179.1	849.2	532.0
Maize/Beans	0.75	33.6	922.1	329.3
Groundnuts/Maize	0.75	67.2	988.2	494.0
Millet	0.73	49.3	449.0	NA
Banana	0.6	13.4	1,976.0	NA
Fallow land	0.9	89.5	NA	NA
Sub Total		**929.1**		
Cereal Legume (Field crops) Dominated Typology				
Millet	0.48	248.5	834.4	NA
Groundnuts/Beans	0.39	228.4	990.0	516.7
Groundnuts/Maize	0.52	163.4	802.8	950.0
Rice	0.25	22.4	1,901.9	NA
Maize/Beans	0.83	615.7	895.9	548.8
Beans/Maize	0.6	1025.3	816.8	947.2
Fallow land	0.8	575.4	-	-
Sub Total		**2879.0**		
Total Crop area		**4724.9**		

1.2.2 Cropping pattern

1.2.2.1 Crop rotation

Crop rotation is a common practice in Matanda. All households interviewed in Matanda with farms under the Rice and the Perennial typologies practice crop rotation, while for Cereal/Legume fields, 94.8% of the farmers apply the practice (Table 6).

Table: Percentage of farmers practicing crop rotation in Matanda irrigation scheme

Typology	Percentage
Rice	100
Cereal/Legume	94.8
Coffee/Banana	100

For Matanda scheme, the major crop rotation sequences according to the household respondents per typology are presented in Table 8. The rotations practiced across typologies although by relatively few farmers are: Maize/Beans; Beans/Maize; and Beans/Millet. For instance, maize followed by beans is carried out by 18.8%, 18.5% and 22.2% under the Rice, Cereal/Legume and Coffee/Banana dominated fields, respectively. Other rotation patterns are not practiced across all the typologies. For example, maize followed by groundnuts is practiced under the Cereal/Legume dominated fields but not under the rice typology.

The data presented also indicate that some farmers rotate crops under the same family such as maize followed by millet within the Rice and Cereal/Legume dominated fields with respective percentages of 43.8 and 14.8 undertaking this cropping pattern. Such sequencing does not exploit the benefits of crop rotation which include sustainable soil nutrient and water utilization as well as pests and disease management. This consequently exacerbates soil nutrient depletion resulting into reduced crop yields.

Table: Major rotations practiced in Matanda irrigation scheme

Season I	Season II	Rice	Cereal/Legume	Coffee/Banana
		Percentage response per typology		
Maize	Beans	18.8	18.5	22.2
Beans	Maize	12.5	16.0	33.3
Beans	Millet	12.5	14.8	11.1
Maize	Millet	43.8	14.8	0.0
Maize	Groundnuts	0.0	1.2	22.2
Beans	Groundnuts	6.3	16.0	0.0
Groundnuts	Beans	0.0	3.7	11.1
Groundnuts	Maize	0.0	1.2	0.0
Groundnuts	Millet	6.3	1.2	0.0
Millet	Beans	0.0	7.4	0.0

1.2.2.2 Intercropping

Like for crop rotation, intercropping is a common cultural practice by the farmers in both schemes in all the typologies. The farmers carrying out the practice are 95.7%, 94.0% and 95.0% for Rice, Cereal/Legume and Coffee/Banana, in Matanda.

Table: Percentage of farmers practicing intercropping

Typology	Percentage
Rice	95.7
Cereal/Legume	83.9
Coffee/Banana	95.0

Maize-Banana intercrop in Nyamabaare

There are various intercropping patterns used but the main ones are beans/maize and maize beans for Matanda

Table: Percentage of respondents practicing the common intercrops per typology

Main crop	Intercrop	Percentage practicing intercropping		
		Rice	Crereal/Legume	Coffee/ Banana
Beans	Maize	23.1	67.1	34.1
Maize	Beans	24.6	32.1	24.4
Groundnuts	Maize		12.1	9.8
Groundnuts	Beans		20.0	
Coffee	Beans			19.5
Coffee	Banana			26.3

1.2.3 Cropping calendars

Cropping calendars for robusta coffee, upland rice, maize, beans and groundnuts were generated through FGDs with the youth, female and male participants held in Matanda schemes. The data indicated minor variations for all the crop calendars across schemes and gender categories. Also, data for beans and groundnuts were related, and thus presented as one cropping calendar.

The discussions also revealed that there are a number of key activities which most of farmers either do not undertake or rarely do during the cropping cycle for all crops. These include purchase of improved seed, secondary weeding, pests and disease management and inorganic fertilizer application.

1.2.3.1 Robusta coffee production calendar

Pruning, de-suckering, mulching, second weeding, herbicide application, pests and disease management and inorganic fertilizer application are all either not practiced or minimally conducted and yet they directly affect productivity of the coffee.

Table: Cropping calendar for Robusta coffee

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Site selection												
Land clearing and preparation												
Nursery bed preparation												
Planting												
De-suckering												
Stumping												
Pruning												
First weeding												
Second weeding												
Pests and disease management												
Herbicides application												
Mulching												
Inorganic fertilizer application												
Harvesting season												
Drying												
Marketing												

Key

	Time period when activity is conducted
	Conducted by very few farmers
	Activity not performed in the area

Robusta coffee production

1.2.3.2 Upland rice production calendar

Farmers commonly use their home saved seed and rarely apply fertilizers. In addition, second weeding, as well as pests and diseases management are not usually undertaken by the rice farmers (Table 12).

Table: Cropping calendar for upland rice

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Site selection												
Land clearing and preparation												
1st Ploughing												
Seed acquisition												
Planting												
1st Fertilizer application												
2nd Fertilizer application												
First weeding												
Second weeding												
Pests and disease management												
Bird scaring												
Harvesting season												
Drying and bulking												
Marketing												

Key

	Time period when activity is conducted
	Conducted by very few farmers
	Activity not performed in the area

Rice cultivation in Kihiihi lowland

1.2.3.3 Maize production calendar

Like for rice, maize producers commonly use home saved seed and seldomly apply fertilizers. Also, second weeding, and pests and diseases management are not conducted by the maize farmers (Table 13).

Table: Cropping calendar for maize

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Site selection												
Land clearing and preparation												
1st Ploughing												
Seed acquisition												
Planting												
1st Fertilizer application												
2nd Fertilizer application												
First weeding												
Second weeding												
Pests and disease management												
Harvesting season												
Drying, winnowing sorting & bulking												
Marketing												

Key

	Time period when activity is conducted
	Conducted by very few farmers
	Activity not performed in the area

Unweeded maize crop in Rushaka village, depicting future low yields

1.2.3.4 Dry beans and groundnuts production calendar

As for rice and maize, farmers mainly use home saved seed and do not apply fertilizers. Besides, second weeding, and pests and diseases management are not usually conducted by the farmers during bean and groundnuts production (Table 14).

Table: Cropping calendar for dry beans and groundnuts

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Site selection												
Land clearing and preparation												
1st ploughing												
Seed acquisition												
Planting												
Fertilizer application												
First weeding												
Second weeding												
Pests and disease management												
Harvesting season												
Drying, winnowing sorting & bulking												
Marketing												

Key

	Time period when activity is conducted
	Conducted by very few farmers
	Activity not performed in the area

1.3 Value Chain Actors in the command area

1.3.1 Technical advisory services

Farmers received capacity building support on different issues from a number of organizations (Table 15). However, across the issues supported, the percentage of farmer beneficiaries is less than average, and the service was provided by NAADS and the District Local Government (DLG) and Raising A village NGO. Worse still, no farmer mentioned to have received support of insurance (Table 15).

Table: Percentage of farmers who received trainings on different issues and respective support institutions

Type of support	Percentage of farmers receiving the support	
	%	Institutions providing the support
Crop production training	46.7	NAADS, DLG, Churches, Raising A village NGO, Micro finance Kadevi, USAID, Coffee shop, UCDA, R.T.V, OWC, NARO, Farm Africa
Post-harvest training	28.8	NAADS, DLG, Raising A village NGO, USAID, Coffee shop, UCDA, R.T.V, OWC, Farm Africa, Coffee Academy, Tobawo Shop
Irrigation	6.6	NAADS, DLG, Raising A village NGO, Church
Marketing	21.3	NAADS, DLG, Raising A village NGO, USAID, Coffee shop, Cooperative, R.T.V, OWC, Bank, Farm Africa, Coffee Academy
Market information	2.8	NAADS, Radio, Raising A village NGO,
Financial training	30.2	NAADS, Raising A village NGO, AWEC, Coffee Academy, SACCO and VSLA
Insurance	0.0	
Business Development	11.3	NAADS, USAID, Raising A village NGO,

1.3.2 Agro-input dealers

The agro dealers whose businesses are located in the project area purchase inputs from wholesalers majorly in container village in Kampala, and sell them mainly to individual farmers. In addition, the agro dealers offer advisory services to the farmers. The major inputs stocked by input suppliers and demanded by the farmers are pesticides followed by spray pumps, while herbicides and fertilizers are least demanded as they are considered to be expensive especially for the small-scale farmers in the area. Although the farmers mentioned and use improved seed, this is normally home saved which they recycle for the subsequent planting, thus it is stoked in low quantities by the agro dealers. Worse still, agro-dealers rarely stock water for production inputs. Generally, the volume of agro inputs demanded by the farmers during a normal season is more than three times to that of bad season.

1.3.3 Produce buyers/traders

Farmers in both schemes across the typologies and commodities usually sell their produce individually and mainly to village traders (Table 16). The latter in turn sell mainly to large buyers who majorly deal in grains and pulses such as maize, beans, groundnuts, millet etc. Both the village traders and large buyers purchase and sell produces using informal arrangements. Most of the large buyers have warehouses located within the project area and sell to major markets in Kampala, Rwanda and Tanzania although some sell to schools and hotels in Kanungu district. Some of the traders also offer services of processing, and market information on commodity pricing and marketable products.

Table: Buyers of farmer produce

Commodity	Buyer	Rice	Cereal/ Legume	Coffee/ Banana
Rice	Village trader	69.7	62.3	71.4
	Wholesaler	27.3	35.1	21.4
	Others	3.0	2.6	7.1
Beans	Village trader	89.7	71.7	65.0
	Institution	0.0	0.0	0.0
	Wholesaler	6.9	24.2	25
	Others	3.4	4.0	10
Maize	Village trader	87.8	71.4	76.8
	Institution	2.4	1.0	1.9
	Wholesaler	7.3	24.5	17.4
	Others	2.4	3.1	3.9
Coffee	Village trader	76.5	55.1	50.0
	Institution	8.8	2.2	0.0
	Wholesaler	14.7	40.4	20.8
	Others		2.2	29.2
Millet	Village trader	100	76.0	83.3
	Institution	0.0	0.0	0.0
	Wholesaler	0.0	24.0	16.7
Ground nuts	Village trader	81.8	52.9	54.5
	Wholesaler	18.2	37.3	18.2
	Others	0.0	9.8	27.3

1.3.4 Financial Services

The team identified a number of Financial Service Providers (FSPs) that include Commercial banks, SACCOs, Farmer groups, and VSLAs. SACCOs provide loans to more farmers than any other category in Matanda with respective percentages of 37.8 and 35.3. In contrast, the findings show that only 9.1% of the individual respondents from Matanda access loans from commercial banks (Table 17). It was reported by the key informants that the entire watershed covering Matanda, has only Stanbic bank, while in the districts there are other banks such as Centenary and post banks, but these are located in Kanungu town which is about 30Km from the command area. On the other hand, SACCOs, Farmer Groups and VSLAs are located within the community. On average, farmers pay interest per year of 43.2% from the informal organisations i.e., Farmer Groups and VSLAs, while commercial banks the interest rate is 24%. However, the majority of farmers do not access credit from commercial banks due to a lot of stringent conditions that are not readily affordable by small scale farmers.

Table: Sources of credit for the farmers

Credit source	Matanda
Commercial banks	9.1
SACCOs	37.8
NGOs	2.2
VSLAs	14.1
Farmer Groups	29.1
Other sources like fellow farmers	16.3

1.4 Marketing and Market Orientation of Crop commodities in Matanda and Enengo Irrigation schemes

1.4.1 Market orientation

The degree of marketing constitutes a key component of the farming system classification (Doppler, 2001). The level of market orientation gives insight into the openness of the farming system to the outside world. A farming system with high degree of market orientation may motivate use of high yielding varieties, augement production with commercial inputs such as water, and predispose favourable attitudes towards information and innovations (Rogers, 1962). A well-developed marketing system induces development in a region thereby improving sustainability of the system and livelihoods of farmers (Doppler, 2002).

The degree of market orientation in the two irrigation schemes that were studied is presented in Table 20. The orientation to marketing was determined by establishing the share of value of farm production that is sold and what is used to meet the subsistence consumption of the family. In both irrigation schemes, the share of rice, coffee, millet and tomatoes was consistently above 50% (Table 18). These are crops with high commercial potential.

Table: The percentage of farm produce that is sold in the household in the two irrigation schemes

Crop sold	%
Rice	55.5
Beans	19.0
Maize	29.5
Coffee	80.2
Millet	45.3
Ground nuts	8.25
Tomatoes	55.9

1.4.2 Market prices

The price of a good or service is what it costs the buyer to acquire it from the seller; the same price is what the seller rewards for giving up its property rights on the good or service. Technically, price is the value expressed in terms of some exchanged commodity. Prices are important to market participants, a decisive factor in agent decisions, since they simplify evaluation of complex transactions, and hence contribute to greater efficiency in their maximization of utility. Therefore, prices represent a very compact way of summarizing information about demand/supply conditions for efficient communication. Price in a market economy plays three important roles namely equilibrating, allocating and rationing (distributive).

The market prices of different agricultural commodities in Matanda command areas are presented in Table 21. In all the command areas, coffee were consistently priced highest per kg of produce compared to maize on the other hand which registered the lowest unit per produce (Table 21). Because of this low prices, maize in all the analysis posted negative gross margins and return to variable costs. The second best priced commodity is rice commodity. Overall all the market price for all commodities averaged above 1000 UGX with the exception of maize and banana commodities (Table 19).

Table: The average market prices of different crop commodities in two irrigation schemes

Commodity	Price (Shs/kg)
Rice	1791
Beans	541
Maize	571
Coffee	**3740**
Millet	1750
Ground nuts	988
Tomatoes	1200
Bananas	988
Cabbage	300

1.4.3 Marketing margins

Market performance is the composition of end results in the dimensions of price, output, production cost, selling cost, product design which enterprises arrive at in any market as the consequences of pursuing whatever lines of conduct they espouse. It refers to the extent to which markets result in outcomes that are deemed good or preferred by society.

Regular and predictable availability of basic commodities at affordable prices is generally considered a desirable outcome. Other desirable outcomes would be that traders do not obtain excessive profits, and that commodities meet certain sanitary standards. In addition, prices paid by consumers should not be excessively above the cost of marketing, processing and transaction costs for a given commodity, and the prices received by producers should cover their costs of production.

Price levels and stability (long-run, short-run and through space), profits margins and costs volumes within the market are some indicators of market performance. There are large differences between prices paid by consumers and prices received by farmers compared to marketing, processing and transaction costs for a given commodity. This indicates that produce buyers or processors are underpaying households that produce agricultural commodities and/or overcharging households that buy food commodities for consumption. These two phenomena reduce incomes of agricultural households and food access for households that depend on the market as a source of food, exposing them to food insecurity.

This issue was examined in the Matanda command areas. The marketing costs and marketing profit margins are presented in Table 22. In both command areas, commodities such as rice, beans, coffee and tomatoes registered positive marketing profit margins. Meanwhile maize and millet posted inconsistent marketing profit margins in the various locations (Table 20). These fluctuations in profit margins would put at risk the actors in these commodity value chains.

Table: Marketing margins of commodities in the different schemes

Marketing activity	Matanda
Rice	
Market search (UGX)	15061
Trading licence (UGX)	24836
Storage costs (UGX)	15906
Transport (UGX)	32567
Total Market costs rice (UGX)	**88370**
Sales revenues (UGX)	*318878*
Rice market profit margin (UGX)	**230508**
Market margin	72.3
Beans	
Market search(UGX)	7653
Trading licence (UGX)	9667
Storage costs(UGX)	15263
Transport(UGX)	9761
Total Market costs beans (UGX)	**42344**
Sales revenue(UGX)	170050
Beans market profit margins(UGX)	**127706**
Market margin (%)	75.1
Maize	
Market search(UGX)	13144
Trading licence (UGX)	10235
Storage costs(UGX)	15680
Transport (UGX)	15585
Total Market costs maize (UGX)	**54644**
Sales Revenues(UGX)	*99944*
Maize market profit margin s	**45300**
Market margin (%)	45.3
Coffee	

Marketing activity	Matanda
Promotion (UGX)	13666
Market search(UGX)	39554
Trading licence (UGX)	19469
Storage costs(UGX)	41893
Transport (UGX)	33326
Total Market costs coffee (UGX)	**147908**
Sal;es Revenues (UGX)	*640119*
Coffee market profit margin (UGX)	**492211**
Market margin (%)	76.9
Millet	
Market search (UGX)	7366
Trading licence (UGX)	2928
Storage costs(UGX)	10516
Transport(UGX)	6363
Total Market costs millet (UGX)	**27173**
Sales revenues (UGX)	*72054*
Millet market profit margin(UGX)	**44881**
	62.3
Ground nuts	
Market search (UGX)	7888
Trading licence (UGX)	4222
Storage costs (UGX)	6705
Transport (UGX)	20831
Total Market costs ground nuts (UGX)	**39646**
Revenues (UGX)	*162332*
Ground nut market profit margin(UGX)	**122686**
Market margin (%)	75.6
Tomatoes	
Market search (UGX)	16666
Trading licence (UGX)	20111
Storage costs (UGX)	19388
Transport (UGX)	19000
Total Market costs tomatoes (UGX)	**75165**
Revenues (UGX)	*235720*
Tomatoes market profit margins(UGX)	**160555**
Market margin (%)	68.1

1.5 Gross Margin Anayses of commodity Enterprises in Matanda Irrigation Scheme

The economic performance of the enterprises or systems derives from the types and quantities of inputs used as well as the levels of innovations applied. Some of the economic tools to aid decision-making include gross margins, profitability, and costs analysis. However, due to the limited availability of detailed information on farm production in rural settings, tools such as net profitability are rendered incapable for comparing farm enterprises. To overcome such deficiencies, gross margin is always preferred over the other tools in assessing the efficiency of enterprises and the systems.

Gross margin provides parameters for resource use efficiency as it determines the enterprise's contribution towards the fixed costs and profits after variable costs have been paid. Thus gross margin analysis thus allows the comparisons of the performance of enterprises. Gross margins were calculated as the difference between total annual revenues and annual variable costs for the agricultural year 2018.

The gross revenues were calculated as the total value of products valued (computed) at farm gate prices irrespective of whether the products were consumed in the home or sold in the market. Variable costs include cost of inputs such as seed, manure, pesticide, hired labour, transportation, and land and equipment rental rates.

The major crops that were considered are banana, coffee, rice, maize, tomatoes, groundnuts, millet and beans as these were the crops that were mainly grown as pure stands and costs of production could appropriately be allocated to them.

1.5.1 Gross margin analysis of different crop typologies Matanda

1.5.1.1 Rice dominated crop typology

This typology had a number of crops under different cropping systems in Matanda command area namely; monocrops and inter crops. Under monocrops farmer grew rice and beans. While under intercrop systems, farmers grew beans and maize in various combinations.

Under the rice dominated typology rice had positive gross margins posting high returns to input and labour costs of 336% and beans was negative registering a return of -9% (Table 21). On the other hand, all the main crops and intercrops registered positive gross margins (Table 21).

Table: Gross margin analysis of existing of crops under mono and intercrops in rice dominated crop typology in Matanda irrigation scheme during 2019

Variable	Monocrops system		Intercrop system	
Main crop	**Rice**	**Beans**	**Beans**	**Maize**
Inputs				
Seeds/seedlings/suckers	245000	135000	90000	80000
herbicides	0	0	0	0
manure	0	0	0	0
fertilizers	0	0	0	0
Pesticides	0	0	0	0
mulching grass	0	0	0	0
stakes/ support woods	0	0	0	0
Sub total Input costs	***245,000***	***135,000***	***90,000***	***80,000***
Labour costs				
Land rent per season				
Land clearing	150,000	155,000	75,000	50,000
Nursery bed preparation				
1st ploughing	119,091	96,563	48,000	51,000
2nd ploughing				
Harrowing				
Leveling and patching	134,667	73,191	35,000	35,000
Planting/ Transplanting	50,333	43,750	43,750	35,625
1st Fertilizer application				
2nd Fertilizer application				
1st weeding	97,143	77,190	36,000	26,500
2nd weeding				
Pests and disease mgt (Spraying pesticides)				
Harvesting	82,727	62,074	31,000	61,991
Post-harvest handling			10000	
Sub total labour costs	***633,961***	***507,769***	***278,750***	***260,116***
Total variable costs	**878,961**	**642,769**	**368,750**	**340,116**
Yields (Kgs/Acre	2137.3	1,087	697	1,235
Prices (UGX/Kg)	1791	541	541	751
Gross Revenue (UGX)	**3,827,904**	**588,067**	**377,309**	**927,485**
Gross margins (UGX/ acre)	2,948,943	- 54,701	8,559	587,369
Return to costs (%)	336	-9	2	173
Intercrop			Maize	bean
Inputs				
Seeds/seedlings/suckers			80000	90000
herbicides			0	0
manure			0	0

fertilizers			0	0
Pesticides			0	0
mulching grass			0	0
stakes/ support woods			0	0
Sub total Input costs			***80,000***	***90,000***
Labour costs				
Land rent per season				
Land clearing			75,000	70,000
Nursery bed preparation				
1st ploughing			43,000	40,000
2nd ploughing				
Harrowing				
Leveling and patching			35,000	35,000
Planting/ Transplanting			20,000	43,750
1st Fertilizer application				
2nd Fertilizer application				
1st weeding			36,000	33,000
2nd weeding				
Pests and disease mgt (Spraying pesticides)				
Harvesting			31,000	62,074
Post-harvest handling			10000	10000
Sub total labour costs			***250,000***	***293,824***
Total variable costs			**330,000**	**383,824**
Yields (Kgs/Acre			646	1,087
Prices (UGX/Kg)			751	541
Gross Revenue (UGX)			**485,200**	**588,067**
Gross margins (UGX/ acre)			155,200	204,243
Return to costs (%)			47	53

1.5.1.2 Legume /field crop dominated typology

This typology had a number of crops under different cropping systems in Matanda command area namely; monocrops and inter crops. Under monocrops farmer grew rice and millet. While under intercrop systems, farmers grew beans, maize and ground nuts in various combinations.

Under the legume/field crop dominated typology rice and millet all had positive gross margins posting high returns to input and labour costs of 288% and 214%, respectively (Table 21). Similarly, all the intercrops registered positive gross margins (Table 21). All the main crops reported positive gross margins except maize and ground nuts (Table 21).

Table: Gross margin analysis of existing crops under mono and intercrops in legume/field crop dominated typology in Matanda irrigation scheme during 2019

Variable		Monocrops		Intercrop			
Main crop		**Rice**	**millet**	**beans**	**Maize**	**Gnuts**	**Gnuts**
Inputs							
Seeds/seedlings/suckers		245000	125000	90000	80000	150000	150000
herbicides		0	0	0	0	0	0
manure		0	0	0	0	0	0
fertilizers		0	0	0	0	0	0
Pesticides		0	0	0	0	0	0
mulching grass		0	0	0	0	0	0
stakes/ support woods		0	0	0	0	0	0
Sub total Input costs		***245,000***	***125,000***	***90,000***	***80,000***	***150,000***	***150,000***
Labour costs							
Land rent per season							
Land clearing		150,000		75,000	50,000		
Nursery bed preparation							
1st ploughing		119,091	113,333	48,000	51,000	106,000	106,000
2nd ploughing							
Harrowing							
Leveling and patching		134,667	84,375	35,000	35,000	83,077	83,077
Planting/ Transplanting		50,333	20,000	43,750	35,625		
1st Fertilizer application							
2nd Fertilizer application							
1st weeding		97,143	50,000	36,000	26,500	45,000	45,000
2nd weeding							
Pests and disease mgt (Spraying pesticides)							
Harvesting		82,727	72,158	31,000	61,991	42,600	42,600
Post-harvest handling				10000			
Sub total labour costs		***633,961***	***339,866***	***278,750***	***260,116***	***276,677***	***276,677***
Total variable costs		**878,961**	**464,866**	**368,750**	**340,116**	**426,677**	**426,677**
Yields (Kgs/Acre		1902	834	814	896	803	990
Prices (UGX/Kg)		1791	1,750	541	571	3,512	3,512
Gross Revenue (UGX)		**3,406,482**	**1,460,200**	**440,347**	**511,502**	**2,819,434**	**3,476,880**
Gross margins (UGX/ acre)		2,527,521	995,334	71,597	171,386	2,392,757	3,050,203
Return to costs (%)		288	214	19	50	561	715
Intercrop				**Maize**	**Bean**	**Maize**	**Bean**
Inputs							
Seeds/seedlings/suckers				80000	90000	80000	90000
herbicides				0	0	0	0

manure				0	0	0	0
fertilizers				0	0	0	0
Pesticides				0	0	0	0
mulching grass				0	0	0	0
stakes/ support woods				0	0	0	0
Sub total Input costs				***80,000***	***90,000***	***80,000***	***90,000***
Labour costs							
Land rent per season							
Land clearing				75,000	70,000	75,000	70,000
Nursery bed preparation							
1st ploughing				43,000	40,000	43,000	40,000
2nd ploughing							
Harrowing							
Leveling and patching				35,000	35,000	35,000	35,000
Planting/ Transplanting				20,000	43,750	20,000	43,750
1st Fertilizer application							
2nd Fertilizer application							
1st weeding				36,000	33,000	36,000	33,000
2nd weeding							
Pests and disease mgt (Spraying pesticides)							
Harvesting				31,000	62,074	31,000	62,074
Post-harvest handling				10000	10000	10000	10000
Sub total labour costs				***250,000***	***293,824***	***250,000***	***293,824***
Total variable costs				**330,000**	**383,824**	**330,000**	**383,824**
Yields (Kgs/Acre				947	549	590	517
Prices (UGX/Kg)				571	541	571	541
Gross Revenue (UGX)				**540,851**	**296,956**	**336,890**	**279,586**
Gross margins (UGX/ acre)				210,851	- 86,868	6,890	- 104,238
Return to costs (%)				64	-23	2	-27

1.5.1.3 Coffee/ Banana typology

This typology had a number of crops under different cropping systems in Matanda command area namely; monocrops and inter crops. Under monocrops farmer grew Coffee, bananas and millet. While under intercrop systems, farmers grew beans, maize, coffee, and ground nuts in various combinations.

Under the rice dominated typology all the considered crops namely; coffee, bananas and millet all had positive gross margins posting high returns to input and labour costs of 238%, 8% and 69% respectively (Table 23).

In terms of intercrops, all the intercrops registered negative gross margin except maize (Table 23). All the main crops reported positive gross margins except beans (Table 23). Overall intercrops though widely practiced are not an economically viable option.

Table: Gross margin analysis of existing of crops under mono and intercrops in Coffee/Banana dominated crop typology in Matanda irrigation scheme during 2019

Variable	Monocrops				Intercrop				
					beans +Maize	Maize + Beans	Coffee+Banana	Coffee +beans	Gnuts +maize
Main crop		**Coffee**	**Banana**	**Millet**	**Beans**	**Maize**	**Coffee**	**Coffee**	**Gnuts**
Inputs									
Seeds/seedlings/suckers		220000	528,000	125,000	90,000	80,000	220,000	175,000	150,000
herbicides		0		0	0	0	0	0	0
Manure		0	400,000	0	0	0	0	0	0
Fertilizers		0		0	0	0	0	0	0
Pesticides		0		0	0	0	0	0	0
Mulching grass		0	150,000	0	0	0	0	0	0
Stakes/ support woods		0	70,000	0	0	0	0	0	0
Sub total Input costs		***220,000***	***1,148,000***	***125,000***	***90,000***	***80,000***	***220,000***	***175,000***	***150,000***
Labour costs									
Land rent per season									
Land clearing		114,285.7	85,714.3		75,000	50,000	114,285.7	114,285.7	
Nursery bed preparation		125,625	50,000				125,625	125,625	
1st ploughing		141,200	121,428.6	113,333	48,000	51,000	141,200	141,200	106,000
2nd ploughing									
Harrowing									
Leveling and patching		92,222.2	60,000	84,375	35,000	35,000	92,222.2	922,22.2	83,077
Planting/ Transplanting		106,136.4	88,529.4	20,000	43,750	35,625	106,136.4	106136.4	
1st Fertilizer application									
2nd Fertilizer application									
1st weeding		92,291.7	79,705.9	50,000	36,000	26,500	92,291.7	92,291.7	45,000
2nd weeding									
Pests and disease mgt (Spraying pesticides)									
Harvesting		113225.8	93181.8	72,158	31,000	61,991	113225.8	113225.8	42,600
Post-harvest handling		89285.7	73428.6		10000		89285.7	89285.7	
Sub total labour costs		***874,272***	***651,989***	***339,866***	***278,750***	***260,116***	***874,272***	***874,272***	***276,677***

Total variable costs		**1,094,272**	**1,799,989**	**464,866**	**368,750**	**340,116**	**1,094,272**	**1,049,272**	**426,677**
Yields (Kgs/Acre		988	1976	449	633	922	1,294	988	988
Prices (UGX/Kg)		3,740	988	1,750	541	571	3,740	3,740	3,512
Gross Revenue (UGX)		**3,695,120**	**1,952,288**	**785,750**	**342,679**	**526,519**	**4,840,682**	**3,695,120**	**3,470,910**
Gross margins (UGX/ acre)		2,600,848	152,299	320,884	- 26,071	186,403	3,746,410	2,645,848	3,044,233
Return to costs (%)		238	8	69	-7	55	342	252	713
Intercrop					**Maize**	**bean**	**banana**	**bean**	**Maize**
Inputs									
Seeds/seedlings/suckers					80000	90000	240000	90000	80000
Herbicides					0	0		0	0
Manure					0	0	200000	0	0
Fertilizers					0	0		0	0
Pesticides					0	0		0	0
Mulching grass					0	0	750000	0	0
Stakes/ support woods					0	0	30000	0	0
Sub total Input costs					***80,000***	***90,000***	***1,220,000***	***90,000***	***80,000***
Labour costs									
Land rent per season									
Land clearing					75,000	70,000		70,000	75,000
Nursery bed preparation							50000		
1st ploughing					43,000	40,000	121428	40,000	43,000
2nd ploughing									
Harrowing									
Leveling and patching					35,000	35,000	60000	35,000	35,000
Planting/ Transplanting					20,000	43,750	88529	43,750	20,000
1st Fertilizer application									
2nd Fertilizer application									
1st weeding					36,000	33,000	79705.8824	33,000	36,000
2nd weeding									
Pests and disease mgt (Spraying pesticides)									
Harvesting					31,000	62,074	93181.8182	62,074	31,000
Post-harvest handling					10000	10000	73428.5714	10000	10000
Sub total labour costs					***250,000***	***293,824***	***566,273***	***293,824***	***250,000***

Total variable costs					**330,000**	**383,824**	**1,786,273**	**383,824**	**330,000**
Yields (Kgs/Acre					549	329	639.2	329	494
Prices (UGX/Kg)					751	541	988	541	571
Gross Revenue (UGX)					**412,259**	**178,184**	**631,530**	**178,184**	**282,074**
Gross margins (UGX/ acre)					82,259	205,640	- 1,154,744	- 205,640	- 47,926
Return to costs (%)					25	-54	-65	-54	-15

1.6 Potential commercial crop enterprises

Gross margin provides parameters for resource use efficiency as it determines the enterprise's contribution towards the fixed costs and profits after variable costs have been paid (Kay and Edwards, 1999). Thus gross margin analysis thus allows the comparisons of the performance of different enterprise under different scenarios.

To make a decision on which enterprises provides economic potential, gross margins analyses were calculated as the difference between total annual revenues and annual variable costs for the agricultural year 2018 under the scenario where optimal production were considered such as irrigation water, good agronomic practices and good post-harvest handling practices.

The gross revenues were calculated as the total value of products valued (computed) at farm gate prices irrespective of whether the products were consumed in the home or sold in the market. Variable costs include cost of inputs such as seed, manure, pesticide, hired labour, transportation, and land and equipment rental rates. The crops with good commercial potential that were considered are, coffee, rice, tomatoes, beans and ground nuts as these were the crops that were mainly grown as pure stands and costs of production could appropriately be allocated to them. Maize was included as a check/control since from above it was already deemed non-viable enterprise under prevailing farm conditions.

1.6.1 Matanda recommended crops

The gross margin analysis of the different crops under good agronomic practices supplemented with irrigation water is presented in Table 27. With the exception of maize and beans all the other crops posted a positive gross margin and positive return to variable costs (Table 27).

Based on the gross margin analysis in (Table 27), focus group discussion on markets and profitability as well as key informants; Rice, Coffee, Groundnuts, Tomatoes, carrots, watermelons and green pepper as well as cabbages are recommended as suitable crops for Matanda Irrigation scheme.

Table: Gross margin analysis of various crops with recommended practices for Matanda irrigation command area

Variable	Rice	Maize	G/nuts	Beans	Banana	Coffee	Tomatoes	Carrots	Watermelons	Pepper	Cabbage
Inputs											
Seeds/seedlings/suckers	360,000	87,500	157,500	70,000	440,000	440,000	30,000	400,000	250,000	30,000	1,500,000
herbicides	40,000	200,000	-	20,000	-	2,020,000	-	20,000	-	-	-
manure	-	500,000	-	500,000	3,750,000	3,750,000	600,000	3,750,000	500,000	500,000	250,000
fertilizers	500,000	750,000	1,580,000	1,750,000	-	1,171,750	750,000	-	1,250,000	1,750,000	1,750,000
Pesticides	153,000	150,000	300,000	90,000	45,000	444,000	465,000	150,000	45,000	75,000	22,500
mulching grass					250,000						
stakes/ support woods					400,000		400,000		400,000		
Sub total Input costs	***1,053,000***	***1,687,500***	***2,037,500***	***2,430,000***	***4,885,000***	***7,825,750***	***2,245,000***	***4,320,000***	***2,445,000***	***2,355,000***	***3,522,500***
Labour costs											
Land clearing	150,000	120,000	100,000	120,000			100,000	110,000	100,000	110,000	100,000
Nursery bed preparation	100,000						100,000	110,000	100,000	100,000	100,000
1st ploughing	150,000	120,000		120,000			140,000	140,000	140,000	140,000	140,000
2nd ploughing	120,000	100,000	10,000	100,000			140,000	140,000	140,000	140,000	140,000
Harrowing	70,000		80,000								
Mulching			80,000		300,000	300,000	250,000		250,000		
Prunning			50,000		50,000	50,000					
De-suckering					35,000	35,000					
Leveling and patching	50,000		50,000					100,000			
Planting/ Transplanting	100,000	80,000	50,000	100,000	80,000	80,000	50,000	50,000	50,000	50,000	50,000
1st Fertilizer application	50,000	50,000	40,000	50,000	80,000	80,000	70,000	70,000	70,000	70,000	70,000
2nd Fertilizer application	50,000	50,000	90,000		80,000	80,000					
Herbicide application	10,000	10,000	148,500	10,000	10,000	10,000					
1st weeding	150,000	60,000	60,000	80,000	80,000	80,000	70,000	70,000	70,000	70,000	70,000
2nd weeding	100,000	60,000	60,000	80,000	100,000	100,000	70,000	70,000	70,000	70,000	70,000
Pests and disease mgt (Spraying pesticides)	138,000	25,000	25,000	50,000	250,000	250,000	25,000	25,000	25,000	25,000	25,000
Digging of holes					300,000	300,000					

Bird scaring	300,000										
Harvesting	250,000	50,000	50,000	40,000	250,000	250,000	50,000	50,000	50,000	50,000	50,000
Drying	35,000	50,000	50,000	40,000	200,000	200,000					
Threshing /shelling	200,000	320,000	320,000	90,000							
Mraketing costs	330,000	528,000	528,000	148,500	264,000	264,000	240,000	240,000	240,000	240,000	200,000
Sub total labour costs	***2,353,000***	***1,623,000***	***1,791,500***	***1,028,500***	***2,079,000***	***2,079,000***	***1,305,000***	***1,175,000***	***1,305,000***	***1,065,000***	***1,015,000***
Total variable costs	**3,406,000**	**3,310,500**	**3,829,000**	**3,458,500**	**6,964,000**	**9,904,750**	**3,550,000**	**5,495,000**	**3,750,000**	**3,420,000**	**4,537,500**
Yields (Kgs/Acre	2,500	2,000	1,800	2,000	10,000	3,750	8,000	10,000	13,000	8,000	15,000
Prices (UGX/Kg)	1,791	549	2,500	1,684	700	3,845	900	1,000	500	800	400
Gross Revenue (UGX)	**4,477,500**	**1,098,000**	**4,500,000**	**3,368,000**	**7,000,000**	**14,418,750**	**7,200,000**	**10,000,000**	**6,500,000**	**6,400,000**	**6,000,000**
Gross margins (UGX/ acre)	1,071,500	-2,212,500	671,000	-90,500	36,000	4,514,000	3,650,000	4,505,000	2,750,000	2,980,000	1,462,500
Return to costs (%)	31	-67	18	-3	1	46	103	82	73	87	32

1.7 CONSTRAINTS EXPERIENCED BY THE FARMERS IN THE COMMAND AREA

There are several production and post-harvest constraints experienced in the command area as indicated in Table 38. Under production, the major constraint is drought in Matanda as ranked number one by 95.7%. For post-harvest handling, the major constraint is prevalence of storage pests – ranked number one by 51.8% of the respondents in Matanda respectively (Table 29).

Table: Crop production and post-harvest constraints

Constraint	Percentage response by rank	
	1	2
Production constraints		
Drought	95.7	2.9
Floods	2.9	2.9
Labour shortage	0.4	13.5
Land shortage	0.4	27.4
Lack agro inputs	0.0	16.3
	0.0	3.4
Inadequate capital	2.4	20.2
Post-Harvest Constraints		
Inadequate storage facilities	41.2	29.4
Storage pests prevalence	51.8	61.2
Inadequate processing equipment	8.2	11.8
Lack chemicals for storage	1.8	2.8

1.8 CLIMATE SMART AGRICULTURE TECHNOLOGIES

1.8.1 Agro inputs use

The key agro inputs reported are improved seed, fertilizers, pesticide, herbicides and manure. Improved seed is used by majority of the farmers in both schemes for all typologies. Herbicides and pesticides usage are also relatively common in Matanda except under the Coffee/banana typology where the respective usage is 32.4% and 23.5%. However, use of mineral fertilizer is generally low in the scheme (Table 30). As for Matanda, use of improved seed. In addition, although low percentages of farmers use mineral fertilizers and pesticides under the rice and Cereal/Legume dominated fields, close to moderate use these inputs under the coffee dominated fields (Table 30). Similarly, near to moderate percentage of farmers use manure under the rice (36.8%) and Cereal/legume (40.0%) fields. Although most of farmers mentioned to use improved seed, they normally buy it once and recycle it for many seasons - normally as home saved in the subsequent planting, thus its demand is limited and consequently, stoked in low quantities by the agro dealers.

Table: Percentage of farmers using the different agro inputs

Agro Input	Percentage of households reported to be using the different inputs		
	Rice	Cereal/ Legume	Coffee/ Banana
Improved Seed	92.3	74.3	73.5
Mineral Fertilizer	15.4	27.2	17.6
Pesticide	53.8	44.5	32.4
Herbicide	59.0	45.5	23.5
Manure	28.2	23.5	38.2

1.8.2 Climate Smart Agriculture technologies in the command area

a. Production and Climate Smart Agriculture Technologies

There are several climate smart agriculture production practices/ technologies applied in the command area. In both schemes under all typologies, most of the farmers use the technologies related to Climate Smart Agriculture as indicated in Table 31.

Table: Percentage of farmers practicing Climate Smart Agriculture

Climate Smart Agriculture Technology	Matanda		
	Rice	Cereals/ legume	Coffee/Banana
Drought tolerant varieties	**66**	**68**	**80**
Early maturing varieties	**91**	**79**	**83**
Use of manure	96	98	75
Mulching	98	93	92
Zero tillage	91	78	80
Safe use and disposal of agro chemicals	84	76	93
Agro forestry	96	73	83

b. Storage and Climate Smart Agriculture Technologies

In the command area, farmers do not use modern technologies adaptable to climate change such as pics bags, cribs and silos for storage of their produce. In contrast, they commonly use ordinary bags. (Table 32).

Table: Storage practices used by the farmers

Storage facility	Rice	Cereals/legume	Coffee/Banana
Ordinary bags	96	91	93.0
Traditional granary	3.0	0.4	0.0
Pics bags	0.0	2.0	0.0
Cribs	3.0	0.4	0.0
Silos	0.0	0.0	0.0
Inside the house on bare floor	20.0	33	20

c. Post-Harvest Handling technologies and Climate Smart Agriculture

Tarpaulins are commonly used across the farm typologies in Matanda. In the former, the percentage usage of tarpaulins is 91.0, 70.0, and 95.0 of the respondents in the Rice, Cereal/Legume and Coffee/Banana dominated fields, respectively. In contrast, shellers and threshers are not popular among across typologies in Matanda irrigation scheme.

Table: Percentage of farmers using the different post-harvest technologies

Technology	Percentage usage		
	Rice	Cereals/legume	Coffee/Banana
Tarpaulin	91.0	70.0	95.0
Thresher	19.0	21.0	15.0
Sheller	14.0	13.0	7.5
Fumigant	40.0	37.0	35.0

1.9 GENDER AND DIVISION OF LABOR

Gender roles in production and marketing were investigated for the crops of rice, coffee, tomatoes, maize, beans and groundnuts using Focus Group Discussions (FGDs). The responses from both irrigation schemes were similar and are presented in figs 2, 3, 4, 5, 6 and 7. The results indicate that the marketing potential of a crop was found as key in determining the gender roles. Males dominate marketing of crops with high market potential i.e., rice and coffee. In contrast, maize, beans and groundnuts which have low value are majorly marketed by the females. Interestingly however, all the activities under the tomato enterprise youth dominated though the majority are males. Although rice and coffee marketing are male dominated, most of the ploughing and weeding are conducted by the females. Nakazi *et al* (2017) also found weeding as one of the major activities that women greatly participate in. Similarly, rice planting, harvesting and threshing activities are mainly carried out by the females. In addition, for the low value crops, all the production activities except site selection in maize cultivation are undertaken by the females. These findings concur with earlier report by Okali (2011), (UBOS 2012) and Ayalew *et al.* (2015) which reported that women in Uganda undertake the majority of agricultural work although they have limited control over production resources, as well as on their own labor and proceeds from sale of outputs. In contrast however, men highly participate in site selection, which could indirectly reveal that they are the land owners who always have to give permission before women can plant. The research further revealed that men offered support in a number of production related activities which required more energy as evidently noted on land clearing. This finding is in agreement with the findings of Nakazi et al (2017) who found men to be typically responsible for the heavier manual tasks such as land preparation.

The low value crops are mainly for household food security. According to McKenna (2014), women put their children and household food security first, and this makes them engage substantially in food crop production but through subsistence farming partly because they lack incentives to increase their production. In contrast, men generally get involved when the food security commodities become market oriented.

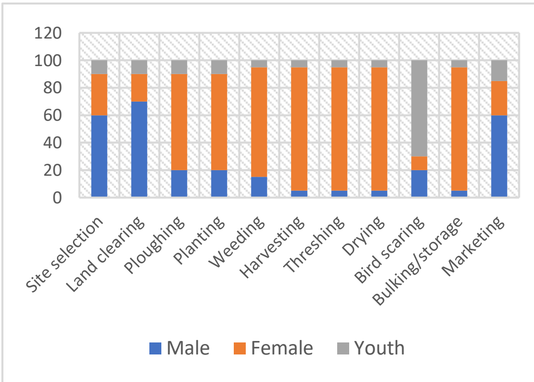

Figure: Gender roles in rice production and marketing

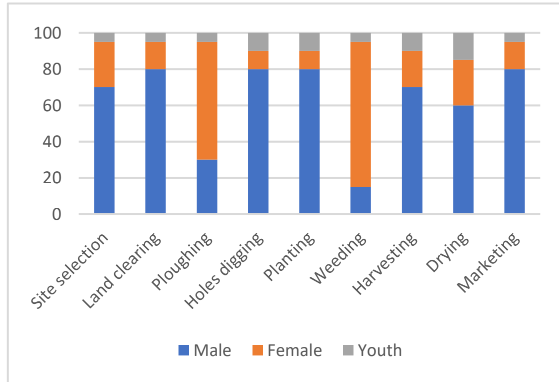

Figure: Gender roles in coffee production and marketing

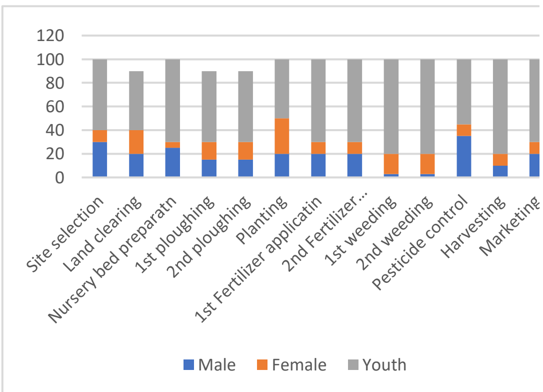

Figure: Gender roles in tomato production and marketing

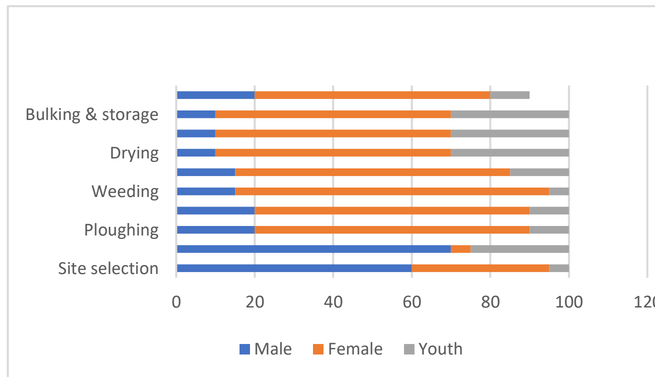

Figure: Gender roles in maize production and marketing

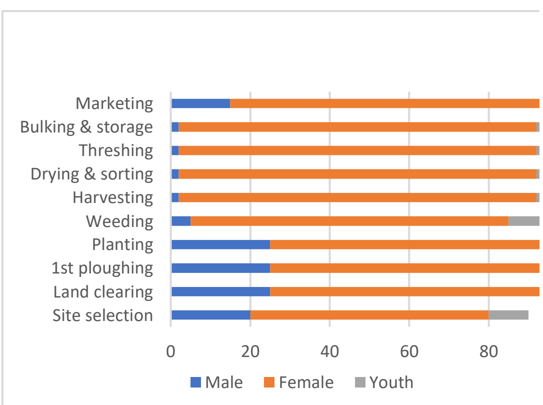

Figure: Gender roles in beans production and marketing

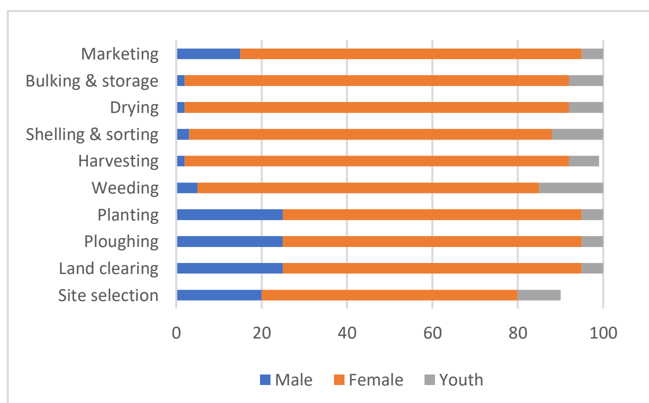

Figure: Gender roles in groundnuts production and marketing

1.10 CONCLUSIONS AND RECOMMENDATIONS

Agriculture is a mainstay for the households in the command area. However, yields for all the crops grown are very low compared to the potential. This is attributed to several factors. For instance, the current findings clearly indicated that farmers in the command area rely heavily on rainfed agriculture, which explains why drought is a prominent constraint faced by the farmers to increased and sustainable agriculture production in the project area. It was also revealed that crop pests and diseases are a major constraint. Besides, very few farmers are using productivity enhancing technologies such as improved and quality seed coupled with fertilizers. Worse still, it was noted that a number of recommended Good Agronomic Practices such as second weeding, pests and disease control and following appropriate crop rotation and intercropping pattern are not conducted by a number of farmers. As well, the farmers use rudimentary storage practices that exacerbate post-harvest losses.

The low yields coupled with high production costs in turn affect the net incomes from the crops produced. For instance, using the existing farming practices, the economic analysis showed that farmers' returns are either small or negative for a number of commodities.

Against this background, we recommend the following agronomic practices to increase, sustain and stabilize crop production in the project area:

a. The home saved seed currently being used has low viability, vigour and high pest and disease prevalence. Thus, on a seasonal basis, farmers need to access and use improved high-quality seed. The research organizations and institutes have been releasing high yielding and adapted crop varieties which are drought tolerant but also resistant to pests and diseases.
b. Relatedly, these seeds for improved crop varieties should be used in combination with other productivity enhancing technologies particularly fertilizers and pesticides but also labor-saving technologies such as herbicides and community tractor services. These inputs should be accessed from reputable agro input dealers to avoid use of counterfeit chemicals.
c. The farmers should adopt a full package of Good Agronomic Practices for all crops grown. This includes adoption of practices such as secondary weeding, integrated pests and disease management, among others. In addition, farmers should follow the recommended sequencing patterns of crop rotations and intercropping during production besides other cultural practices like timely planting and weeding.
d. The farmers need to adopt the use of improved storage technologies such as hermatic bags. Good quality storage is essential as it reduces commodity deterioration in both quantity and quality, while sustaining household food security. Furthermore, it allows owners of stocks to postpone the sale of those stocks until a time during the annual production, harvesting, and merchandising cycle when demand exceeds supply and favorable prices can be realized.
e. There is need to reduce reliance on rainfed agriculture by the farmers. Thus, government and development partners should support development of suitable irrigation systems by providing a conducive policy environment as well as supportive irrigation infrastructure.
f. Support investments in financing schemes: Low confidence by commercial banks in the sector which increases the level of risk and therefore the cost of finance. Financially, farmers do not have access to financial services that would allow them to get the working capital to purchase inputs on credit; and, for the agro-dealers part, the farmers' limited resources often force them to extend long payment terms. Design of programs to link farmers and agro dealers to farmer friendly banks as well as negotiating good friendly interest rates.

g. Support investments in Feeder roads to ease of movement of produce within the districts and within the region, efforts should be put to sourcing funding for local governments to expand and maintain rural road network in the irrigation areas.
h. Government and development partners should prioritize enterprises that have a potential for high economic returns like rice, tomatoes, coffee, millet and groundnuts.
i. To enhance adoption of the above, government, development partners and the private sector should collaborate to strengthen the extension system for the farmers to access the necessary knowledge and skills to ultimately sustain agricultural production in the command area.

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Key respondents interviewed

Name	Institution	Title	Contact
Owomuhanje Celeb	Local Government, Kanungu	District Commercial Officer	+256774154555
Mude John	Kihihi Farmers' Cooperative Society	Operations Manager	+256772551023
	Private -Processor	Owner	
Jovelet M	Rising the village	Operations Officer	Number not given
Sabbiti Dicky	Private sector	Trader	+256782002375
Turyamwesimira Dustun	Private sector	Trader	+256782363432
Kyatuhaire Charity	BRAC microfinance	Loans Officer	
Amutuhairwe Jane	Stanbic Bank	Credit Officer	
Habarurema Pascal	Input supplier Kihihi Town	Owner/Attendant	+256782445161
Nkwasibwe Godwin	Local Government	District Agriculture officer	
Hon: Henry Mwongera	Local government	Secretary production and natural resources	
Mugisha B	Local government - Kihihi Subcounty	Chairperson	+256701118637
Nasser Patrick	Local Government- Kihihi Town council	Parish Chief	+256757749828
Mugarura Micheal	Local Government- Nyakinoni Subcounty	Subcounty Agriculture Officer	+256774952620
Peter Turiyo	Kanungu	District Production Coordinator	+256775558370
Ambrose Ahabwe	Kanungu	Trader	+256783656884

APPENDIX K CHANCE FINDS PROCEDURE

A. **Purpose**

The purpose of this procedure is to ensure the protection of underground cultural heritage property within the project area including potential archaeological finds discovered during trench works for the Matanda Irrigation Scheme.

B. **Roles and Responsibility**

All MWE and contractor personnel operating within the Matanda irrigation scheme Project are responsible for the application of this procedure.

a) Ministry of Water and Environment

The Ministry guarantees the availability of the economic, human and technical resources needed to ensure that cultural property resources are preserved and protected. It contains Water for Production Department which will oversee the implementation of the schemes.

b) Contractor Firm

It is the responsibility of the manager of the company contracted to build the infrastructure to ensure that during trench work, all discovered cultural heritage property is preserved.

c) Contractor Supervisors

The supervisors are the competent persons acting for the Contractor Firm. They are the technicians who supervise the digging of trenches and laying of the pipes. They must report to the Contractor Manager (CM) any discovered archaeological finds.

d) Foremen

These report to the supervisors and lead the workers in carrying out their duties.

e) Workers

These carry out the tasks as directed by their foremen.

C. **Archaeological artefacts and Cultural Chance Finds**

During the period of the construction of the project infrastructure which involves excavations, it is possible that chance finds will be encountered. These may include the following:

- Archaeological heritage which has remained unnoticed in the past.
- An encounter with a grave containing human remains which the local residents may have not mentioned at the survey stage.

In order to avoid potential damage to cultural property discovered during construction, the following will apply:

- Workers must be vigilant to any relics found during excavation. In case of a discovery during the excavation, workers must report the findings to the foreman.
- The Foremen must stop immediately the work and communicate the findings to the Supervisor.
- The Supervisor then communicates the findings to the Contractor Manager.
- The Contractor Manager then reports to the Ministry of Water and Environment, Department of Water for Production.
- The Ministry of Water and Environment then notifies the Department of Monuments and Museum (Uganda Museum).
- Any further excavations or continuation of the infrastructure development at the site of the discovered heritage will be undertaken only with the approval of the Uganda government competent Authorities.
- Cultural heritage supervision and management during construction
- Chance find training, management and response
- Interface and coordination with relevant authorities
- Monitoring and reporting of intervention activities to recover and record cultural heritage values

The project activities will then continue after the following have taken place:

- In the case of archaeological artifacts discovery, the Uganda Museum will grant a period where specialists from the Department of Museums and Monuments excavate and curate the artifacts professionally.
- In the case of discovered human remains the police will have to be notified and either the remains are taken for forensic investigation or the LC1 authorities sanction the reburial of the remains at another location. The Contractor then meets the relocation and reburial expenses.

Appendix L CONTRACTOR ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

Plans	Relevance	Issues Covered
Environmental Management and Action Plan	The contractor guided by the ESMMP included in this report will have to update it, in relation to the present project commencement period.	▪ Noise and vibration levels mitigation and monitoring ▪ Construction dust mitigation and monitoring ▪ Pollution prevention and protection measures ▪ Design input on spill prevention/location/containment structures around sensitive equipment, installation of appropriate spill clean-up equipment and development of response procedures ▪ Assessment and measures to prevent pollutants to enter pathway at source ▪ Actions to be followed in case pollutants enter the pathway in order to avoid discharge ▪ Waste Management, including: ▪ Waste hierarchy (i.e. reduction at source, reuse, recycling, energy recovery, responsible disposal) and green procurement; ▪ Identification and classification of waste; ▪ Waste register; ▪ Waste handling (i.e. collection, segregation and containers, storage, treatment, transport and documentation, disposal); and Monitoring and reporting. ▪ Resource Management including: ▪ Objectives, targets, processes in place for resource efficiency ▪ Water abstraction, conservation, discharge measures ▪ Aggregate management planning ▪ Energy and fuel management
Land Acquisition Management Plan	The plan will guide land acquisition temporary construction of workers camps, storage yards, dumping sites spoil areas, quarry sites, and borrow sites in respect to the World Bank Operational Policy (OP) 4.12 on Involuntary Resettlement and the national legal framework on land acquisition.	▪ Evidence of ownership of the land ▪ Nature of agreements ▪ Evidence of payments ▪ Involvement of third parties like family members ▪ Registering acquired sites as work places if required ▪ Restoration of area
Subcontractors and Supply Chain Management Plan	The plan will guide procurement and vetting of all sub-contractors on the project.	▪ Roles & responsibilities of sub-contractors ▪ Includes key requirements extracted from above plans & procedures ▪ Need to develop subcontractor's relevant safeguard plans ▪ Establish Health, Safety and Environmental performance standards to monitor ▪ Monitoring and reporting to the main contractor ▪ Principles, methodology and acquisition of construction materials
Security Management Plan	Based on anticipated social misdemeanour, such a plan is sought to guide security protocols on the project specifically at the workers camp and storage yard.	▪ Security measures, particularly for the construction stage of the project ▪ Access control, registration, security briefings, involvement of LCs and Uganda Police, fencing of construction section in the vicinity of settlements or communities.

Plans	Relevance	Issues Covered
Mobilization plan	Once the project site is handed over to the contractor and before the Project commences, the contractor will need to mobilize all equipment, material, and personnel on site.	▪ Mobilization of the key staff ▪ Training and skill development activities ▪ Subcontractor employment practices conformance, reporting and monitoring ▪ Key Organization Plan, Recruitment and Career Development Procedure, Working Conditions, Disciplinary Procedure, Training Procedure, staff contracts, benefits ▪ Preparation of the Local Recruitment Procedure to address inter alia the following measures: ➢ Promotion of local recruitment at all levels of the Project and facilitating the qualification and recruitment of local candidates, for example with appropriate skills training. ➢ Information to the local population (e.g. through the Liaison Officers of the Project) about opportunities for employment. The recruitment will be monitored and reported by Contractors' HR Department and Sociologist. ➢ Maximize use of local subcontractors and suppliers. Information about work opportunities will be made available to the local population. ➢ Workers' community interaction behavioural code of conduct
Traffic Management Plan	A Traffic Management Plan that will regulate traffic throughout the construction phase. Issues of dust, traffic jam and noise are more so regulated by this plan in place. The plan will also help protect road users and workers and keep traffic delays to a minimum through proper and clear signage.	▪ Road traffic management including: site speed limits, vehicle inspection requirements, operating rules and procedures ▪ Local traffic signage ▪ Traffic accidents risk control ▪ Training of pedestrian workers to work safely around trucks and operating equipment and provide constant warnings to each other in the event of being in risky locations or conditions. ▪ Training of drivers and equipment operators ▪ Site Access Procedure ▪ Communication protocols and procedures ▪ Internal monitoring and reporting ▪ Vehicle Inspection Check List and Vehicle Movement Log Book ▪ Drivers/Operators Code of Conduct
Grievance Management Plan	The plan will bear a Grievance Redress Management (GRM) as safeguard procedure tool to manage grievances associated and which may come up during the project implementation. The plan will describe avenues for stakeholders and community members in the project area to lodge a complaint or express a grievance against the project, its staff or contractors during project implementation. It will also describe procedures, roles and responsibilities in the grievance management process.	The Human Resource management plan shall form a basic guideline for all workers so as to maintain a friendly, cooperative and healthy working environment. All workers shall be made aware of the guidelines upon their formal employment by the Human Resource Manager and Health & Safety Officer in an induction. Efforts shall be made to create conditions which enable staff to coordinate their work with their family life. Employees shall be required to maintain a high standard of conduct and work performance and this shall include; Observing all policies and procedures, treating colleagues with courtesy and respect, treating visitors and clients in a professional manner at all times, working safely at all times; and team work / Team Spirit. The contractor's Human Resource Manager shall make all employees aware of the recruitment policy and procedure, working time, medical examination and treatment, annual leave, maternity leave, paternity leave and sick leave, dismissal and disciplinary procedure among others.

Occupational Health and Safety Management Plan	The project construction phase may involve risks, an Occupation Health and Safety Management Plan needs to be developed so that these risks are outlined to every worker and mitigation and enhancement measures provided. It is good practise that accidents are mitigated on construction site well before they occur.	The main goal of Occupational Health and Safety management is to promote a safe and secure work environment through careful identification and management of hazards. It seeks to facilitate and empower workers and managers at all levels to participate in the avoidance, minimization and complete eradication of accidents and diseases associated with unsafe and insecure work places. It further seeks to enhance worker productivity through appropriate training and provision of tools that enhance performance, reduce lost time through accidents and limit material and financial losses arising from inappropriate equipment's, workers, methods and complacent personnel. The safety and health plan is designed to achieve the following specific objectives. a) Achieve Zero reporting of accidents of all sorts and near misses throughout the construction life span of the project; thereby eliminating losses resulting from injuries and infections and diseases at the work place; b) Eliminate exposure and incidences of occupational injuries and diseases among all categories of the workforce; and c) Operate a flexible and quick response system to injuries at the work sites, following thorough training of all project staff in OHS procedures at induction; thus, instilling a culture of responsibility and accountability on Safety and Health. The overall implementation of the plan will lie with the Project Manager who will delegate functional duties to the Health and Safety Officer. The OHS plan is a living document that will be updated in consultation with all employees, the client and supervising consultant. Periodic audits both internal and those commissioned by regulatory agencies shall also inform periodic updates of the health and safety plan. In addition, the contractor will; Make OHS plan readily available to all workers and all people concerned about this project and ensure they have an opportunity to read, understand, clarify and ask questions; Keep a copy of the management plan for the whole duration of the project; Review the plan regularly throughout the project and make any revisions known to those working on the project. Among others, the contractor shall endure the following; **a) Risk assessment and Management;** The contractor shall undertake risk assessment as a way of estimating health risks from exposure to various levels of a workplace hazard. Understanding how much exposure to a hazard poses health risks to workers will the contractor to appropriately eliminate, control, and reduce those risks. This risk assessment will answer three basic questions: What can happen? How likely is it to happen? What are the consequences if it does happen? The contractor shall identify the risks associated with the various construction activities, propose and implement measure to avert these risks and mitigate the impacts. **b) Health and safety reporting and audits;** The OHS officer shall produce monthly reports to be discussed at the site meetings. The content of the report shall reflect all aspects of hazards identified. Detailed statistics on Implementation of safety plan including but not limited to the following shall be presented; Induction training carried out by section; Fire drills conducted (number and sections); Health and safety tool box talks conducted; Incident statistics categorized where possible; Fatalities on the project by section If any; Near miss records; Notifiable incidences; Disbursement and use of PPEs; Compliance levels among employees by section; Equipment certification by relevant agencies; External inspections and their outcomes (If any). c) **Training and OHS awareness**; The contractor shall ensure that all employees undertake induction training before commencement of work to cover basics of work place procedures including; Work regulations, OHS instructions (general & section specific), Personal behaviour and mannerism, Fire drills and fire fighting skills, Emergence evacuation procedures, Rights and obligations and Incident reporting procedures among others. Tool Box Trainings will be conducted either every morning or weekly depending on the risk assessment of particular activities on how to safeguard against possible accidents. d) **Incident reporting and investigation procedures**; The purpose of the procedure is to ensure all incidents and accidents involving contractor's personnel, visitors, property and activities are reported, investigated, and recorded.

Plans	Relevance	Issues Covered
		The role of the Health and Safety officer is to facilitate and co-ordinate the reporting, recording and investigation of all OHS incidents by: a) Receiving all notifications of incidents/accidents and ensure proper response is being followed including reporting, investigations and review. b) Once aware of an emergency, the response coordinator shall take the following actions: - Contact or communicate with emergency services - Coordinate activities of all personnel in the emergency response team and monitor its effectiveness - Inform the Contract Manager or Site Manager of the emergency - Coordinate the activities of all personnel in the emergency response team and make further directions as required by the situation - Inform the team, Contract Manager and Site Manager of the end of the emergency situation c) Maintain the Project Emergency Response Plans and associated processes d) Display names and contacts of personnel to be reached out in case of emergences e) Provide the incident report, and actions being taken to prevent reoccurrence f) Coordinate training requirements for the emergency response team and all other site personnel. g) Ensure that adequate emergency response information and instructions are provided in trainings and inductions h) Undertake planned inspections to ensure emergency response equipment and facilities are complete
Recruitment and labour plan	It is good practise that recruitment on the construction site fulfils recommendations, policy and regulations of government. For example, child labour policy gender mainstreaming, local content and labour influx.	The Labour Management Plan shall form a basic guideline for all workers so as to maintain a friendly, cooperative and healthy working environment. All workers shall be made aware of the guidelines upon their formal employment by the Human Resource Manager and Health & Safety Officer in an induction. Efforts shall be made to create conditions which enable staff to coordinate their work with their family life. Employees shall be required to maintain a high standard of conduct and work performance and this shall include; Observing all policies and procedures, treating colleagues with courtesy and respect, treating visitors and clients in a professional manner at all times, working safely at all times; and team work / Team Spirit. The contractor's Human Resource Manager shall make all employees aware of the recruitment policy and procedure, working time, medical examination and treatment, annual leave, maternity leave, paternity leave and sick leave, dismissal and disciplinary procedure among others.
Cultural plan	Such a plan is prepared to ensure that the irrigation scheme development process fully respects the dignity, human rights, economies and the culture of VMGs and that the project has a broad community support from the affected VMGs. It will also provide procedures to ensure that the impacts are mitigated and that the Batwa's benefit from the project.	▪ Cultural heritage supervision and management during construction ▪ Chance find training, management and response ▪ Interface and coordination with relevant authorities ▪ Monitoring and reporting of intervention activities to recover and record cultural heritage values A Standard Outline for a VMGP is presented in Appendix F (Refer)

Plans	Relevance	Issues Covered
Soil Erosion, Reinstatement & Landscape Management Plan	This will be anchored on in alleviation of anticipated degradation of soils and soil erosion due to cleared surface vegetation.	▪ Defines soil erosion controls and associated standards ▪ Temporary and permanent erosion control measures ▪ Inspection and maintenance programme ▪ Reinstatement and vegetation measures and planning
Waste Management Plan	A lot of waste is anticipated during the pre-construction, construction and post construction phase. These may include solid and liquid waste, hazardous and nonhazardous among others. They tend to be a threat to the community if not well managed.	Construction is accompanied with generation of wastes that include both biodegradable and non-biodegradable wastes. During the construction phase, quantities of excavated materials and other wastes will be generated which will require disposal in an appropriate and environmentally acceptable manner. The disposal strategy shall be based upon the waste management principle of reducing the amount of waste requiring final disposal through waste avoidance, material re-use, and recycling. Excavated materials and residual wastes may give rise to impacts during their handling, temporary stockpiling or storage on site, transportation and final disposal. The basis for waste management actions will be segregation at source, storage and disposal of different types of waste. The entire waste management process will be anchored on active separation of wastes at point of generation. The essence of waste segregation at source is to enable re-use, recycling and the choice for the most appropriate disposal technology should the first two fail. Separation of wastes at source further reduces chances of cross contamination of waste streams by hazardous wastes hence making it safer for both the waste management team and the receiving environment. The following generic steps will be followed; i. **Storage**: Well labelled bins shall form the basis of storage to facilitate easy removals and evacuation to disposal trucks. The project will utilize, the use of Colors or Labelling of waste collection bins, depending on what is considered feasible. ii. **Collection and Transportation**: A Waste collection schedule shall be designed by the site foreman assisted by the Contractor's Environment Officer. There being no waste disposal sites in the district, the contractor shall engage, through consultation of the District environment officer, a registered waste handling company to undertake the collection and transportation to the disposal sites preferably in Kanungu district. iii. **Hazardous Waste storage permits**: Used oils in particular will be collected and stored in sealed drums on a sheltered concrete ground to avoid any contact with bare soil surface. As required by NEMA, the contractor shall obtain a license for storage of Hazardous waste e.g. used oils on site awaiting transportation and disposal by a NEMA registered hazardous waste handler. However, final disposal of all hazardous wastes shall be done by a suitable NEMA licensed hazardous waste management company that shall be identified by the contractor. **iv. Waste inventory and record keeping:** The contractor and, if sub-contracted, the waste transporter will maintain written records of waste movement of both licensed and non-licensed waste activities. As a minimum, for waste tracking purposes, records will be kept in relation to the: ▪ Amount and the type of waste generated, stored, treated or disposed of; ▪ Amount and the type of waste transported; ▪ Date of transportation; and ▪ Name and location of the waste facility that receives the waste. These records will be kept for as long as the project is on-going.

Plans	Relevance	Issues Covered
HIV and other STIs Prevention and Management Plan	The influx of labour into the community around the project area and the improvement of income as a result of employment from the project more often result into behavioural disorder that may come up with social related evils such as prostitution. This tends to result into the spread of HIV and other diseases. A sensitization plan against HIV need to be developed to fight the vice. The plan will provide a framework for; Managing HIV/AIDS programs and activities amongst workers and their partners and in the community; Discouraging discrimination of persons with HIV/AIDs in the project; Raising awareness among project staff and host communities and Encourage safe sexual behavior on the project.	▪ This plan shall include measures that will be implemented in order to ensure control of the spread of HIV/AIDS and Sexually Transmitted Infections (STI) between the workers and the local community. ▪ The contractor shall have in place an HIV/AIDS and STIs Policy in which he shall show commitment to the protection of the rights of employees living with HIV/AIDS (in close consultation with Uganda AIDS Commission), Prevention through information, education and training of both the workers and the community and free screening and counselling policies for STI and HIV/AIDS cases among project staff. ▪ Regarding employees, the Contractor shall periodically, with support from the District Health Office, organise Information, Education and Communication Campaigns including free counselling and testing exercises. The contractor shall also establish a well-equipped and staffed HIV/AIDS site clinic preferably at the worker's camp that will provide the free counselling and testing services to the workers. In addition, condoms, both male and female, shall be freely provide to the workers and shall be preferably placed in the respective toilets for easy and convenient access. ▪ Regarding the communities, the contractor shall organise campaigns in which he/she shall conduct Information, Education and Communication Campaigns including free counselling and testing of community members.
Stakeholder Engagement Plan	This plan will define a technically and culturally appropriate approach to consultation and disclosure throughout the construction phase. This will be aimed at improving and facilitating decision making and creation of an atmosphere of understanding that actively involves project-affected people and other stakeholders in a timely manner, and that these groups are provided sufficient opportunity to voice their opinions and concerns that may influence Project decisions.	The aim shall be to ensure that adequate and timely information is provided to project affected people and all stakeholders, that proper mechanisms for information, consultation, and involvement is established, and that this process will enable opportunities for dialogue, two-way discussion and active public participation. It can be expected that good implementation of stakeholder engagement will contribute in positive acceptance of the project activities and avoid as much as possible annoyance/dissatisfaction of the affected people that could be caused by the project activities. Communication with stakeholders should focus on those issues of most concern to local stakeholders, whether they are based on real or perceived risks and impacts. A monthly stakeholder engagement programme/schedule will be made by the contactor's Sociologist and Other Safeguard staff for engagements clearly stating the location, topics and dates. Stakeholder Engagement Plan shall entail; ▪ Objectives of the Stakeholder Engagement Plan ▪ Principles for Effective Stakeholder Engagement ▪ Stakeholder Analysis and Identification of Stakeholders ▪ Implementation of the Stakeholder Engagement Plan ▪ Resources and Responsibilities ▪ Stakeholder Engagement Methods, Tools and Materials ▪ Stakeholder Engagement Monitoring and Evaluation, and Reporting

Plans	Relevance	Issues Covered
Community Liaison/ Engagement Plan	The linkage between community and the project is of great importance for the success of any project. The project needs to have a clear plan on how to link with the community. This will; set a strong community relationship so as to increase awareness about the project and ensure community involvement and ownership in its implementation; ensure effective engagement with local leaders and their communities throughout all phases of the project; actively build and maintain productive working relationships, based on principles of transparency, accountability, accuracy, trust, respect and mutual interests with affected persons and communities at large; implement methods proposed which can increase awareness and lead to the protection of project and community resources through community policing.	This guidance outlines important aspects to consider when planning a community engagement strategy. There are a variety of approaches to community consultation and engagement. The aim of this is to be able to plan and deliver an appropriate community engagement process that will allow achievement of the desired outcomes. This means being clear about project aims, identifying target audience, understanding available resources and capacity, and planning accordingly. Community Engagement Plan shall entail; ▪ Objectives of the Community Engagement Plan ▪ Community Engagement Plan Implementation Structure ▪ Community Engagement Plan Implementation Approach ▪ Community Engagement Plan Training ▪ Community Engagement Matrix ▪ Community Engagement Standards ▪ Community Engagement Reporting Format ▪ Community Engagement Attendance Format
Gender and Social Equity Management Plan	Gender related issues must be clearly spelled out throughout the project cycle. These may include recruitment systems, sanitation facilities and roles played by women and men. This plan will be aimed at enhancing gender mainstreaming and strengthening gender equality during the implementation of the project.	The Contractor's Gender Management Plan shall include; provision of gender sensitive working conditions and facilities, awareness creation and description of recruitment procedures among others. The contractor shall submit a monthly report detailing among others: ▪ Mobilisation and recruitment strategies employed. ▪ Number of workers employed disaggregated by sex, age. ▪ Task allocation by sex. ▪ Proportion of women employed in supervisory positions. ▪ Proportion of wages accruing to women. ▪ Facilities provided to enhance women's participation in road works. ▪ Capacity building for both female and male workers. ▪ Lessons learnt from implementations that can be the basis of documenting good practices. The report shall be verified by the Environment and Social Manager.

Emergency Response and Incident Management Plan	In case of an emergency related to operation such as fire, of structures among others, a plan on how evacuation can be done need to be developed early enough. This plan will; prepare effectively the project team for emergency response and critical incidents; Reduce risk of severe injury and illness through appropriate management; Contain risk to limit potential harm to the environment and surrounding infrastructure; and Minimizing disruption to the community and surrounding businesses. The plan will bear an Incident Investigation, Reporting and Management Procedure.	The plan applies to all forms of emergencies and incidents that have or are likely to cause, or have caused serious injury, and/or grave damage to the environment or property. It covers all aspects, activities and sites of the project. Emergencies will be managed through effective coordination, communication and response procedure. All incidents will be immediately reported to a supervisor who will contact Environmental officer, who in turn reports to the Health and safety officer. While all incidents shall be reported in the monthly EHS report, all serious incidents shall immediately be reported to the Health and safety officer, who also reports to the Project Manager. The Project Manager will also report to the supervising engineer (SE), who also will report to the MWE staff. All incidents will be investigated and the appropriate course of action will be taken to address the root cause. The contractor shall ensure that trained first aiders are present at the camp and on the project roads during construction. Their roles shall include; ▪ Provide and record first aid treatment when required. ▪ Ensure that first aid kits are provided on every active site and supplies are replenished. ▪ Be evacuation officers in case of fire of natural incident that may affect an entire building, sites like borrow areas, campsites or laboratories; be responsible for occupants' safety and evacuation. ▪ Keep an updated list of employees and visitors on site and carry the name list during evacuation. An assessment will be undertaken to determine and mark out evacuation routes for each area or facility of the project auxiliary facilities. Workers will be drilled to follow the identified routes to assembly point. The assembly points shall be delineated in the site layout plan, labelled with a sign and communicated to all workers. When an emergency incident occurs, the following response actions shall be taken: Persons present must maintain calm ▪ As fast as practicable determine what may have happened and the nature of the emergency. This will help decide whether to attend to injured persons/situation or to communicate. ▪ The actions required maybe to attend to the injured person, stop machines or notify the safety Officer or his/her representative. Only trained first-aiders will provide assistance to injured persons. ▪ The Safety Officer, or his/her representative if necessary, will call for emergency services (ambulance, police as necessary), and at appropriate moments notify the Project Manager. ▪ The site shall then be made safe to prevent further injury, loss, accident or incident. Actions here may include diverting traffic, suppressing fire, preventing objects from falling, shutting down equipment or utilities, and taking other necessary measures. ▪ Secure the site of the incident to ensure that it is not disturb; while allowing only disturbance to the extent that is essential to maintain life or relieve human suffering and prevent immediate or further losses. This is to allow incident investigation. ▪ The Safety Officer or his/ her representative shall ensure the Contract Manager is notified immediately. ***Evacuation procedure:*** All staff shall be made aware of the possible escape routes and Assembly point during induction and regularly refreshed through drills and during trainings, or toolbox talks. An Evacuation Personnel shall be designated for every site, and is particularly applicable for Campsites, borrow areas and culvert sections among others. In the event of an emergency, the Safety Officer or his/her representative will give instruction to sound so that personnel evacuate to a specific area. ▪ Personnel onsite must follow the instructions of the Evacuation Personnel. ▪ Personnel must follow the directional pointers to the nearest emergency exit. ▪ Evacuation must be undertaken in accordance to the emergency lay out plan. ▪ Unscathed and mobile employees must be the first to be evacuated followed by the weak and the injured.

Plans	Relevance	Issues Covered
		▪ Evacuation personnel must work in pairs where possible to assist one another lifting heavy injured employees. ▪ Aid mobile employees who are struggling or appear unsure, and assist visitors. ▪ All personnel must keep calm and be evacuate by walking quickly and not run. ▪ Tasks of emergency services must not be obstructed. ▪ All personnel onsite must report directly to the allocated assembly point. ▪ Persons in assembly points and those that may have been injured must be counted and missing persons searched ▪ Personnel must not leave the assembly point until it has been deemed safe to do so. ▪ The evacuation personnel must be the last one to leave the area. ***Training:*** All project workers shall be inducted before commencement of work, and will be briefed on the emergency response procedure. ▪ All employees and sub-contractors will be trained in emergency response procedures within one month of their start-date. ▪ Workers will be helped to understand potential emergency risks, appropriate first-person response to incidents and notification procedures. The training shall be mandatory and will be conducted on a quarterly basis. Training shall to include, but not limited to the following: Fire fighting, First Aid, Emergency Evacuation; and Medical and Environmental Emergencies. ***Recording and investigations*** All incidents will be registered by Safety Officer in the Project's EHS database. Once registered, all incidents will be investigated for identification of causes and preventative actions. The relevant aspects of the Environmental and Social Incident Reporting Tool (ESIRT) are presented in Appendix L and they include; (i) Reportable incidents (ii) Incident investigation Reporting Guide (iii) Incident Investigation (iv) Incident Reporting Forms

Plans	Relevance	Issues Covered
Chance Finds Procedure/ Plan	Archaeological and Physical Cultural Resource (PCR) items of value may be found during excavation for the trenches for the closed pipeline network distribution. It is important to follow the established Chance Find Procedure and prepare a specific PCR Plan upon which these items will be handled if found in number.	During the period of the construction of the project infrastructure which involves excavations, it is possible that chance finds will be encountered. These may include the following: ▪ Archaeological heritage which has remained unnoticed in the past. ▪ An encounter with a grave containing human remains which the local residents may have not mentioned at the survey stage. In case of discovery of a physical cultural resource, such as (but not limited to) archaeological sites, historical sites, remains and objects, or a cemetery and/or individual graves during excavation or construction, the following steps shall be taken: ▪ Stop all works in the vicinity of the find, and immediately report the findings to the supervisor who will then notify the Construction Manager and the Environment Officer Environmental Manager ▪ The Manager shall notify the Department of Museums and Monuments (contact of commissioner is +256 772485624) giving the location and nature of the finds ▪ The contractor shall also notify MWE safeguards staff at the head quarters (Luzira) and the District Environment Officer ▪ Record details in Incident Report and take photos of the find ▪ Delineate the discovered site or area; secure the site to prevent any damage or loss of removable objects ▪ Any further excavations or continuation of the infrastructure development at the Site of the discovered heritage will be undertaken only with the approval of Department of Museums and Monuments and MWE Staff. In the case of discovered human remains, LC1 and Kanugu district police station will have to be notified and either the remains are taken for forensic investigation or the LC1 authorities sanction the reburial of the remains at another location. The Contractor then meets the relocation and reburial expenses.

Plans	Relevance	Issues Covered
Spill Management Plan	Presence of potential hazardous materials like vehicle fluids and construction chemicals, contamination prevention, emergency spill response, and responsibilities associated with hazardous materials during the project there must be a plan to prepare for any spill.	Sources of oil spills on any construction project will include spillage of oil from engines of equipment (during refuelling, servicing or leakages due to fault in equipment tank). These could range from minor to major spills if a large number of fuel drums are damaged simultaneously. In case of an oil spillage, the response teams should be equipped with the following response equipment: ▪ Spill kits containing absorbent pillows and fabric for vehicles ▪ Plastic bags ▪ Rubber gloves The health and safety of personnel is paramount during an oil spill. Protective gear should be used when carrying out an oil spill clean-up. Spill management shall majorly involve containment and recovery of oil spills where practicable and the contractor shall ensure that the Health and Safety Officer and foremen are equipped with sufficient materials and equipment to contain all spills. ***Training*** The contractor shall ensure that all workers are trained in prevention and management of oil spills and leaks. This shall be done during induction of workers and throughout the construction phase trough regular sensitization. This training will cover procedures for reporting a spill, health and safety issues, and the use of equipment (e.g. absorbents, safety drums, etc.). General response strategy for oil spills shall follow the procedure outlined below; ▪ The contractor and all workers shall ensure that oil spill equipment is in a known and accessible location. ▪ If a spill occurs, work shall be stopped or minimised to avoid any further spillage. Ensure safety of all personnel. Check for fire and explosion risk. Ensure safety equipment is worn. ▪ For all spills, absorbents shall be deployed to contain fuel if possible. It may be possible to hold fuel in depressions by using absorbent materials. ▪ If possible, pump shall be used to remove fuel from ground straight into drums, while ensuring that sufficient good quality empty drums are available near the spill site. ▪ Absorbent material such as sawdust or sand shall be spread on any remaining fuel or oil outside which cannot be pumped or manually removed. Oil soaked absorbents must be picked up and put into plastic bags and/or empty drums. ▪ Drums or containers of recovered oil shall be stored in fuel containment areas close to workshops or other designated areas at the site. ▪ Containers or drums of recovered fuel/water, oil-soaked absorbents and contaminated clothing used in the clean-up shall then be transported for disposal by the licensed hazardous waste handler. Recovered oil, if usable, shall be stored at designated oil storage areas for later use.

Plans	Relevance	Issues Covered
Quality Management Plan	In order to achieve quality in all project operations, the contractor shall have and implement a Quality Management Plan.	The competency needs of all personnel performing activities which affect the quality of manufacture/construction shall be identified by the contractor. Personnel performing specified assigned tasks shall be appropriately qualified on the basis of training, skills and/or experience, which will be confirmed by the Contractors Project Management team and approved by the Supervising Engineer/consultant as required. Records of training and competencies (written confirmation by Contractors Project Manager) will be kept and maintained at the project office at the camp. The status of the constructed works will be identified by the progressive completion of Inspection and testing documentation which are Work Inspection Procedures and Checklists. The contractor shall be responsible for the quality of the works. Checklists will be signed for each operation (e.g. earth work, concrete work, metal work, landscape work, etc. including mechanical, electrical and hydraulic works) to verify that works have been completed in accordance with requirements. In addition, the contractor shall submit to the supervising consult, material approval request for inspection and approval of material before use. The Project Manager shall ensure that the Project Quality Management Plan is reviewed monthly to ensure that: ▪ The objectives and requirements of the Project Quality Management Plan are still valid, and are being met. ▪ Forthcoming activities are reviewed and any necessary amendments to the Project Quality Management Plan are put in place before the relevant work begins. QMP processes shall be reviewed to ensure continuing suitability and effectiveness.
Communication Management Plan	The plan will bear the project communication strategy aimed at; Creating awareness about the project among the local communities; Encouraging community participation and support the project; and Creation of awareness about health and safety issues like HIV/AIDS, STDs, protection against any accidents that might occur as the project is ongoing and after the project.	Communication Management Plan shall entail; ▪ Purpose of this communication strategy ▪ Assumptions of the strategy ▪ Identified risks of poor communication ▪ Communication approaches ▪ Target audiences and roles ▪ Determination of key messages ▪ Key messages ▪ Communication channels ▪ Communication reporting methods ▪ Communication Channel ▪ Communications Management Action Plan
Decommissioning plan	Once the project is completed, the contractor will need to demobilize all equipment, selected infrastructure, material, and personnel off site.	The contractor shall prepare site specific decommission plans to serve as a guide during the implementation process to allow disturbed sites to regain their ecological functionality, connectivity and stability in the ecosystem through re-vegetation using indigenous plant species, with a long-term goal of stimulating biodiversity recovery to ensure it blends with that of the surrounding landscape. The restoration will focus on but not limited to; drainage pathways, temporary material storage and stockpile areas borrow pits, workers' camp site, among others. Perpetual monitoring from the on-set of the project throughout its implementation shall be undertaken during the rehabilitation processes and final restoration, with emphasis placed on the continuity between site characteristics and the adjacent landscapes. Reporting of restoration works will be done by the Contractor's Environmentalist, with approval from the District Environment officer, supervising engineer and the designated MWE personnel upon satisfactions from other, if any, regulatory agencies involved.
Capacity Building Plan	All personnel on site will have to receive various trainings as per their recruitment departments.	The contractor shall develop measures to continuously build and improve the capacity and skills of the employees. The workers shall be inducted in the Environmental and Social Safeguards at the start of the proposed projects and periodic training shall be given to workers in their specific areas of operation. This shall contribute to the quality of construction and save material as well as providing increased skills that can help the workers even after project completion.

Plans	Relevance	Issues Covered
Pandemic Preparedness & Response Plan	On 30 January 2020, the Director-General of WHO declared the coronavirus disease 2019 (COVID-19) outbreak a public health emergency of international concern under the International Health. Pandemic Preparedness & Response Plan, tailored specifically for the project should be prepared and implemented by the contractor to prevent, rapidly detect and effectively respond to any pandemic outbreak thereby reducing morbidity and mortality in the project.	A. **COVID-19 Background;** COVID-19 Identification and Definition; COVID-19 Transmission; COVID-19 Signs and symptoms; Situation of COVID-19 Outbreak in the project area; Relationship between COVID-19 and Project B. **Purpose** The main objective of the C19PRP is to prevent, rapidly detect and effectively respond to COVID-19 outbreak thereby reducing morbidity and mortality in the project. The purpose of this plan will be provision of a framework for; Assessing the project works risks to COVID-19; Provide COVID-19 Infection Prevention Measures; Status of adherence to the National COVID-19 preventive and control requirements including COVID 19 construction field safety guidelines for rural electrification projects published on 6th April, 2020 C. **Project Works Risk matrix.** A project works risk matrix should be compiled, and not limited to; Material procurement & deployment; Stakeholder & Community Engagement; Construction and commissioning works, Transportation **D. Basic Infection project Prevention Measures;** Entail all preventive measures proposed by contractor in response to anticipated COVID-19 in the project area; such as; ▪ **During Lock Down**; Stay Home; Acquisition of a travel permit for emergency; Disinfection; Team social distancing ▪ **In case there is No Lock Down**; Hand Sanitizing; Appropriate PPE; Social distancing; Housekeeping practices; Screening; Security; Training and Awareness; Travels and deliveries; Communications and signage; Safe behavior and practice; Review and Updates **E. Implementation Responsibilities:** For effective implementation of the C19PRP, it should clearly delegate responsibilities for the project site key staff mainly the safeguard personnel, including the Class Z certified electrician or foremen. **F. Communication plan:** All symptoms of COVID-19 will be reported immediately to the Medical team or COVID_19 Task force for the designated area and stakeholders. And all staff that are sick or feel sick and are at work, will inform their direct supervisor who in turn will share the same information with the safeguard personnel on contractor's team. A comprehensive communication hierarchy will be prepared herewith. **G. Procedures for prompt identification and isolation of sick people:** Steps will be developed on how to identify, handle, and treat sick personnel **H. C19PRP Programs:** Both Safeguard team of Contractor and Supervising Consultant shall undertake regular monitoring of C19PRP programs as per action plan. Indicators shall be developed against which progress shall be reported. This will include; Presences of approved C19PRP**;** Housekeeping status; Number of COVID-19 related trainings and inductions; Number of COVID-19 related pep talk/ toolbox topics; Number COVID-19 related PPE procured and issued/replaced; No of fully equipped hand washing points/ quantity of hand sanitizer**;** Records of screening; No of registered workers, community or Authoritative grievances**;** COVID-19 National preventive and control requirements adherence status**;** COVID-19 construction field safety guidelines for rural electrification projects adherence status**;** Status citations of C19PRP implementation in the health Monthly reports. **Note**: This is currently to put on halt and will be broaden during project implementation to refer to other pandemic incase of an outbreak.

Appendix M BASELINE, ECOLOGICAL STATUS AND USE OF KIRURUMA RIVER

A. FLOW DURATION ANALYSIS

The Dam for Matanda scheme is located on river Kirurama. The drainage area up to the dam site is 150.73sq.km. There is a Gauge and Discharge site (84270) at Katete-Kahili road on the downstream of the dam site. The drainage area up to the G&D site is 162sq.km. Daily G&D data of Kirurama River (Matanda) is available for 34 years for the period from 1964 to 1997. Internal consistency checks are applied for validating the data. From the internal consistency checks, the data is found to be consistent. There are a few gaps in the data sets. The gaps are filled judicially. The gaps vary from one day to a month. It is mostly one day.

The flow discharges at the proposed Matanda Intake were derived using the area-discharge ratios based on the provided river discharge from DWRM and the delineated subcatchment areas. The catchment area for the river section that contributes to the flow at the proposed intake was estimated to be 159.2 km^2 while the catchment area at River Kiruruma gauging station was 162 km^2. River flow gauging data for River Kiruruma was available from 1964 to 1985. The discharge time series for the 1964 to 1985 were, therefore, utilized for the purpose. From this available hydrological data, the mean monthly flow for River Kiruruma varied from 1.31 m^3/s to 2.55 m^3/s in the dry (July) and wet seasons (October), respectively. The river had a median monthly flow of 1.48 m^3/s at the intake location with a Mean Annual Flow of 1.84 m^3/s. The average annual flow (AAF) at Matanda Dam location is determined as 54.12 MCM and corresponding discharge is 1.72 cumecs. The 75% dependable flow available at Matanda Dam location is determined as 45.6 MCM.

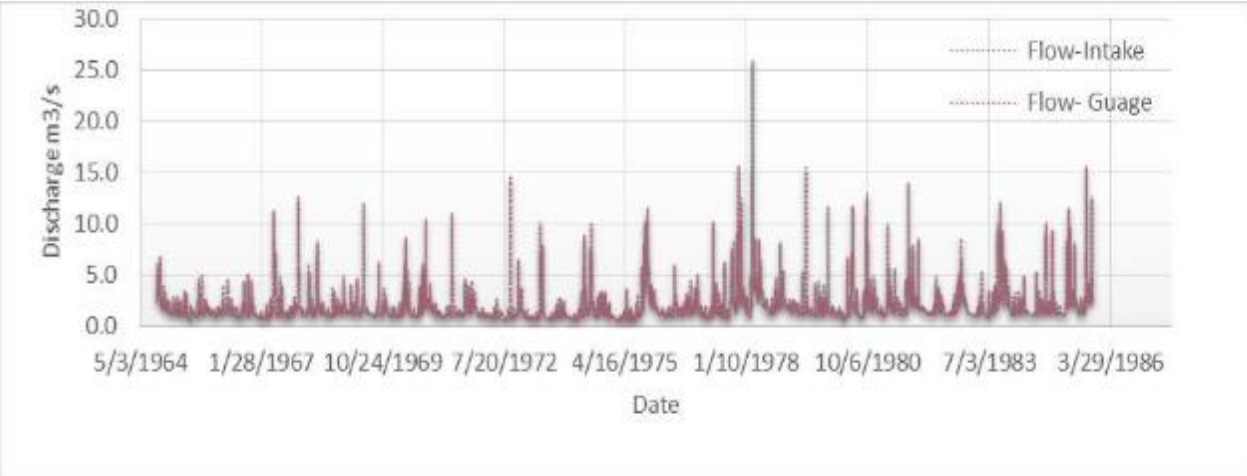

Figure: River Kiruruma discharge series at the proposed Matanda Irrigation Scheme Intake point

Site	Upper site	
Dependability	**Mean flow (m^3/s)**	**Annual flow (MCM/year)**
80%	**1.05**	49.4
90%	**0.8**	45.8
95%	**0.67**	42.9

River Kiruruma is a perennial river with highly predictable flows. Predictability ranges in value from 0 to 1 and is composed of two additive components: constancy (C), a measure of temporal invariance, and contingency (M), a measure of periodicity. The predictability of a stream with very constant flow will be mostly due to C, while the predictability of a stream with highly variable flow with a fixed periodicity will be mostly due to M.

Table: Annual flow statistics at the proposed Matanda Intake point

Period of Analysis	Mean Annual Flow (m3/s)	Annual C.V.	Flow Predictability	Constancy/ Predictability	% of Floods in 60 day Periods	Flood Free Season* (days)
1964-1986 (21 Years)	1.55	0.81	0.62	0.87	0.29	12

*Length of flood-free season in days of the longest period common to all water years where flows are at or below the high pulse threshold in every year.

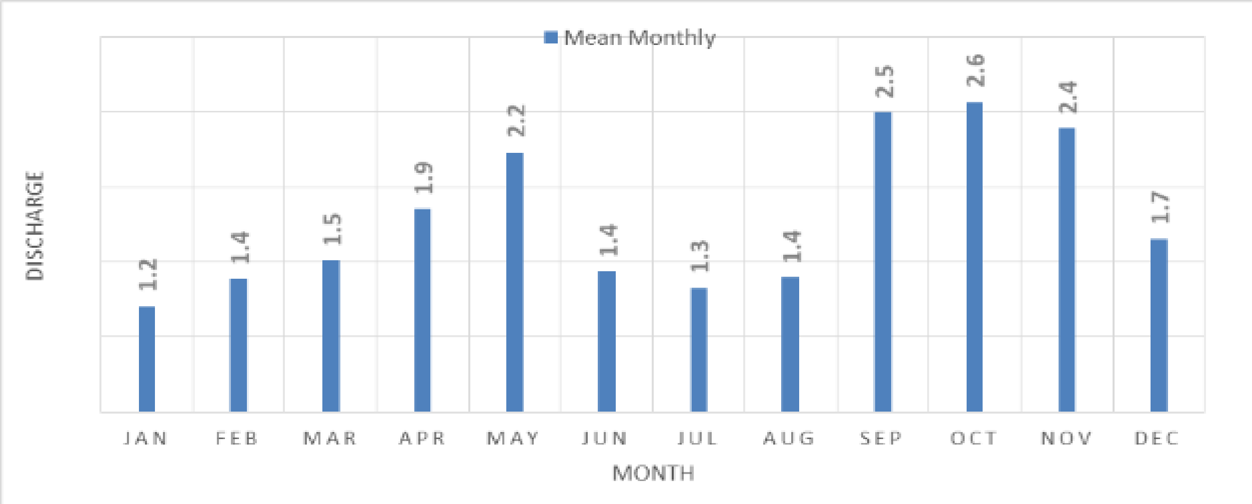

Figure: Mean Monthly Flow at the proposed Matanda Intake

Table : River Kiruruma Flow descriptive statistics at proposed Dam Site

Site	Upper site	
Variable	Mean flow (m^3/s)	Annual flow (MCM/year)
Mean	**1.84**	58.2
Median	**1.7**	57.4
Minimum	**0.35**	35.6
Maximum	**6.69**	81.5
Standard deviation	**0.89**	9.8

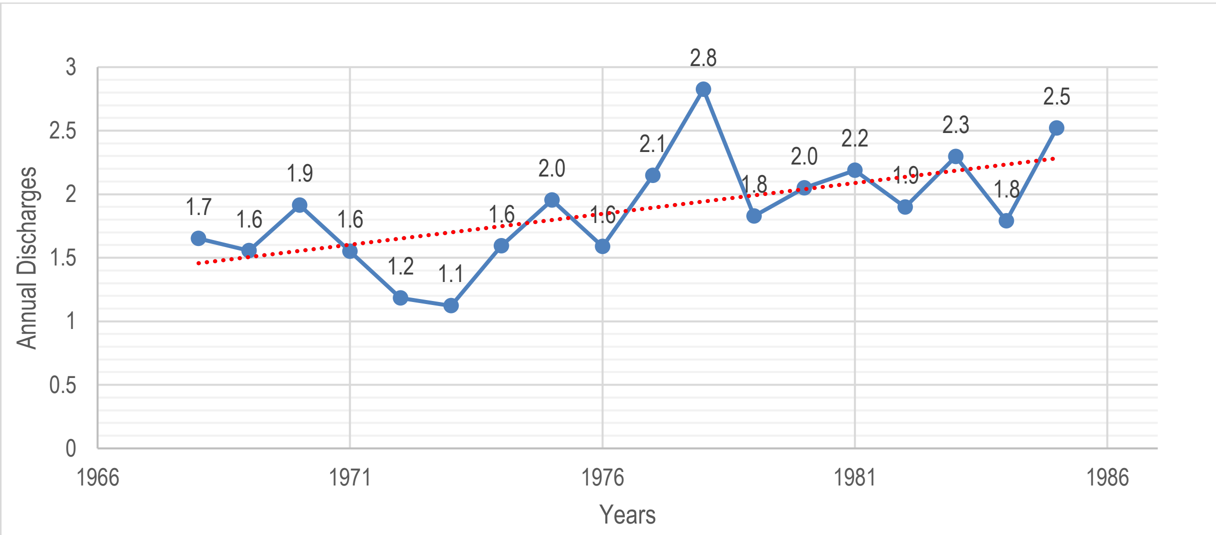

Figure: Flow Percentiles at the proposed Matanda Intake

B. FDC Curve

The Flow Duration Curves (FDC) were developed from daily discharges of River Kiruruma at the proposed intake site. The flow was expressed as variation over the year. The probability of exceedance for the different flows over the year. From this FDC Low flow indices were determined based on more than 50% exceedance. The flow exceeded for 95% of the year (Q95) was taken as the characteristic value for minimum river flow (Relatively low flow Level). A flattened curve reveals a heavily spring-fed river with the annual flow spread more evenly over the year, giving useful flow for a longer period, and less severe floods. Many studies have reported Q95 and Q90 values to be highly inadequate to meet environmental flow requirements and even the growth of some fish species (Caissie and El-Jabi, 1995). Other low flow characteristics such as the 7-day minimum flow for a 10- and 2-year return periods i.e. 7Q10 and 7Q2, respectively similarly generate very low flow, which can have serious adverse biological effect on aquatic habitats. With that background, the FDC Q50 (a much higher flow level) method or median monthly flow method or Aquatic Base Flow (ABF) was adopted for this study with peculiarity that a proportion of it (30%) is proposed as environmental flow. Q50 at the proposed Matanda Intake point was estimated as 1.36 m^3/s.

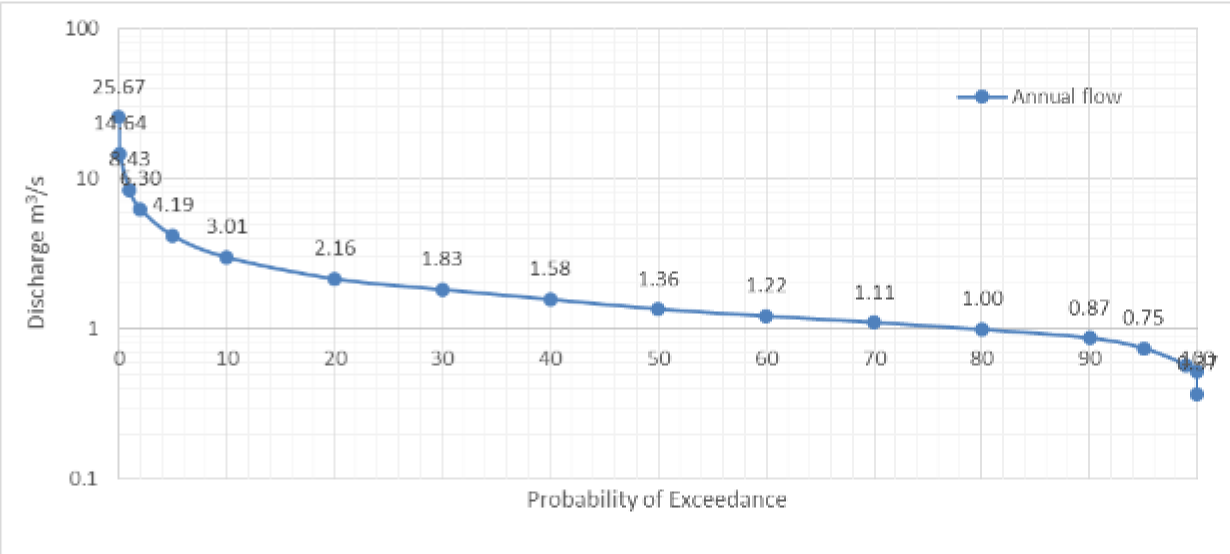

Figure: Flow duration curve (FDC) for the period of analysis (1964-1986) at the proposed Matanda Intake point.

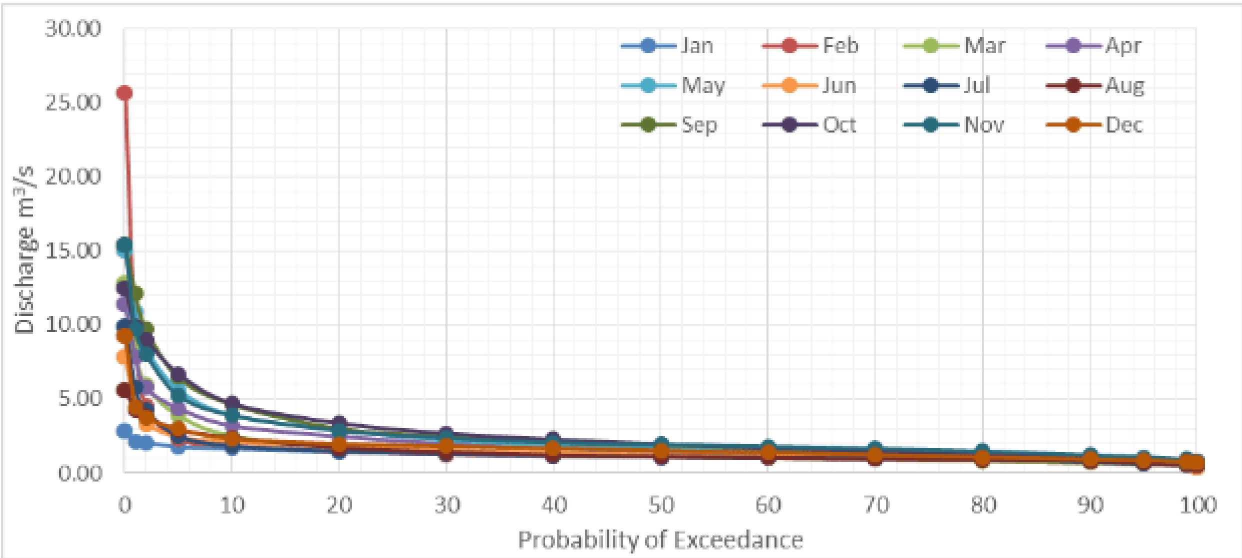

Figure: Monthly flow exceedances at different times

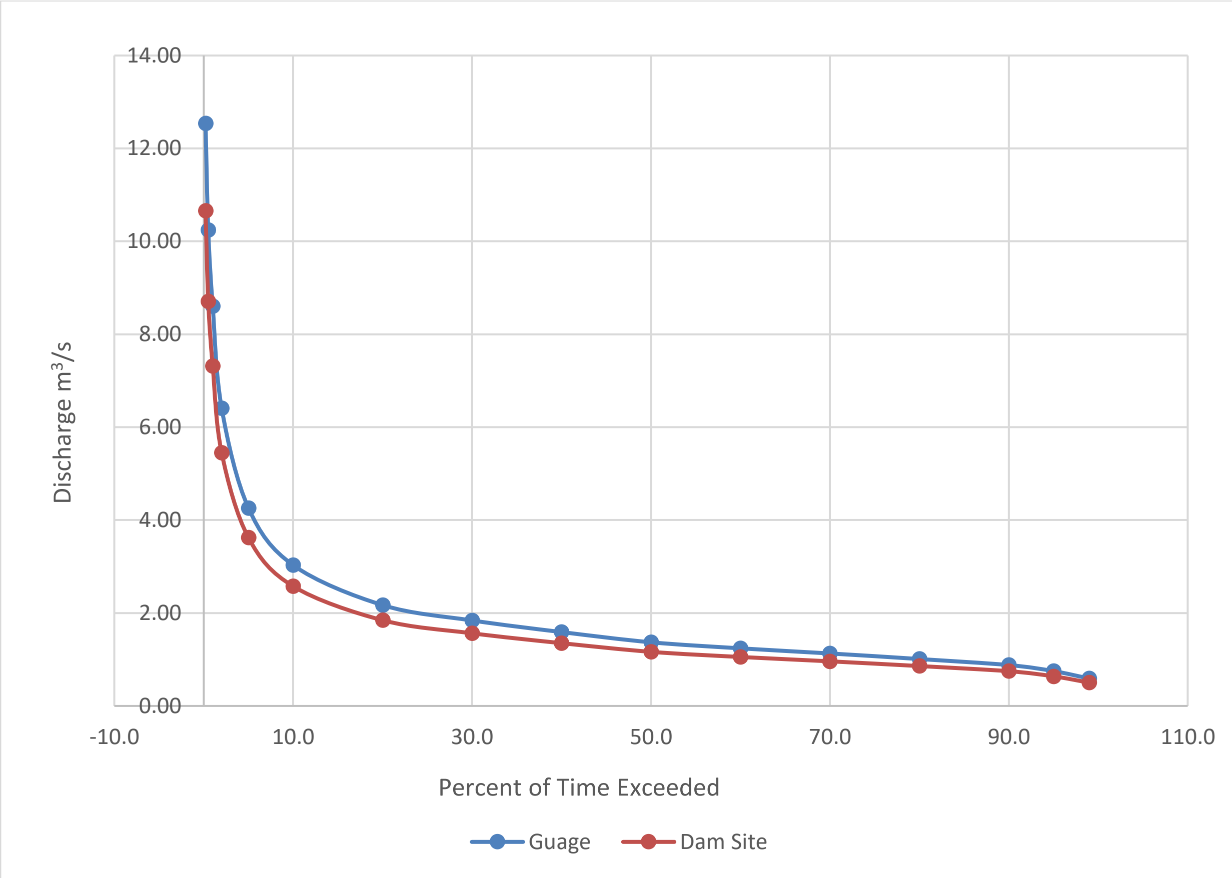

Figure: Flow duration curve (FDC) for the period of analysis (1964-1986) at the proposed Matanda

Table: Flow exceeded at different times based on annual flow duration curve

Percent of Time Exceeded	**Gauge**	**Dam Site**
99.0	0.59	0.50
95.0	0.75	0.64
90.0	**0.88**	**0.75**
80.0	1.01	0.86
70.0	1.13	0.96
60.0	1.24	1.05
50.0	1.37	1.16
40.0	1.59	1.35
30.0	1.84	1.56
20.0	2.17	1.84
10.0	3.03	2.58
5.0	4.26	3.62
2.0	6.41	5.45
1.0	8.61	7.32
0.5	10.25	8.71
0.2	12.54	10.66

Table: Monthly flow exceedances at different times based on monthly FDC curves

Percent of Time Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99.0	0.5015	0.45	0.50	0.54	0.47	0.48	0.49	0.49	0.646	0.71	0.8075	0.663
95.0	**0.62**	**0.50**	**0.54**	**0.66**	**0.72**	**0.63**	**0.55**	**0.60**	**0.8**	**0.83**	**0.9605**	**0.77**
90.0	**0.697**	**0.60**	**0.61**	**0.75**	**0.88**	**0.74**	**0.66**	**0.71**	**0.9**	**0.95**	**1.054**	**0.83**
80.0	0.833	0.73	0.73	0.88	1.01	0.83	0.81	0.81	1.08	1.09	1.2835	0.91
70.0	0.884	0.83	0.83	0.97	1.16	0.89	0.87	0.84	1.218	1.23	1.43905	1.054
60.0	0.9265	0.89	0.89	1.07	1.30	0.99	0.90	0.90	1.454	1.47	1.564	1.156
50.0	0.9945	0.96	0.99	1.19	1.46	1.07	0.96	0.99	1.641	1.68	1.6745	1.292
40.0	1.0625	1.03	1.10	1.47	1.67	1.16	1.03	1.10	1.828	1.92	1.785	1.42
30.0	1.1305	1.11	1.28	1.77	1.94	1.33	1.14	1.29	2.105	2.25	2.04	1.539
20.0	1.241	1.29	1.54	2.16	2.53	1.52	1.29	1.58	2.565	2.91	2.49	1.692
10.0	1.41	1.62	2.19	2.82	3.39	1.80	1.60	2.20	3.953	4.24	3.32	1.96
5.0	1.55	2.05	3.26	3.81	4.90	2.09	2.18	2.82	5.519	5.93	4.38	2.45
2.0	1.83	4.59	4.75	5.02	7.28	2.58	3.62	3.71	7.965	8.03	7.20	3.15
1.0	2.00	11.13	6.03	6.77	9.38	3.03	4.84	4.10	10.38	8.66	8.41	3.57
0.5	2.22	15.02	7.31	8.66	10.01	6.15	5.50	5.71	11.41	9.71	10.38	4.11
0.2	2.44	20.75	8.05	9.51	11.94	6.79	8.33	11.20	13.06	12.43	10.66	4.63
Min Value	**0.44**	**0.39**	**0.45**	**0.50**	**0.45**	**0.32**	**0.45**	**0.45**	**0.58**	**0.66**	**0.75**	**0.60**
Max Value	**2.45**	**22.20**	**8.46**	**9.87**	**13.02**	**6.83**	**8.60**	**11.84**	**13.32**	**13.39**	**10.68**	**4.72**

C. Low flow and minimum volume frequency analysis

A low flow analysis for River Kiruruma used hydrological based flow indices and exceedance percentiles. A flow index, such as the 7Q10 (0.1 m3/s). The 7Q10 is calculated as the lowest flow for seven consecutive days within a 10-year return period (Caissie et al. 2007). 7Q2 (0.6m^3/s) index represents minimum quantity of stream flow necessary to protect the habitat during drought situation and sustained assimilative capacity of river (Nosrati et al, 2014). The low flow and volume frequency analysis was run for durations of 1, 3, 7, 15, 30, 60, 90, 120 and 183 days for specified percentiles of 10, 25, 50, 75 and 90%. It is evident from the low flow analysis that River Kiruruma is a perennial stream with no single day without flows. Extreme water conditions, the 3-, 7-, 30-, and 90-day minimums are taken from moving averages and corresponding percentiles estimated.

To estimate the low flows, a data set of 1, 3, 7, 10, 30, 90-day annual minimum data were selected as follows;

- For every year, 1, 3, 7, 10, 30, 90-day moving averages were computed from a dataset of daily flow values.
- From these, the lowest value per year was selected to represent the lowest value for that year.
- A data series of these values was put together as the 1, 3, 7, 10, 30, 90-day annual minimum flow dataset.

(a) Distribution Fitting

Frequency analysis on this dataset was then carried out as follows;

- A cumulative distribution function (CDF) plot of the 1, 3, 7, 10, 30, 90-day minimum flow data was constructed.
- (Two distributions, namely Extreme Value type 1 (EV1) distribution and Generalized Extreme Value (GEV) distribution, were then fitted to the CDF to compare which has a better fit to the data.
- The GEV distribution was then used to fit the data and generate the low flows corresponding to different return periods.
- The GEV distribution was then used to fit the data and generate the low flows corresponding to different return periods.

One day annual minimum flow was estimated as 0.44 m^3/s while the 90-day annual minimum flow was estimated as 0.7m^3/s. It is evident from the low flow analysis that River Kiruruma is a perennial stream with no single day without flows.

Table: Low flow and minimum volume frequency analysis

Percent Chance Non-Exceedance	1	3	5	7	10	15	30	60	90	120	183
99	2.2	2.4	2.5	2.7	2.7	2.8	2.9	3.3	2.8	2.6	2.7
95	1.5	1.5	1.6	1.6	1.7	1.7	1.8	2	1.9	2	2.2
90	1.2	1.3	1.3	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.9
80	1	1	1	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.7
50	0.7	0.8	0.8	0.8	0.8	0.8	0.9	1	1	1.2	1.3
20	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.1
10	**0.5**	**0.6**	**0.6**	**0.6**	**0.6**	**0.6**	**0.7**	**0.7**	**0.8**	0.8	1
5	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.9
2	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8
1	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8
0.5	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.6	0.7
0.2	0.4	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.6	0.7

The zero-flow days and base flow index parameters are modeled after the suite of flow parameters described by Poff and Ward (1989). The model outputs are listed in the table below.

Low Flow Indices	Median(m^3/s)
1-Day	0.71
3-Day	0.7133
7-Day	0.7186
30-Day	0.8013
90-Day	0.9686
Number of zero days	0
Baseflow Index	0.463

D. Peak flow analysis and maximum volume frequency analysis

Extreme water conditions, the 3-, 7-, 30-, and 90-day maximums are taken from moving averages and corresponding percentiles estimated. Maximum volume frequency analysis curves, with proper caution, may be regionalized, and are useful in the study of water supply and storage requirements. Volume curves, relating time to the maximum 1-, 3-, 7-, 30-, and 90-day discharges were extracted from daily discharge time series. The volume curves are important for reservoir design at feasibility and detailed design stage when storage is necessary.

Table: Peak flows and maximum volume frequency analysis

Percent Chance Exceedance	1	3	5	7	10	15	30	60	90	120	183
0.2	23.0	21.2	18.5	16.3	15.4	13.8	13.2	10.3	7.6	6.7	5
0.5	21.6	19.8	17.1	15.1	14.2	12.5	11.4	8.9	6.8	6.1	4.6
1	20.5	18.5	16	14.2	13.2	11.6	10.1	7.8	6.3	5.6	4.4
2	19.2	17.2	14.9	13.2	12.2	10.6	8.8	6.9	5.7	5.1	4.1
5	17.3	15.3	13.1	11.7	10.7	9.2	7.3	5.7	5	4.5	3.7
10	15.6	13.7	11.7	10.4	9.5	8.1	6.2	4.9	4.4	4	3.3
20	13.6	11.8	10.1	9	8.1	6.9	5.1	4	3.7	3.5	3
50	10.1	8.6	7.3	6.5	5.8	4.9	3.6	2.9	2.8	2.6	2.3
80	7.0	5.9	5.1	4.5	3.9	3.4	2.6	2.2	2.1	2	1.8
90	5.7	4.8	4.1	3.7	3.2	2.8	2.2	1.9	1.8	1.7	1.6
95	4.7	4	3.5	3.1	2.6	2.4	2	1.7	1.6	1.5	1.4
99	3.2	2.7	2.4	2.1	1.8	1.7	1.6	1.4	1.3	1.2	1.1

Low Flow Indices	Median(m^3/s)
1-Day	9.94
3-Day	7.703
7-Day	5.586
30-Day	3.129
90-Day	2.171

Percent Chance Exceedance	Computed Curve Flow	Expected Curve	Confidence Limits	
			0.05	0.95
0.2	24.4	27.3	35.4	19.3
0.5	22.5	24.6	31.8	18
1	20.9	22.5	29	17
2	19.3	20.5	26.1	15.9
5	17	17.7	22.2	14.2
10	15.1	15.5	19.1	12.9
20	13	13.2	15.9	11.2
50	9.5	9.5	11.1	8.3
80	6.8	6.7	7.8	5.6
90	5.6	5.4	6.6	4.4
95	4.7	4.5	5.7	3.5
99	3.4	3	4.3	2.3

Project Design Flood

a) Design Flood

Design flood is the peak discharge for which a structure is to be designed for its safety and smooth function/operation. On judicious consideration of the functional importance of the structure, risks and losses of life and property involved (Risk / hazard potential) in the event of its failure, the criterion for the design flood is selected. The `Design Flood' strictly representing the inflow, which must be discharged under normal conditions, with a safety margin provided by the free board. Based on guidelines, the inflow design flood for Matanda dam is considered as 10000yr frequency flood and that works out to 158.41cumecs.

b) Check Flood

As per ICOLD bulletin 82, the present trend in many countries is to make a distinction between dam safety and works discharge capacity considering safety and economy. This leads to the adoption of two design floods and their corresponding spillway discharge capacities. The safety Check Flood is often made equal to Probable Maximum Flood (PMF). It is an acceptable practice to check the crest structure waterway and energy dissipater to exhibit marginally safe performance characteristics for this flood. The PMF is works out to 181.63 cumecs and for this flood the spillway and dam are checked.

c) Flood Hazard

The “hazard potential” is the possible adverse incremental consequences that result from the release of water or stored contents due to failure or misoperation of the dam. Incremental consequences are defined as the impacts that would occur due to failure or misoperation of the dam over those that would have occurred without failure or misoperation of the dam. The hazard potential assigned to a dam is based on consideration of the incremental adverse effects of failure during both normal and flood flow conditions. Hazard potential does not indicate the structural integrity of the dam itself, but rather the consequences should dam failure occur. These hazard potential classes are also summarized in table below.

Table: Recommended Dam Classification System Based on Hazard Potential

Hazard Poten Classification	Loss of Human Life	Economic Loss, Environmental Loss, and Disruption of Lifeline Facilities
High	Probable (one or more expected	Yes (but not necessary for classification)

Hazard Poten Classification	Loss of Human Life	Economic Loss, Environmental Loss, and Disruption of Lifeline Facilities
Significant	None expected	Yes
Low	None excepted	Low and generally limited to owner

The hazard potential for the proposed dam is related to its location upstream of Kihihi Town. The current hazard potential is low because the town is far from the river course and is at higher elevation compared to the river valley and therefore loss of human life is not expected, and probability of economic loss, environmental loss, or disruption of lifeline facilities is low.

Table: Design flood requirements for dams according to FEMA (2013)

Hazard Potential Classification	Definition of Hazard potential classification	Inflow Design Flood
High	Probable loss of life due to dam failure or mis operation (economic loss, environmental damage, or disruption of lifeline facilities due to dam failure or mis operation)	PMF
Significant	No probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities due to dam failur or mis operation	0.1% Annual chance Exceedance Flood (1,000-year Flood)
Low	No probable loss of human life and low economic and/or environmental losses due to dam failure or mis operation	1% Annual chance Exceedance Flood (100yr Flood) or a smaller flood justified by rationale

E. Environmental Flow Components

River discharges have been delineated into four environmental flow components based on realization by research ecologists that river hydrographs can be divided into a repeating set of hydrographic patterns that are ecologically relevant. The fundamental principle considered in this study is to establish flows that maintain integrity, natural seasonality and variability of flows, including floods and low flows. Calculated from daily flow data using the Nature Conservancy‘s Indicators of Hydrological Alteration (IHA) software (https://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/MethodsandTools/IndicatorsofHydrologicAlteration/Pages/iha-software-thank-you-en.aspx), the parameters quantify the magnitude (size), frequency, timing, duration, and rate of change/flashiness of the annual flow regime. The components are: Low flows; Extreme low flows; Small floods; and large floods.

It is essential to maintain adequate flows during low flow periods, as well as maintain higher flows and floods. Extreme low flow conditions also perform important ecological functions. The assessment of the environmental flow to guide water abstraction for Matanda irrigation scheme was entirely based on the lows and low flow extreme thresholds determined using IHA software, Version 7.1. The low flow thresholds allow surface water abstractions for irrigation and assessment of effluent discharge quotas in receiving streams (Smakhtin and Toulouse, 1998) as a matter of waste load allocations in relation with the receiving river’s waste assimilative and auto-epuration capacity.

Environmental flow to ensure sustainability of permanent and seasonal wetlands, effective sediment transport, continuous ground water recharges, and minimum peaks of small and large floods were considered as part of Environmental Flow Requirements (EFR). It can be noted that though the FDCs during both the dry and wet seasons indicate the availability of water in River Kiruruma, it is of limited advantage from the biological point of view because the biota is significantly affected by time of the year when they experience a particular flow volume and velocity.

The EFC extreme low flow threshold is 0.75 m^3/s while the extreme high flow threshold was 2.2653 m^3/s. The annual extreme low flow peak was 0.695 m^3/s (obtained from daily discharges using threshold obtained from IHA software Version 7.1). Though this software calculates parametric statistics values (Mean and Standard deviations), non-parametric statistics (Median) are presented in this study because for most situations non-parametric statistics are a better choice due to the skewed (non-normal) nature of many hydrologic datasets. These EFCs reflect on the flow variability within the river and are pertinent on determining whether sensitive biota within the river system would (not) be significantly affected.

Five different types of Environment Flow Components (EFCs): low flows, extreme low flows, high flow pulses, small floods and large floods were determined as Indicators of Hydrologic Alteration (IHA). Most importantly, from the model, the timing and maximum flow of each year's largest flood or lowest flows, then calculates the mean and variance of these values over some period of time could be determined. Comparative analysis could then help statistically describe how these patterns could change for a particular due to abrupt impacts such as dam construction or more gradual trends associated with land- and water-use changes as a result of say, the proposed irrigation schemes development.

High-flow pulses indicate water flows that do not overtop the channel banks. These pulses provide important and necessary disruptions in flows. During drought periods, rivers drop to very low levels (Extreme Low Flows) that can be stressful for many organisms, but may provide necessary conditions for other species.

The extreme low flow threshold was estimated as 0.75 m^3/s. Flow discharges 2.265m^3/s, 10.68m^3/s and 17.79 m^3/s correspond to High flow peak, Small Flood peak and large flood peak respectively.

Table:: Environmental Flow Component thresholds

EFC Flow threshold	**Medians** (m^3/s)
Extreme low flow threshold	0.75
Extreme Low Flow peak	0.695
Low Flow	1.5
High Flow peak	2.265
Low Pulse	0.9
High Pulse Threshold	1.71
EFC small flood minimum peak flow:	9.94
Small Flood peak	10.68
EFC large flood minimum peak flow:	13.37
Large flood peak	17.79

In natural rivers, after a rainfall event has passed and associated surface runoff from the catchment has subsided, the river returns to its base- or low-flow level. During small floods, fish and other mobile organisms are able to move upstream, downstream, and onto floodplains or flooded wetlands to access additional habitats such as secondary channels, backwaters, sloughs, and shallow flooded areas. Floods maintain geomorphological structures as well as move nutrients and sediments downstream and are important for connectivity of the reach as well as the water quality.

Extreme low flow peaks (Table below Row 1) are very low levels rivers drop to during drought periods. During rainfall, a river will rise above its low-flow level, high-flow peak (Table below, Row 2) includes any water rises that do not overtop the channel banks. Small flood (Table below, Row 5) includes all river rises that overtop the main channel but does not include more extreme, and less frequent, floods. Large Floods (Table below, Row 8) are important in forming key habitats such as oxbow lakes and floodplain wetlands. Rise rate indicates the median of all the positive differences between the consecutive daily values. Fall rate is median of all negative differences between consecutive daily values.

Table: Environmental Flow Component Low Flows

Month	Low Flow	Coefficient of Dispersion
January	1.035	0.1884
February	0.9775	0.2967
March	0.925	0.2811
April	1.07	0.278
May	1.295	0.1622
June	1.035	0.186
July	0.995	0.1759
August	1	0.1975
September	1.27	0.3051
October	1.328	0.209
November	1.44	0.2066
December	1.273	0.3811

Low flow percentile values (i.e., 10%, 25%, Median (50%), 75% and 90%) for each calendar month were obtained.

Table: Environmental flow components (EFC)-Monthly Low Flows at the proposed Matanda Irrigation Scheme Intake

EFC Monthly Low Flows	10%	25%	50%	75%	90%	(75-25)/50
January	0.83	0.90	1.04	1.09	1.29	0.19
February	0.82	0.85	0.98	1.14	1.28	0.30
March	0.83	0.89	0.93	1.15	1.31	0.28
April	0.90	0.95	1.07	1.25	1.46	0.28
May	0.93	1.12	1.30	1.33	1.63	0.16
June	0.88	0.96	1.04	1.15	1.46	0.19
July	0.83	0.90	1.00	1.08	1.25	0.18
August	0.83	0.88	1.00	1.07	1.24	0.20
September	0.97	1.10	1.27	1.49	1.68	0.31
October	0.92	1.17	1.33	1.45	1.63	0.21
November	1.04	1.30	1.44	1.60	1.64	0.21
December	0.85	0.99	1.27	1.48	1.61	0.38

Table: Environmental flow components (EFC)-Extreme Low Flows, High flows, Small Floods and Large Floods at the proposed Matanda Irrigation Scheme Intake

EFC Parameters	10%	25%	50%	75%	90%	(75-25)/50
Extreme Low Flow Peak	0.59	0.66	0.70	0.72	0.75	0.09

High Flow Peak	1.978	2.15	2.265	2.398	2.7	0.1093
Small Flood Peak	9.94	10.19	10.68	12.18	13.32	0.1868
Large Flood Peak	13.38	13.38	17.79	22.2	22.2	0.4958

APPENDIX N HYDRAULIC CHARACTERISTICS FOR THE RIVER KIRURUMA STRETCH DOWNSTREAM OF THE PROPOSED MATANDA IRRIGATION SCHEME ABSTRACTION POINT

Reach	River Station	Profile	Q Total (m^3/s)	Min Ch El (m)	W.S. El (m)	Crit W.S. (m)	E.G. El (m)	E.G. Slope (m/m)	Vel Ch L (m/s)	Flow Area (m^2)	Top Widt H (m)	Froude # Chl
Kiruruma1	5830	Extre me Low Flow	0.9	1156.57	1156.7	1156.7	1156.73	0.021985	0.8	1.13	17.37	1
Kiruruma1	5830	High Flow Peak	2.3	1156.57	1156.76	1156.76	1156.81	0.020011	0.97	2.36	25.13	1.02
Kiruruma1	5830	Small Flood	12.05	1156.57	1156.93	1156.93	115703	0.01688	1.36	8.87	48.71	1.02
Kiruruma1	5830	Large Flood	18	1156.57	1156.99	1156.99	1157.11	0.015158	1.52	11.88	52.93	1.02
Kiruruma1	**5417**	Extre me Low Flow	0.9	1148.58	1148.71	1148.8	1149.31	0.430247	3.43	0.26	4.2	4.39
Kiruruma1	**5417**	High Flow Peak	2.3	1148.58	1148.75	1148.91	1149.78	0.469584	4.49	0.51	5.88	**4**.85
Kiruruma1	**5417**	Small Flood	12.05	1148.58	1148.91	1149.21	1151.12	0.432366	6.58	1.83	11.11	5.18
Kiruruma1	5417	Large Flood	18	1148.58	1148.97	1149.33	1151.52	0.400052	7.07	2.55	13.1	5.12
Kiruruma1	5164	Extre me Low Flow	0.9	1144.58	1144.75	1144.75	1144.79	0.020998	0.92	0.98	11.88	1.02
Kiruruma1	5164	High Flow Peak	2.3	1144.58	1144.81	1144.82	1144.88	0.022095	1.18	1.95	16.74	1.1
Kiruruma1	5164	Small Flood	12.05	1144.58	1145	1145.05	1145.19	0.026921	1.92	6.27	30.01	1.34
Kiruruma1	5164	Large Flood	18.0	1144.58	1145.06	1145.13	1145.30	0.02859	2.18	8.26	34.46	1.42
Kiruruma1	4734	Extreme Low Flow	0.9	1141.12	1142.14	1141.18	1142.14	0	0.01	99.71	139.56	0
Kiruruma1	4734	High FlowbPeak	2.3	1141.12	1142.22	1141.22	1142.22	0.000001	0.02	110.74	142.67	0.01
Kiruruma1	4734	Small Flood	12.05	1141.12	1142.44	114135	1142.44	0.000007	0.08	144.32	150.21	0.03
Kiruruma1	4734	Large Flood	18	1141.12	1142.52	1141.41	1142.53	0.000011	0.11	156.57	152.32	0.04
Kiruruma1	4409	Extre me Low Flow	0.9	1140.31	114214		1142.14	0	0.01	153.93	142.15	0
Kiruruma1	4409	High Flow Peak	2.3	1140.31	1142.22		114222	0	0.01	165.17	145.55	0
Kiruruma1	4409	Small Flood	12.05	1140.31	1142.44		1142.44	0.000002	0.06	199.52	154.58	0.02
Kiruruma1	4409	Large Flood	18	114031	1142.52		1142.52	0.000004	0.08	212.12	157.22	0.02
Kiruruma1	4056	Extre me Low Flow	0.9	1142.01	1142.13		1142.14	0.002913	0.36	2.47	27.03	0.39
Kiruruma1	4056	High Flow Peak	2.3	1142.01	1142.2	1142.13	1142.21	0.003174	0.48	4.82	37.68	0.43
Kiruruma1	4056	Small Flood	12.05	1142.01	1142.41	1142.3	1142.44	0.003651	0.76	15.83	68.13	0.5
Kiruruma1	4056	Large Flood	18	1142.01	1142.48	1142.36	1142.52	0.003782	0.85	21.11	78.64	0.53
Kiruruma1	3300	Extre me Low Flow	0.9	1140.54	1140.61	1140.61	1140.64	0.025156	0.65	1.38	32.01	1
Kirurum1	3300	High Flow Peak	2.3	1140.54	1140.65	1140.65	1140.69	0.020979	0.88	2.62	33.91	1.01
Kiruruma1	3300	Small Flood	12.05	1140.54	114081	1140.81	1140.91	0.015333	1.42	8.46	41.71	1.01
Kiruruma1	3300	Large Flood	18	1140.54	1140.87	1140.87	1141	0.014001	1.58	11.42	45.15	1
Kiruruma1	2787	Extre me Low Flow	0.9	1133.69	1139.16	1133.86	1139.16	0	0	804.03	225.69	0
Kiruruma1	2787	High Flow Peak	2.3	1133.69	1139.32	1133.94	1139.32	0	0	840.99	227.97	0

Reach	River Station	Profile	Q Total (m^3/s)	Min Ch El (m)	W.S. El (m)	Crit W.S. (m)	E.G. El (m)	E.G. Slope (m/m)	Vel Ch L (m/s)	Flow Area (m^2)	Top Widt H (m)	Froude # Chl
Kiruruma1	2787	SmallFlood	12.05	1133.69	1139.81	1134.18	1139.81	0	0.01	955.05	234.88	0
Kiruruma1	2787	LargeFlood	18	1133.69	1139.99	1134.27	1139.99	0	0.02	997.13	237.38	0
Kiruruma1	2525	Extre me LowFlow	0.9	1135.69	1139.16		1139.16	0	0	316.16	161.41	0
Kiruruma1	2525	High Flow Peak	2.3	1135.69	1139.32		1139.32	0	0.01	342.89	166.63	0
Kiruruma1	2525	Small Flood	12.05	1135.69	1139.81		1139.81	0	0.03	428.79	181.37	0.01
Kiruruma1	2525	Large Flood	18	1135.69	1139.99		1139.99	0	0.04	461.54	186.05	0.01
Kiruruma1	2379	Extreme Low Flow	0.9	1136.36	1139.16		1139.16	0	0.01	102.99	80.61	0
Kiruruma1	2379	High Flow Peak	2.3	1136.36	1139.32		1139.32	0	0.02	116.57	86.07	0.01
Kiruruma1	2379	Small Flood	12.05	1136.36	1139.81		1139.81	0.000003	0.07	163.01	102.55	0.02
Kiruruma1	2379	Large Flood	18	1136.36	1139.99		1139.99	0.000004	0.1	181.8	108.5	0.02
Kiruruma1	2132	Extre me Low Flow	0.9	1138.78	1139.13		1139.15	0.004417	0.71	1.27	6.95	0.53
Kiruruma1	2132	High Flow Peak	2.3	1138.78	1139.27		1139.31	0.005028	0.94	2.44	9.59	0.6
Kiruruma1	2132	Small Flood	12.05	1138.78	1139.68		1139.8	0.005667	1.5	8.05	17.37	0.7
Kiruruma1	2132	Large Flood	18	1138.78	1139.83		1139.97	0.005728	1.66	10.85	20.21	0.72
Kiruruma1	1948	Extre me Low Flow	0.9	1138.42	1138.73		1138.78	0.010573	0.99	0.91	5.82	0.8
Kiruruma1	1948	High Flow Peak	2.3	1138.42	1138.88		1138.95	0.008346	1.15	2.01	8.65	0.76
Kiruruma1	1948	Small Flood	12.05	1138.42	1139.32		1139.45	0.006767	1.6	7.52	16.75	0.76
Kiruruma1	1948	Large Flood	18	1138.42	1139.47		1139.63	0.006563	1.75	10.28	19.58	0.77
Kiruruma1	1636	Extre me Low Flow	0.9	1137.99	1138.36	1138.24	1138.38	0.002201	0.51	1.77	9.45	0.38
Kiruruma1	1636	High Flow Peak	2.3	1137.99	1138.5		1138.53	0.002635	0.69	3.34	13	0.43
Kiruruma1	1636	Small Flood	12.05	1137.99	1138.88	1138.7	1138.95	0.003923	1.21	9.95	22.44	0.58
Kiruruma1	1636	Large Flood	18	1137.99	1138.99		1139.09	0.004559	1.42	12.71	25.36	0.64
Kiruruma1	1487	Extreme Low Flow	0.9	1137.87	1138.09	1138.09	1138.15	0.018963	1.06	0.85	7.69	1.01
Kiruruma1	1487	High FlowPeak	2.3	1137.87	1138.19	1138.19	1138.28	0.016741	1.27	1.8	11.2	1.01
Kiruruma1	1487	Small Flood	12.05	1137.87	1138.49	1138.49	1138.64	0.013949	1.7	7.08	24.86	1.02
Kiruruma1	1487	Large Flood	18	1137.87	1138.6	1138.6	1138.77	0.012835	1.8	9.98	30.17	1

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CERTIFICATE OF ANALYSIS-WATER QUALITY

CLIENT: Air, Water and Earth Ltd (MWE) **PROJECT**: ESIA and RAP for Rwimu, Kibimba, Matanda Irrigation Schemes-Kanungu District (Rain Season)

Sampling date: 24th to 27th July 2020 **Delivery date**: 29th July 2020 **Analysis dates**: 29th July -3rd August 2020

Sample ID/ Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13
Apparent colour (PtCo)	0	1044	1748	0	0	2550	101	670	826	441	332	358	107
Turbidity (FAU)	1	186	233	7	4	369	13	102	47	65	54	227	217
Total suspended solids (TSS) (mg/l)	4	235	205	3	2	432	6	94	23	95	43	261	14
Total Alkalinity (mg/l)	105	85	10	50	90	70	30	45	30	90	30	95	40
Nitrates (mg/l)	11.6	nd	nd	24.8	15.1	nd	19.7	nd	nd	83	nd	nd	12.3
Ammonia nitrogen (mg/l)	0.011	0.070	0.026	nd	0.021	0.069	0.019	0.042	0.104	0.041	0.121	0.363	0.050
Total Phosphorus (mg/l)	0.119	1.049	0.800	0.651	0.430	0.720	0.478	2.067	1.155	1.253	0.640	1.144	0.850
Fluorides (mg/l)	2.05	1.95	1.65	0.50	0.55	0.45	0.30	1.50	0.05	1.45	0.15	1.45	0.55
Total Iron (mg/l)	0.04	1.25	1.32	0.08	0.06	3.48	0.42	2.94	1.37	0.37	0.44	3.98	0.31
Sulphates (mg/l)	29.9	108.2	37.0	23.3	6.8	5.2	12.5	25.2	4.1	30.7	8.4	27.2	16.5
BOD_5 (mg/l)	2	13	9	5	nd	nd	8	1	2	16	5	nd	1
COD (mg/l)	18	40	23	20	21	12	24	8	10	37	13	17	9

Key: 1 – Kafiga borehole 2 – River kyoganibanywa 3 – River Kafinga Matanda 4- Protected Spring 5 – Mufifi Borehole 6 – River Kiruru Reservoir 7 – Kinyangwe protected spring 8 – River Rafinga II Matanda 9 – Kabukwenda shallow Well 10 – Tributary of Kiruruma 11- Mbabafi Felix Spring 12 – River Kiruruma Confluence point 13 – Marita Shallow well; n.d - not detected: Detection limit for Nitrates, Ammonia nitrogen and BOD_5 is 0.015, 0.008 and 10mg/l respectively

Checked by: Mrs. R. Kulabako (PhD)
In-charge PHEE lab

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CERTIFICATE OF ANALYSIS-WATER QUALITY

CLIENT: Air, Water and Earth Ltd (MWE) **PROJECT**: ESIA and RAP for Rwimu, Kibimba, Matanda Irrigation Schemes

Sampling date: 3rd June 2020 **Delivery date**: 8th June 2020 **Analysis dates**: 8th -10th June 2020

Sample ID/ Parameter	PA	PB	PC	PD	PE	WHO drinking water standards*
Apparent colour (PtCo)	471	590	630	570	340	ns
Turbidity (FAU)	69	80	82	85	49	5
Total suspended solids (TSS) (mg/l)	62	75	89	77	57	nil
Total Alkalinity (mg/l)	135	140	145	150	105	ns
Nitrates (mg/l)	nd	nd	nd	nd	6.3	50
Ammonia nitrogen (mg/l)	0.013	0.011	0.005	0.010	0.015	ns
Total Phosphorus (mg/l)	0.592	0.674	0.68	0.842	0.484	ns
Fluorides (mg/l)	0.20	0.20	0.30	nd	0.50	1.5
Total Iron (mg/l)	2.91	3.02	3.08	3.62	0.78	0.3†
BOD_5 (mg/l)	28	31	26	42	19	ns
COD (mg/l)	78	92	52	97	50	ns

*WHO drinking water standards (2017); ns-not specified;
n.d - not detected: Detection limit for Nitrates and Fluorides is 0.015 mg/l;
†*For aesthetic reasons. No health based guideline value given.*

Commentary

The water was sampled from the specified locations traversing River Kiruruma (PA-PD) and a spring (PE) to ascertain the baseline water quality. A comparison with WHO drinking water standards indicates that the water from the sampled locations does not comply for turbidity, TSS and Total Iron. Observation of the samples from these sources shows that the water is not clear and is with some suspended materials. The high iron levels (>0.3mg/l) measured in all the samples are associated with undesirable taste in beverages, staining of sanitary ware and laundry. The source of the iron in the water at all the sampled locations may likely be due to the chemical composition of the soils within the catchment. The measured apparent colour and turbidity levels, suspended solids and total iron concentrations for these sources negatively impacts the aesthetics (colouration, e.g., dirty for PA) of the water. The Total Phosphorus concentrations in these water sources shows that these sources are not likely recipients of wastewaters or runoff from the catchment area containing relatively high levels of phosphorus which nutrient is associated with eutrophication. Whereas WHO does not specify standards for BOD_5 and COD (typically wastewater quality parameters), a comparison with national effluent discharge standards shows that these are below (BOD_5<50mg/l; COD<100mg/l). However, locations PB and PD may be recipients of relatively high strength wastewater (with high organic material).

Rkakawunde
Checked by: Mrs. R. Kulabako (PhD)
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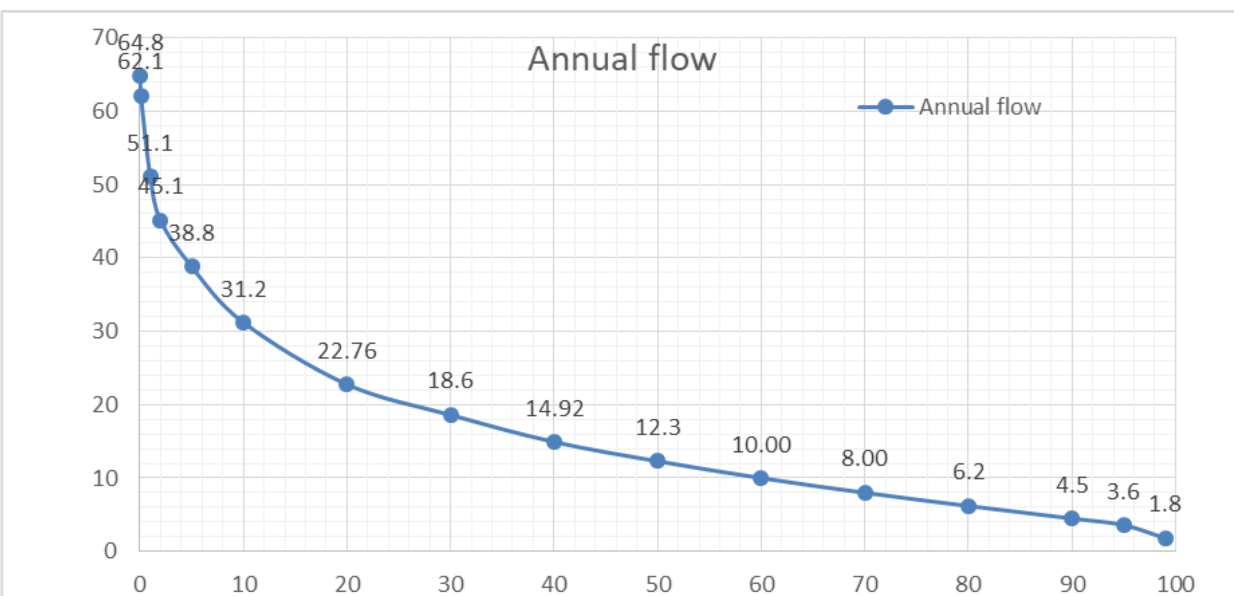
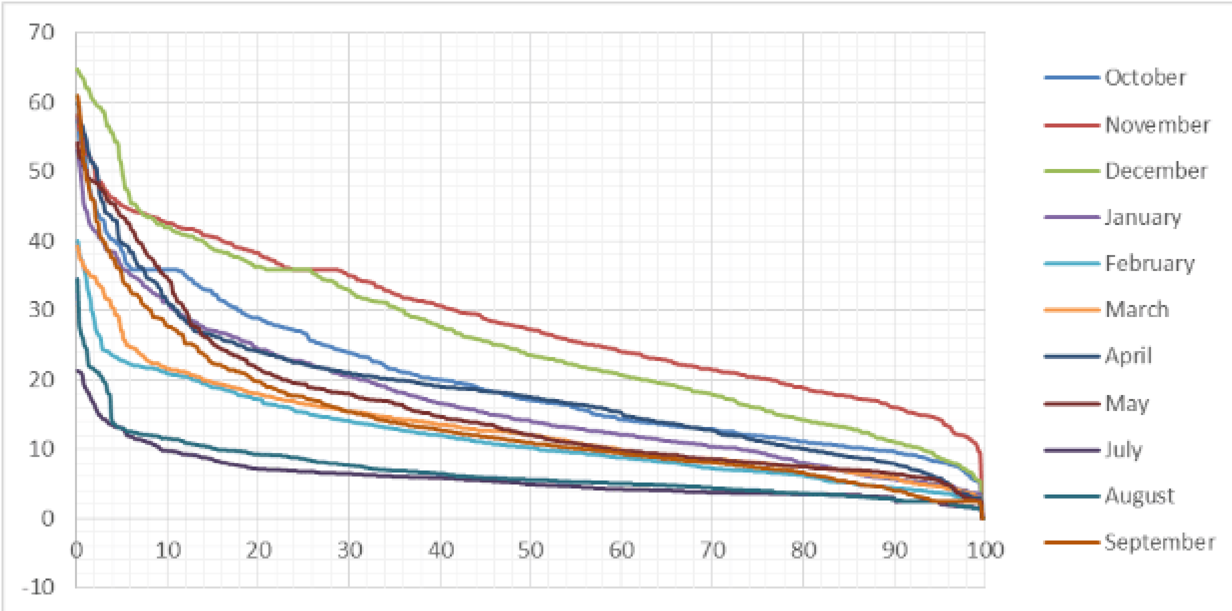
APPENDIX P OTHER RIVERS FLOWING THROUGH QUEEN ELIZABETH NATIONAL PARK (NTUNGWE DRAINAGE NETWORK

A. FDC Curve for River Mitano

The FDC developed daily discharges of the River Mitano at the proposed intake for Enengo Irrigation scheme. The Mitano river flow was expressed as variation over the year. The vertical axis indicated the flow while the horizontal axis gives the percentage of the year or months that the flow exceeds the value given on the y-axis. FDC indicated the level of flow that will be available for at least 50% of the year (Q50). The Low flow indices are based on more than 50% exceedance obtained from FDC. The flow exceeded for 95% of the year (Q95) which was taken as the characteristic value for minimum river flow. A flattened curve reveals a heavily spring-fed river with the annual flow spread more evenly over the year, giving useful flow for a longer period, and less severe floods. The base flow index and sharp of the curve reveals the sustained flow throughout the year which relatively significant volume contributed by ground water. Based on Ugandan Directorate of Water Resource Management (DWRM) guidelines the low flow is indicated by Q90 (4.9m^3/s) and Q95 (3.9m^3/s) as revealed by the FDC. However many studies have reported Q95 and Q90 values to be highly inadequate to meet environmental flow requirements and even the growth of some fish species (Caissie and El-Jabi 1995), for this study to ensure environmental sustainability the low flow can be consider as Q99(2.0m^3/s) as per the FDC since the river is perennial stream. Since the river stretch below the proposed take off point is no longer in its pristine natural state, the FDC was modified for current state observed as modified and largely modified in most section of the river. The water requirement for ecological functions under low flow scenarios indicated by Q99 (1.3) and Q99 (0.8) for moderately and largely Modified status of river respectively.



Figure; Flow duration curve for the period of analysis at Enengo intake



Figure; monthly flows exceedance at different times

The river discharges have been delineated into for environmental flow components based on realization by research ecologist that river hydrographs can be divided into a repeating set of hydrographic patterns that are ecologically relevant. The components consider here are; i) low flows, ii) Extreme low flows, iii) small floods and iv) large floods. Not only is it essential to maintain adequate flows during low flow periods, but higher flows and floods and also extreme low flow conditions also perform important ecological functions.

The fundamental principle considered in this study is to establish flows that maintain integrity, natural seasonality and variability of flows, including floods and low flows. It can be noted that though the FDCs at both indicate the availability of water in river Mitano but is of limited advantage from the biological point of view because the biota is significantly affected by time of the year when they experience a particular flow volume and velocity.

The extreme low flow threshold was estimated as 4.3 m^3/s (Table 11) and Extreme low peak estimated at 3.65m^3/s (Table 12). The extreme low flow at 10% percentile correlates with the Q99 obtained for largely modified flow duration curve in the thresholds for high flow, small floods and large floods are indicated in Table 12. The low flow thresholds (Table 12) allow surface water abstractions for Irrigation and assessment of effluent discharge limits in receiving streams (smakhtin and Toulouse, 1998).

Table; Environmental Flow Component (EFC) thresholds

EFC Flow threshold	**Medians**
EFC High flow threshold	20.8
EFC Extreme low flow threshold	4.3
EFC small flood minimum peak flow	46.3
EFC large flood minimum peak flow:	61.66

Table; Environmental Flow Component Parameters at different thresholds

EFC Parameters	10%	25%	50%	75%	90%	(75-25)/50
Extreme Low Peak	0.75	3.1	3.65	4.05	4.17	0.2603
High flow peak	22.26	24.43	26.4	29.4	31.74	0.1884
Small Flood peak	46.48	48.6	54.2	56.9	59.44	0.1531
Large Flood Peak	62.1	62.1	63.45	64.8	64.8	0.04255

a) Low flow and minimum volume frequency analysis

The low flow analysis for River Mitano used hydrological based flow indices and exceedance percentiles to recommend low flow and in stream conditions. A flow index, such as the 7Q10 flow interpreted as the 7-day low flow with a 10-year return period and the exceedance percentile 7Q10 was estimated as 2.2m^3/s. 7Q10 (2.2m^3/s) index represents minimum quantity of stream flow necessary to protect the habitat during drought situation. The low flow and volume frequency analysis was run for durations of 1, 3, 7, 15, 30, 60, and 90 for specified percentiles of 10, 25, 50, 75 and 90%.

It's evident from the low flow analysis that river Mitano is perennial stream with no single day without follows.

Table; Low flow and minimum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day minimum	0.3	2.9	4.1	5.0	7.2	0.5
3-day minimum	1.6	3.0	4.1	5.0	7.5	0.5
7-day minimum	2.2	3.1	4.1	5.3	8.0	0.5
30-day minimum	2.6	3.4	4.4	6.0	9.2	0.6
90-day minimum	2.7	4.2	5.9	8.3	12.0	0.7

Table; Low flow exceeded at different times for different durations in days

Percentage of Time Exceeded	1	3	7	15	30	60	90	120	183
99	9.6	10.1	11.2	13.3	13.7	18	16.4	18.2	21.1
95	7.7	7.9	8.4	9.3	9.8	10.8	11.7	12.9	16.7
90	6.7	6.8	7.1	7.7	8.2	8.6	9.8	10.8	14.6
80	5.7	5.7	5.9	6.2	6.7	6.8	8	8.8	12.3
70	5.1	5	5.1	5.3	5.8	5.8	6.9	7.6	10.8
60	4.5	4.4	4.5	4.7	5.1	5.2	6.1	6.7	9.6
50	4.1	3.9	4	4.2	4.5	4.7	5.5	6	8.6
40	3.7	3.4	3.6	3.7	4.1	4.4	4.9	5.4	7.7
30	3.2	3	3.2	3.3	3.6	4	4.4	4.9	6.8
20	2.8	2.5	2.7	2.9	3.1	3.8	3.8	4.3	5.9
10	2.3	2	2.2	2.4	2.6	3.5	3.2	3.6	4.7
5	1.9	1.6	1.9	2	2.2	3.3	2.7	3.1	3.9
2	1.5	1.3	1.5	1.7	1.9	3.2	2.3	2.7	3.2
1	1.3	1.1	1.4	1.5	1.7	3.1	2.1	2.5	2.7
0.5	1.2	0.9	1.2	1.4	1.5	3.1	1.9	2.3	2.4
0.2	1	0.7	1	1.3	1.4	3	1.7	2	2

b) Peak flow analysis and maximum volume frequency analysis

The frequency of extreme events (floods) was assessed by fitting probability distributions to annual maximum flows derived from the daily stream flow. Maximum volume frequency analysis curves, with proper caution, may be regionalized, and are useful in the study of water supply and storage requirements. Volume curves, relating time to the maximum 1-day, 3-day, 7-day, 30-day and 90-day, discharge was extracted from daily discharge time series (Table 15**.**). The volume curves are important for reservoir design at feasibility and detailed design stage.

Table; Peak flows and maximum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day maximum	33.6	42.2	46.3	55.2	61.9	0.3
3-day maximum	31.9	40.9	44.9	54.0	60.7	0.3
7-day maximum	29.6	37.4	43.7	47.5	59.1	0.2
30-day maximum	22.3	28.2	31.9	41.4	49.8	0.4
90-day maximum	16.8	20.1	22.7	34.2	38.9	0.6
3-day maximum	31.9	40.9	44.9	54.0	60.7	0.3
7-day maximum	29.6	37.4	43.7	47.5	59.1	0.2
30-day maximum	22.3	28.2	31.9	41.4	49.8	0.4
90-day maximum	16.8	20.1	22.7	34.2	38.9	0.6

c) Environmental Flow Components

The Indictors of Hydrologic Alteration (IHA) software version 7.1 calculated parameters for five different types of Environment Flow Components (EFCs): low flows, extreme low flows, high flow pulses, small floods and large floods. High-flow pulses included any water rises that do not overtop the channel banks. These pulses provide important and necessary disruptions in low flows. During drought periods, rivers drop to very low levels **(Extreme Low flows)** that can be stressful for many organisms, but may provide necessary conditions for other species, flows during such period represent the extreme low flows. These low-flow levels are sustained by groundwater discharge into the river Low flows are the dominant flow condition in most rivers. In natural rivers, after a rainfall event has passed and associated surface runoff from the catchment has subsided, the river returns to its base- or low-flow level. During **small floods**, fish and other mobile organisms are able to move upstream, downstream, and out into floodplains or flooded wetlands to access additional habitats such as secondary channels, backwaters, sloughs, and shallow flooded areas. Extreme floods **(Large floods)**– will typically re-arrange both the biological and physical structure of a river and its floodplain. These large floods can literally flush away many organisms, thereby depleting some populations but in many cases also creating new competitive advantages for some species.

Table: Environmental flow components (EFC)-Monthly Low Flows at Enengo Intake

Months EFC Low Flows	10%	25%	50%	75%	90%	(75-25)/50
Jan	5.6	8.2	12.5	17.6	19.9	0.7
Feb	4.8	7.2	10.2	14.5	18.7	0.7
Mar	6.1	8.4	11.9	15.0	17.0	0.6
Apr	8.0	10.6	16.3	17.7	19.0	0.4
May	6.9	7.9	10.6	14.9	18.0	0.7
Jun	5.2	5.7	8.5	11.1	14.5	0.6

Months EFC Low Flows	10%	25%	50%	75%	90%	(75-25)/50
Jul	4.5	5.0	6.0	6.7	10.2	0.3
Aug	4.5	5.1	6.2	8.1	11.7	0.5
Sep	6.2	7.9	11.1	13.0	17.0	0.5
Oct	10.5	11.8	12.7	17.3	19.5	0.4
Nov	15.3	16.4	17.4	18.9	20.0	0.1
Dec	10.1	13.3	16.4	18.1	19.5	0.3

The EFC extreme low flow threshold is **4.3 m^3/s with the extreme low peak indicated as 3.65m^3/s** while the extreme high flow threshold was **26.4m^3/s.** The annual extreme low peak was **estimated to occur** for duration of 5.75days while the high flow peak was estimated for duration of 6days.

Table: Environmental flow components (EFC)-Extreme Low Flows, High flows, small floods and Large Floods at Enengo Intake

EFC Parameters	Medians	Coefficient of Dispersion
Extreme low peak	3.65	0.26
Extreme low duration	5.75	2.04
Extreme low timing	200	0.23
Extreme low freq.	1	5.00
High flow peak	26.4	0.19
High flow duration	6	0.71
High flow timing	327	0.32
High flow frequency	6	0.58
High flow rise rate	2.717	0.79
High flow fall rate	-1.897	-0.61
Small Flood peak	54.2	0.15
Small Flood duration	23	1.70
Small Flood timing	119	0.42
Small Flood freq.	1	1.00
Small Flood rise rate	3.144	1.13
Small Flood fall rate	-1.671	-0.86
Large flood peak	63.45	0.04
Large flood duration	127	0.32
Large flood timing	350.5	0.05
Large flood freq.	0	0.00
Large flood rise rate	0.5062	0.25
Large flood fall rate	-1.093	-0.24

RIVER IBALYA FLOW DURATION ANALYSIS

River Ibalya is a tributary of river Kiruruma gauged 0:34:51, 29:47:35E at Elevation 1010 on Kanunugu-Katete Road. At the gauging point the river drains a catchment area of approximately 119sqkm. Usable Historical discharge Data for river Ibalya is available for period 1964 to 1982. From historical hydrological data available the median monthly flow in the River Ibalya varies between 0.781m^3/s to 1.622m^3/s in dry (July) and wet seasons (September) respectively. However, these flow rates do not take floods peaks into considerations. The mean annual flow was 1.33 with coefficient of variation of 0.86.

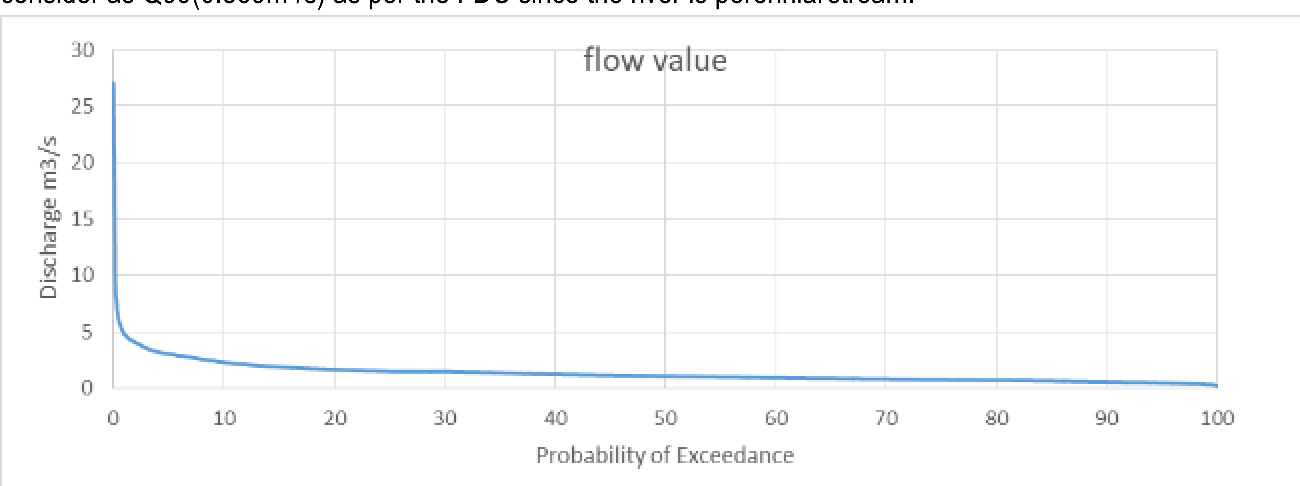
Predictability ranges in value from 0 to 1 and is composed of two additive components: constancy (C), a measure of temporal invariance, and contingency (M), a measure of periodicity. The predictability of a stream with very constant flow will be mostly due to C, while the predictability of a stream with highly variable flow with a fixed periodicity will be mostly due to M. Length of flood-free season. This is the length in days of the longest period common to all water years where flows are at or below the high pulse threshold in every year.

Table; Annual flow statistics for different period of analysis for river Ibalya

Period of Analysis	Mean Annual Flow	Annual C. V	Flow Predictability	Constancy/ Predictabili ty	% of Floods in 60d Periods	Flood Free Season
1964-1982 (21Years)	1.33	0.86	0.57	0.86	0.27	4

B. FDC Curve

The FDC developed daily discharges of the River Ibalya at the gauging point expressed as variation over the year. The vertical axis indicated the flow while the horizontal axis gives the percentage of the year or months that the flow exceeds the value given on the y-axis. FDC indicated the level of flow that will be available for at least 50% of the year (Q50). The Low flow indices are based on more than 50% exceedance obtained from FDC. The flow exceeded for 95% of the year (0.472) which was taken as the characteristic value for minimum river flow. A flattened curve reveals a heavily spring-fed river with the annual flow spread more evenly over the year, giving useful flow for a longer period, and less severe floods. The base flow index (0.394) and sharp of the curve reveals the sustained flow throughout the year which relatively significant volume contributed by ground water. Based on Ugandan Directorate of Water Resource Management (DWRM) guidelines the low flow is indicated by Q90 (0.56m^3/s) and Q95 (0.472m^3/s) as revealed by the FDC (Figure 12). However many studies have reported Q95 and Q90 values to be highly inadequate to meet environmental flow requirements and even the growth of some fish species (Caissie and El-Jabi 1995), for this study to ensure environmental sustainability the low flow can be consider as Q99(0.369m^3/s) as per the FDC since the river is perennial stream.



Figure; Flow duration curve for River Ibalya

The river discharges have been delineated into for environmental flow components based on realization by research ecologist that river hydrographs can be divided into a repeating set of hydrographic patterns that are ecologically relevant. The components consider here are i) low flows, ii) Extreme low flows, iii) small floods and iv) large floods. Not only is it essential to maintain adequate flows during low flow periods, but higher flows and floods and also extreme low flow conditions also perform important ecological functions. The fundamental principle considered in this study is to establish flows that maintain integrity, natural seasonality and variability of flows, including floods and low flows. It can be noted that though the FDCs at both indicate the availability of water in river Ibalya. The extreme low flow threshold was estimated as 0.564m^3 and Extreme low peak estimated at 0.5093m^3/s (Table 18). The extreme low flow at 10% percentile correlates with the Q99.The low flow thresholds (Table 18) allow surface water abstractions for Irrigation and assessment of effluent discharge limits in receiving streams (smakhtin and Toulouse, 1998).

Table; Environmental Flow Component (EFC) thresholds

EFC Flow threshold	Medians
EFC High flow threshold	1.492
EFC Extreme low flow threshold	0.564
EFC small flood minimum peak flow	7.97
EFC large flood minimum peak flow:	24.89

Table; Environmental Flow Component Parameters at different thresholds

EFC Parameters	10%	25%	50%	75%	90%	(75-25)/50
Extreme Low Peak	0.4195	0.496	0.509	0.516	0.528	0.04
High flow peak	1.601	1.863	2.01	2.19	2.28	0.1609
Small Flood peak	7.972	8.062	12.73	13.47	18.75	0.425
Large Flood Peak	24.89	24.89	26	27.11	27.11	0.0855

a) Low flow and minimum volume frequency analysis

The low flow analysis for River Ibalya used hydrological based flow indices and exceedance percentiles to recommend low flow and in stream conditions. A flow index, such as the 7Q10 flow interpreted as the 7-day low flow with a 10-year return period and the exceedance percentile 7Q10 was estimated as 0.31m^3/s (Table 21). 7Q10 (0.31m^3/s) index represents minimum quantity of stream flow necessary to protect the habitat during drought situation. The low flow and volume frequency analysis was run for durations of 1, 3, 7, 15, 30, 60, and 90 for specified percentiles of 10, 25, 50, 75 and 90%. It's evident from the low flow analysis that river Ibalya is perennial stream with no single day without follows.

Table; Low flow and minimum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day minimum	0.25	0.37	0.43	0.57	0.68	0.46
3-day minimum	0.28	0.39	0.48	0.62	0.72	0.50
7-day minimum	0.31	0.40	0.51	0.64	0.82	0.46
30-day minimum	0.33	0.48	0.59	0.72	0.86	0.42
90-day minimum	0.51	0.59	0.81	0.93	1.02	0.43

Table; Low flow exceeded at different times for different durations in days

Percent Chance Exceedance	1	3	7	15	30	60	90	120	183
99	0.80	0.80	1.00	1.00	1.00	1.10	1.20	1.30	1.70
95	0.70	0.70	0.80	0.80	0.90	1.00	1.00	1.20	1.40
90	0.60	0.70	0.70	0.70	0.80	0.90	1.00	1.10	1.30
80	0.60	0.60	0.60	0.70	0.70	0.80	0.90	1.00	1.20
50	0.50	0.50	0.50	0.50	0.60	0.60	0.70	0.80	1.00
20	0.30	0.30	0.40	0.40	0.40	0.50	0.60	0.70	0.80
10	0.30	0.30	0.30	0.30	0.40	0.40	0.50	0.60	0.70
5	0.20	0.30	0.30	0.30	0.30	0.40	0.40	0.50	0.70
2	0.20	0.20	0.20	0.30	0.30	0.30	0.40	0.50	0.60
1	0.20	0.20	0.20	0.20	0.20	0.30	0.40	0.40	0.60
0.5	0.10	0.20	0.20	0.20	0.20	0.30	0.30	0.40	0.60
0.2	0.10	0.10	0.20	0.20	0.20	0.20	0.30	0.30	0.50

b) Peak flow analysis and maximum volume frequency analysis

The frequency of extreme events (floods) was assessed by fitting probability distributions to annual maximum flows derived from the daily stream flow. Maximum volume frequency analysis curves, with proper caution, may be regionalized, and are useful in the study of water supply and storage requirements. Volume curves, relating time to the maximum 1-day, 3-day, 7-day, 30-day and 90-day, discharge was extracted from daily discharge time series (Table 23). The volume curves are important for reservoir design at feasibility and detailed design stage.

Table; Peak flows and maximum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day maximum	3.81	4.71	7.97	12.79	24.89	1.01
3-day maximum	3.50	4.13	5.63	8.38	18.59	0.75
7-day maximum	2.84	3.47	4.28	5.59	10.82	0.50
30-day maximum	1.86	2.22	2.60	3.45	4.32	0.47
90-day maximum	1.26	1.62	1.82	2.21	2.67	0.33

c) Environmental Flow Components

The Indictors of Hydrologic Alteration (IHA) software version 7.1 calculated parameters for five different types of Environment Flow Components (EFCs): low flows (Table 23), extreme low flows, high flow pulses, small floods and large floods. High-flow pulses included any water rises that do not overtop the channel banks. These pulses provide important and necessary disruptions in low flows. During drought periods, rivers drop to very low levels **(Extreme Low flows)** that can be stressful for many organisms, but may provide necessary conditions for other species, flows during such period represent the extreme low flows. These low-flow levels are sustained by groundwater discharge into the river Low flows are the dominant flow condition in most rivers. In natural rivers, after a rainfall event has passed and associated surface runoff from the catchment has subsided, the river returns to its base- or low-flow level. During **small floods**, fish and other mobile organisms are able to move upstream, downstream, and out into floodplains or flooded wetlands to access additional habitats such as secondary channels, backwaters, sloughs, and shallow flooded areas. Extreme floods **(Large floods)** – will typically re-arrange both the biological and physical structure of a river and its floodplain. These large floods can literally flush away many organisms, thereby depleting some populations but in many cases also creating new competitive advantages for some species.

Table: Environmental flow components (EFC)-Monthly Low Flows at River Ibalya

Months EFC Low Flows	10%	25%	50%	75%	90%	(75-25)/50
Jan	0.63	0.74	0.89	1.09	1.44	0.39
Feb	0.67	0.71	0.79	0.95	1.24	0.30
Mar	0.69	0.76	0.84	0.96	1.24	0.24
Apr	0.71	0.85	1.03	1.23	1.44	0.36
May	0.75	0.87	1.10	1.24	1.42	0.34
Jun	0.77	0.83	0.88	1.16	1.41	0.37
Jul	0.61	0.64	0.81	1.00	1.37	0.44
Aug	0.65	0.72	0.85	1.03	1.20	0.36
Sep	0.71	0.86	1.06	1.36	1.42	0.47
Oct	0.80	0.99	1.22	1.40	1.45	0.33
Nov	0.98	1.10	1.20	1.37	1.43	0.22
Dec	0.77	0.90	1.10	1.29	1.46	0.36

The EFC extreme low flow threshold is **0.5564 m^3/s with the extreme low peak indicated as 0.5093m^3/s** while the extreme high flow threshold was **1.492m^3/s.** The annual extreme low peak was **estimated to occur** for duration of 3.0days while the high flow peak was estimated for duration of 3days.

Table: Environmental flow components (EFC)-Extreme Low Flows, High flows, small floods and Large Floods for river Ibalya

EFC Parameters	Medians	Coefficient of Dispersion
Extreme low peak	0.5093	0.03903
Extreme low duration	3	0.7083
Extreme low timing	81	0.3924
Extreme low freq.	4	2
High flow peak	2.01	0.1609
High flow duration	3	0.4167
High flow timing	248	0.4997
High flow frequency	13	0.4615
High flow rise rate	0.467	0.6607
High flow fall rate	-0.3143	-0.6527
Small Flood peak	12.73	0.425
Small Flood duration	16	1.406
Small Flood timing	290	0.4973
Small Flood freq.	0	0
Small Flood riserate	2.561	1.544
Small Flood fallrate	-0.7428	-0.7274
Large flood peak	26	0.08549
Large flood duration	32	0.875
Large flood timing	92	0.1803
Large flood freq.	0	0

EFC Parameters	Medians	Coefficient of Dispersion
Large flood riserate	2.142	0.009659
Large flood fallrate	-2.163	-1.398

RIVER RUSHAYA FLOW DURATION ANALYSIS

The flow series for river Rushaya was segmented into two that is from 1959 to 1961 and from 1964 to 1971. The Minimum and maximum flows for the 1964 to 1971 series were 0.156 and 42.373 m^3/s respectively with a mean of 1.974m^3/s. The monthly averages ranged between 0.56 m3/s (July) to 4.56m^3/s (September).

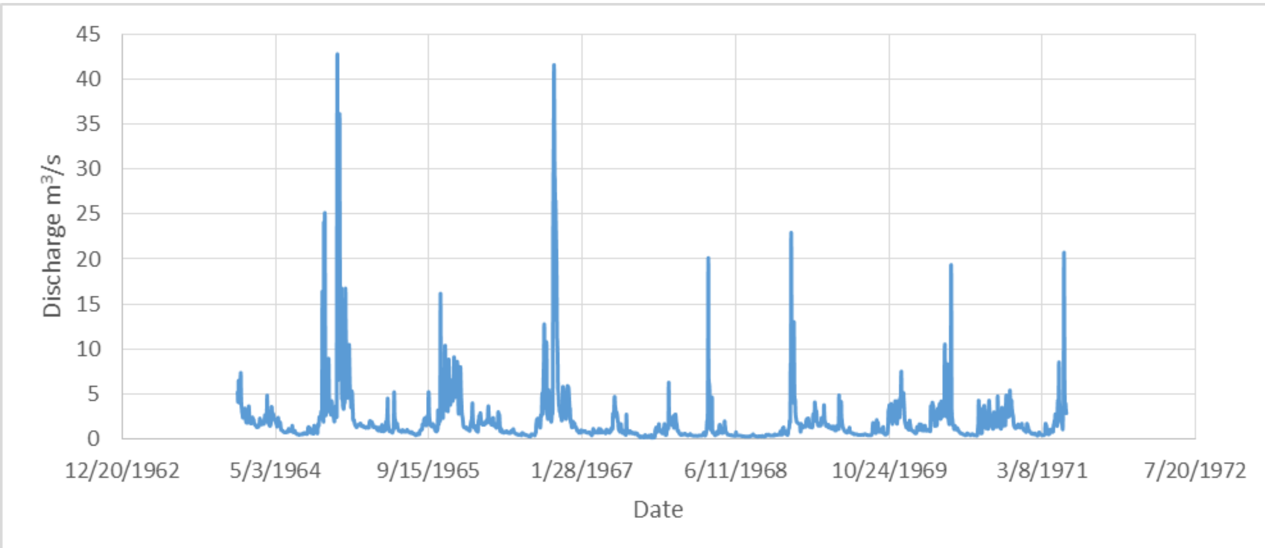


Figure: River Rushaya Hydrograph 1964 to 1971

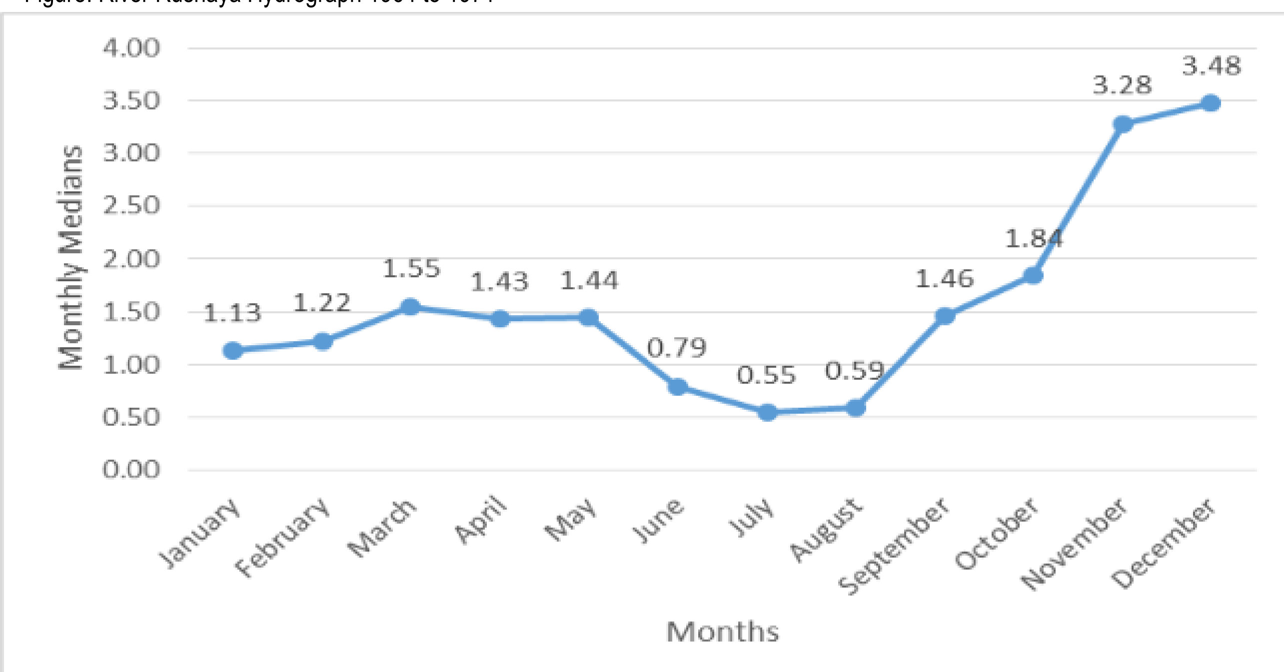


Figure : River Rushaya monthly median flows (1964 to 1971)

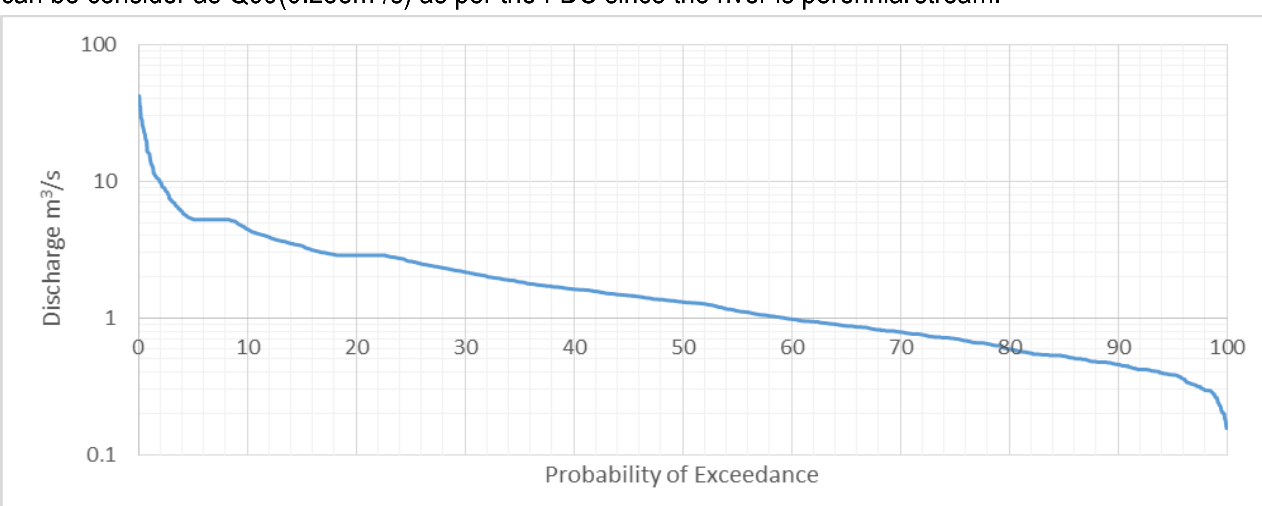
Predictability ranges in value from 0 to 1 and is composed of two additive components: constancy (C), a measure of temporal invariance, and contingency (M), a measure of periodicity. The predictability of a stream with very constant flow will be mostly due to C, while the predictability of a stream with highly variable flow with a fixed periodicity will be mostly due to M. Length of flood-free season. This is the length in days of the longest period common to all water years where flows are at or below the high pulse threshold in every year.

Table; Annual flow statistics for different period of analysis at Gauge site of River Rushaya

Period of Analysis	Mean Annual Flow	Annual C. V	Flow Predictability	Constancy/Predictability	% of Floods in 60d Periods	Flood Free Season
1964 to 1971	2.12	1.41	0.52	0.64	0.4	11

C. FDC Curve

The FDC developed daily discharges of the River Rushaya was expressed as variation over the year. The vertical axis indicated the flow while the horizontal axis gives the percentage of the year or months that the flow exceeds the value given on the y-axis. FDC indicated the level of flow that will be available for at least 50% of the year (Q50). The Low flow indices are based on more than 50% exceedance obtained from FDC. The flow exceeded for 95% of the year (Q95) which was taken as the characteristic value for minimum river flow. A flattened curve reveals a heavily spring-fed river with the annual flow spread more evenly over the year, giving useful flow for a longer period, and less severe floods. The base flow index and sharp of the curve reveals the sustained flow throughout the year which relatively significant volume contributed by ground water. Based on Ugandan Directorate of Water Resource Management (DWRM) guidelines the low flow is indicated by Q90 ($0.456m^3/s$) and Q95 ($0.384m^3/s$) as revealed by the FDC (Table 26). However many studies have reported Q95 and Q90 values to be highly inadequate to meet environmental flow requirements and even the growth of some fish species (Caissie and El-Jabi 1995), for this study to ensure environmental sustainability the low flow can be consider as Q99($0.258m^3/s$) as per the FDC since the river is perennial stream.



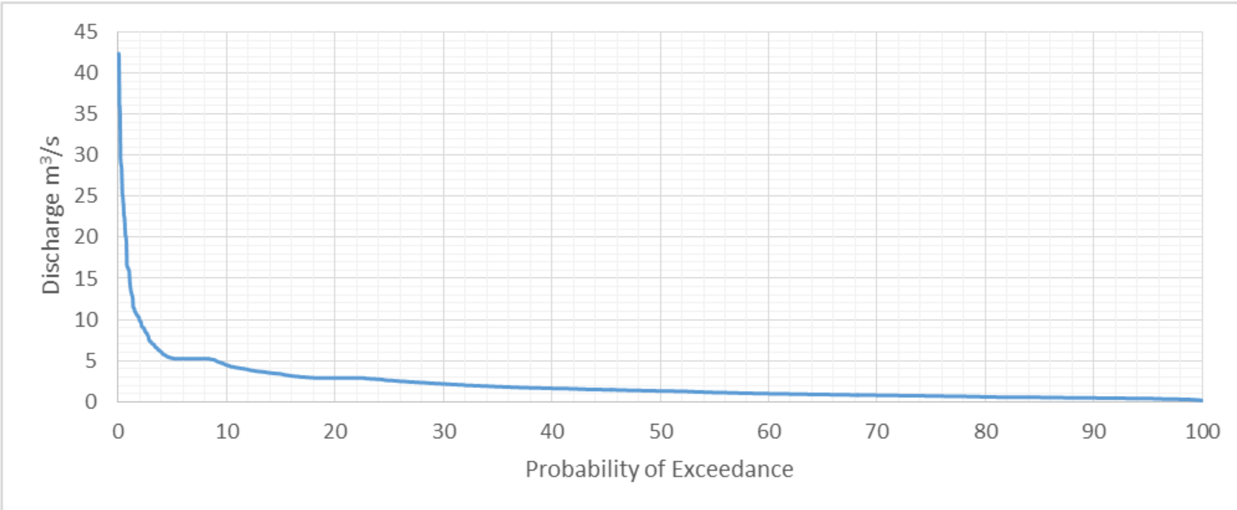


Figure ; Flow duration curve for river Rushaya

The river discharges have been delineated into for environmental flow components based on realization by research ecologist that river hydrographs can be divided into a repeating set of hydrographic patterns that are ecologically relevant. The components consider here are i) low flows, ii) Extreme low flows, iii) small floods and iv) large floods. Not only is it essential to maintain adequate flows during low flow periods, but higher flows and floods and also extreme low flow conditions also perform important ecological functions. The fundamental principle considered in this study is to establish flows that maintain integrity, natural seasonality and variability of flows, including floods and low flows. It can be noted that though the FDCs indicate the availability of water in river Rushaya. The extreme low flow threshold was estimated as 0.457m^3/s and Extreme low peak estimated at 0.421 m^3/s (Table 26). The extreme low flow at 10% percentile correlates with the Q99 obtained for largely modified flow duration curve. The thresholds for high flow, small floods and large floods are indicated. The low flow thresholds allow surface water abstractions for Irrigation and assessment of effluent discharge limits in receiving streams (smakhtin and Toulouse, 1998).

Table; Environmental Flow Component (EFC) thresholds

EFC Flow threshold	Medians
EFC High flow threshold	0.457
EFC Extreme low flow threshold	0.421
EFC small flood peak flow	23.85
EFC large flood peak flow:	42.37

Table; Environmental Flow Component Parameters at different thresholds

EFC Parameters	10%	25%	50%	75%	90%	(75-25)/50
Extreme Low Peak	0.29	0.40	0.42	0.43	0.44	0.05
High flow peak	3.22	3.39	3.91	4.71	5.48	0.34
Small Flood peak	20.27	20.88	23.85	37.40	41.54	0.69
Large Flood Peak			42.37			

a) Low flow and minimum volume frequency analysis

The low flow analysis for River Rushaya used hydrological based flow indices and exceedance percentiles to recommend low flow and in stream conditions. A flow index, such as the 7Q10 flow interpreted as the 7-day low flow with a 10-year return period and the exceedance percentile 7Q10 was estimated as 0.3m^3/s (Table 29). 7Q10 (0.3m^3/s) index represents minimum quantity of stream flow necessary to protect the habitat during drought situation. The low flow and volume frequency analysis was run for durations of 1, 3, 7, 15, 30, 60, and 90 for specified percentiles of 10, 25, 50, 75 and 90%. It's evident from the low flow analysis that river Rushaya is perennial stream with no single day without follows.

Table; Low flow and minimum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day minimum	0.16	0.28	0.38	0.43	0.48	0.38
3-day minimum	0.17	0.29	0.40	0.44	0.49	0.38
7-day minimum	0.18	0.30	0.41	0.47	0.51	0.43
30-day minimum	0.24	0.34	0.47	0.56	0.60	0.45
90-day minimum	0.34	0.47	0.68	0.78	0.87	0.45

Table; Low flow exceeded at different times for different durations in days

Percentage of Time Exceeded	1	3	7	15	30	60	90	120	183
99	0.8	0.8	0.9	1	1.1	1.1	1.2	1.3	1.5
95	0.7	0.7	0.8	0.8	0.9	1	1.1	1.2	1.4
90	0.6	0.6	0.7	0.7	0.8	0.9	1	1.1	1.4
80	0.6	0.6	0.6	0.6	0.7	0.8	0.9	1	1.3
50	0.4	0.4	0.5	0.5	0.5	0.6	0.7	0.8	1
20	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.8
10	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.6
5	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.5
2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4
1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
0.5	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3
0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2

b) Peak flow analysis and maximum volume frequency analysis

The frequency of extreme events (floods) was assessed by fitting probability distributions to annual maximum flows derived from the daily stream flow. Maximum volume frequency analysis curves, with proper caution, may be regionalized, and are useful in the study of water supply and storage requirements. Volume curves, relating time to the maximum 1-day, 3-day, 7-day, 30-day and 90-day, discharge were extracted from daily discharge time series (Table 30). The volume curves are important for reservoir design at feasibility and detailed design stage.

Table; Peak flows and maximum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day maximum	7.39	16.70	20.20	36.83	42.37	1.00
3-day maximum	5.99	11.54	13.54	24.80	37.02	0.98
7-day maximum	5.26	7.28	9.19	16.37	31.95	0.99
30-day maximum	2.86	4.45	5.32	10.45	14.53	1.13
90-day maximum	1.47	3.06	4.09	6.76	7.70	0.91

c) Environmental Flow Components

The Indictors of Hydrologic Alteration (IHA) software version 7.1 calculated parameters for five different types of Environment Flow Components (EFCs): low flows (Table 31.), extreme low flows, high flow pulses, small floods and large floods. High-flow pulses included any water rises that do not overtop the channel banks. These pulses provide important and necessary disruptions in low flows. During drought periods, rivers drop to very low levels **(Extreme Low flows)** that can be stressful for many organisms, but may provide necessary conditions for other species, flows during such period represent the extreme low flows. These low-flow levels are sustained by groundwater discharge into the river Low flows are the dominant flow condition in most rivers. In natural rivers after a rainfall event has passed and associated surface runoff from the catchment has subsided, the river returns to its base- or low-flow level. During **small floods**, fish and other mobile organisms are able to move upstream, downstream, and out into floodplains or flooded wetlands to access additional habitats such as secondary channels, backwaters, sloughs, and shallow flooded areas. Extreme floods **(Large floods)** – will typically re-arrange both the biological and physical structure of a river and its floodplain. These large floods can literally flush away many organisms, thereby depleting some populations but in many cases also creating new competitive advantages for some species.

Table: Environmental flow components (EFC)-Monthly Low Flows for River Rushaya

Months EFC Low Flows	10%	25%	50%	75%	90%	(75-25)/50
Jan	0.48	0.93	1.13	1.58	2.28	0.58
Feb	0.59	0.69	1.21	1.52	1.84	0.68
Mar	0.54	0.85	1.43	1.81	1.87	0.66
Apr	0.69	0.86	1.19	1.97	2.50	0.93
May	0.70	0.90	1.20	1.62	1.80	0.60
Jun	0.66	0.67	0.79	0.88	0.93	0.27
Jul	0.50	0.52	0.55	0.70	0.77	0.34
Aug	0.52	0.53	0.63	0.82	0.89	0.48
Sep	0.48	1.02	1.23	1.63	1.95	0.50
Oct	0.51	0.66	1.40	2.12	2.24	1.04
Nov	0.65	1.45	2.00	2.42	2.43	0.48
Dec	0.58	0.99	1.45	1.84	1.88	0.58

The EFC extreme low flow threshold is **0.456 m^3/s with the extreme low peak indicated as 0.421m^3/s** while the extreme high flow threshold was **3.907m^3/s.** The annual extreme low peak was **estimated to occur** for duration of 3days while the high flow peak was estimated for duration of 6days.

Table 33: Environmental flow components (EFC)-Extreme Low Flows, High flows, small floods and Large Floods

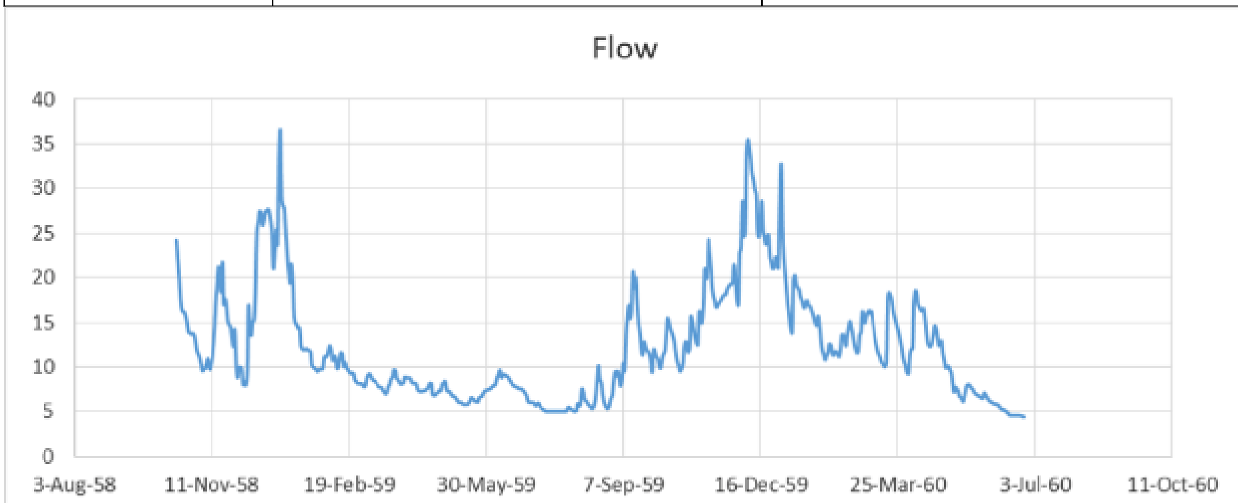
EFC Parameters	Medians	Coefficient of Dispersion
Extreme low peak	0.421	0.05
Extreme low duration	3.5	1.29
Extreme low timing	216	0.11
Extreme low freq.	3.5	0.79
High flow peak	3.907	0.34
High flow duration	3	0.58
High flow timing	364.8	0.33
High flow frequency	7.5	0.77
High flow rise rate	1.098	0.68
High flow fall rate	-0.64	-0.98
Small Flood peak	23.85	0.69
Small Flood duration	30.5	3.03
Small Flood timing	293.5	0.43
Small Flood freq.	0.5	2.00
Small Flood rise rate	5.842	0.27
Small Flood fall rate	-1.348	-0.74
Large flood peak	42.37	
Large flood duration	52	
Large flood timing	326	
Large flood freq.	0	0.00
Large flood rise rate	19.94	
Large flood fall rate	-0.7862	

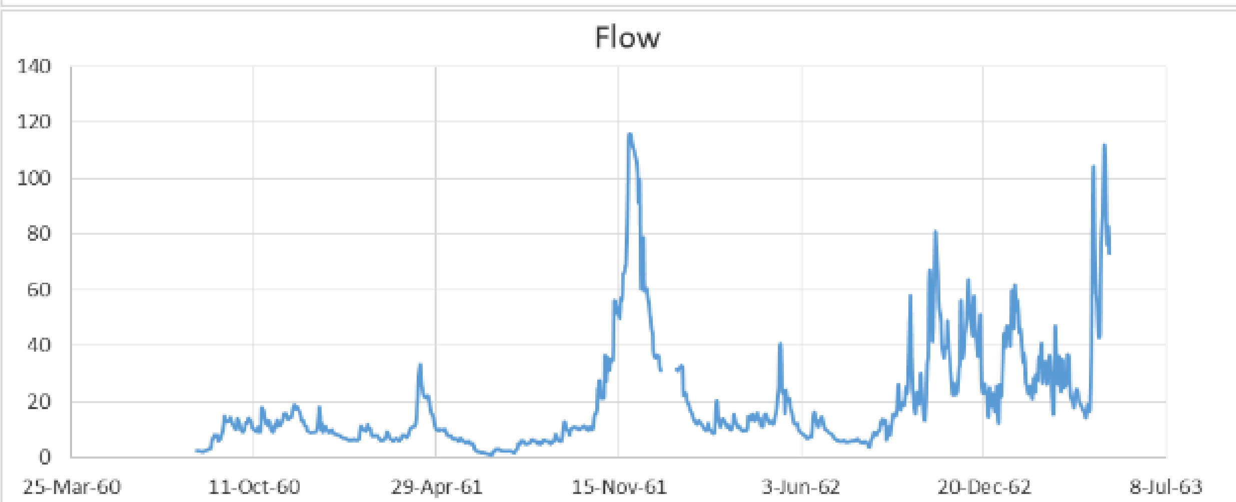
%	No Change	A	B	C	D	E	F
0.01	12.430	12.260	10.630	7.016	4.484	2.796	2.077
0.1	12.260	10.630	7.016	4.484	2.796	2.077	1.684
1	10.630	7.016	4.484	2.796	2.077	1.684	1.439
5	7.016	4.484	2.796	2.077	1.684	1.439	1.008
10	4.484	2.796	2.077	1.684	1.439	1.008	0.815
20	2.796	2.077	1.684	1.439	1.008	0.815	0.709
30	2.077	1.684	1.439	1.008	0.815	0.709	0.465
40	1.684	1.439	1.008	0.815	0.709	0.465	0.399
50	1.439	1.008	0.815	0.709	0.465	0.399	0.278
60	1.008	0.815	0.709	0.465	0.399	0.278	0.253
70	0.815	0.709	0.465	0.399	0.278	0.253	0.250
80	0.709	0.465	0.399	0.278	0.253	0.250	0.248
90	0.465	0.399	0.278	0.253	0.250	0.248	0.246
95	0.399	0.278	0.253	0.250	0.248	0.246	0.243
99	0.278	0.253	0.250	0.248	0.246	0.243	0.241
99.9	0.253	0.250	0.248	0.246	0.243	0.241	0.239
99.99	0.250	0.248	0.246	0.243	0.241	0.239	0.237

NTUNGWE RIVER FLOW DURATION ANALYSIS

The flow series for river Ntungwe was segmented into two that is from 1959 to 1961 and from 1964 to 1971. The monthly median flows for the period 1960 to 1963 series ranged between 4.339 and 25.95 m3/s respectively. The mean annual flow for the period 1960 to 1963 was 21.64 m^3/s.

	Period of Analysis: 1959-1960 (2 years)	Period of Analysis: 1960-1963 (4 years)
January	14.45	19.36
February	11.23	10.01
March	11.03	9.376
April	10.25	15.47
May	6.77	12.25
June	6.245	6.397
July	4.77	4.339
August	5.21	6.148
September	8.183	14.15
October	18.18	11.65
November	15.42	25.95
December	24.5	23.49





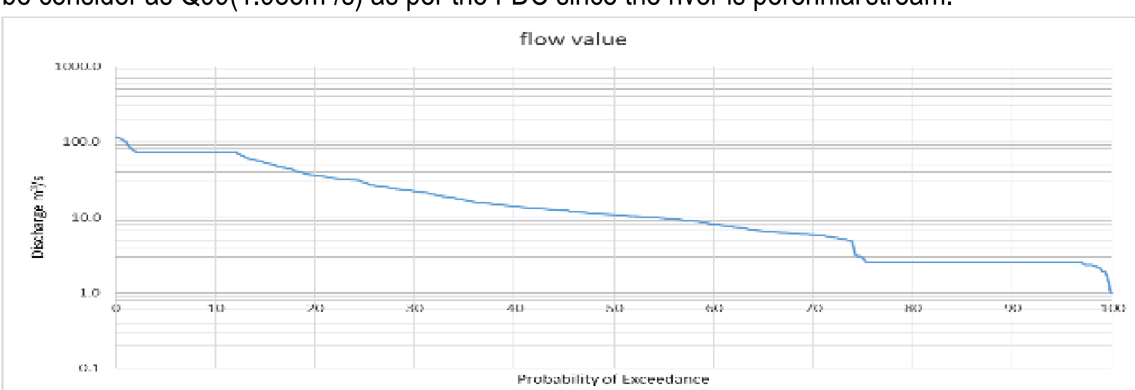
Predictability ranges in value from 0 to 1 and is composed of two additive components: constancy (C), a measure of temporal invariance, and contingency (M), a measure of periodicity. The predictability of a stream with very constant flow will be mostly due to C, while the predictability of a stream with highly variable flow with a fixed periodicity will be mostly due to M. Length of flood-free season. This is the length in days of the longest period common to all water years where flows are at or below the high pulse threshold in every year.

Table; Annual flow statistics for different period of analysis at Gauge site of River Ntungwe

	Period of Analysis: 1959-1960 (2 years)	Period of Analysis: 1960-1963 (4years)
Normalization Factor	1	1
Mean annual flow	11.47	21.64
Non-Normalized Mean Flow	11.47	21.64
Annual C. V.	0.58	1.15
Flow predictability	0.84	0.52
Constancy/predictability	0.58	0.58
% of floods in 60d period	0.38	0.5
Flood-free season	148	16

D. FDC Curve

The FDC developed daily discharges of the River Ntungwe was expressed as variation over the year. The vertical axis indicated the flow while the horizontal axis gives the percentage of the year or months that the flow exceeds the value given on the y-axis. FDC indicated the level of flow that will be available for at least 50% of the year (Q50 (10.8 m^3/s)). The Low flow indices are based on more than 50% exceedance obtained from FDC. The flow exceeded for 95% of the year (Q95) which was taken as the characteristic value for minimum river flow. A flattened curve reveals a heavily spring-fed river with the annual flow spread more evenly over the year, giving useful flow for a longer period, and less severe floods. The base flow index and sharp of the curve reveals the sustained flow throughout the year which relatively significant volume contributed by ground water. Based on Ugandan Directorate of Water Resource Management (DWRM) guidelines the low flow is indicated by Q90 (2.57m^3/s) and Q95 (2.57m^3/s) as revealed by the FDC (Table 26). However many studies have reported Q95 and Q90 values to be highly inadequate to meet environmental flow requirements and even the growth of some fish species (Caissie and El-Jabi 1995), for this study to ensure environmental sustainability the low flow can be consider as Q99(1.985m^3/s) as per the FDC since the river is perennial stream.



Figure; Flow duration curve for river Ntungwe

The river discharges have been delineated into for environmental flow components based on realization by research ecologist that river hydrographs can be divided into a repeating set of hydrographic patterns that are ecologically relevant. The components consider here are i) low flows, ii) Extreme low flows, iii) small floods and iv) large floods. Not only is it essential to maintain adequate flows during low flow periods, but higher flows and floods and also extreme low flow conditions also perform important ecological functions. The fundamental principle considered in this study is to establish flows that maintain integrity, natural seasonality and variability of flows, including floods and low flows. It can be noted that though the FDCs indicate the availability of water in river Ntungwe. The extreme low flow threshold was estimated as 2.57m^3/s and Extreme low peak estimated at 1.45 m^3/s (Table 26). The extreme low flow at 10% percentile correlates with the Q99 obtained for largely modified flow duration curve. The thresholds for high flow, small floods and large floods are indicated. The low flow thresholds allow surface water abstractions for Irrigation and assessment of effluent discharge limits in receiving streams (smakhtin and Toulouse, 1998).

Table; Environmental Flow Component (EFC) thresholds

EFC Flow threshold	Medians
EFC Extreme Low flow	1.45
EFC Extreme low flow threshold	2.57
EFC small flood peak flow	72.62
EFC large flood peak flow:	115.9

Table; Environmental Flow Component Parameters at different thresholds

EFC Parameters	10%	25%	50%	75%	90%	(75-25)/50
Extreme Low Peak			1.453			
High flow peak	33.38	33.38	36.75	38.66	38.66	0.1437
Small Flood peak			96.42			
Large Flood Peak			115.9			

a) Low flow and minimum volume frequency analysis

The low flow analysis for River Ntungwe used hydrological based flow indices and exceedance percentiles to recommend low flow and in stream conditions. A flow index, such as the 7Q10 flow interpreted as the 7-day low flow with a 10-year return period and the exceedance percentile 7Q10 was estimated as 0.3m^3/s (Table 29). 7Q10 (0.3m^3/s) index represents minimum quantity of stream flow necessary to protect the habitat during drought situation. The low flow and volume frequency analysis was run for durations of 1, 3, 7, 15, 30, 60, and 90 for specified percentiles of 10, 25, 50, 75 and 90%. It's evident from the low flow analysis that river Rushaya is perennial stream with no single day without follows.

Table; Low flow and minimum volume frequency analysis

D-Minimum Flows	10%	25%	50%	75%	90%	(75-25)/50
1-day minimum	0.99	1.28	3.04	10.64	12.87	3.08
3-day minimum	1.04	1.33	3.26	12.41	15.10	3.39
7-day minimum	1.26	1.52	3.67	13.64	16.51	3.30
30-day minimum	2.11	2.21	4.11	18.02	22.12	3.85
90-day minimum	2.55	2.85	5.91	25.01	30.67	3.75

Table: Environmental flow components (EFC)-Monthly Low Flows for River Ntungwe

Months	10%	25%	50%	75%	90%	(75-25)/50
January	7.2	7.2	21.9	22.3	22.3	0.7
February	8.0	8.0	12.1	25.7	25.7	1.5
Months	**10%**	**25%**	**50%**	**75%**	**90%**	**(75-25)/50**
March	6.9	6.9	11.8	23.8	23.8	1.4
April	13.7	13.7	15.7	18.1	18.1	0.3
May	7.4	7.4	11.8	16.2	16.2	0.7
June	5.1	5.1	7.7	10.2	10.2	0.7
July	3.1	3.1	4.6	6.1	6.1	0.7
August	3.5	3.5	5.8	6.5	6.5	0.5
September	8.7	8.7	11.8	15.5	15.5	0.6
October	11.2	11.2	12.1	19.7	19.7	0.7
November	14.4	14.4	25.0	27.3	27.3	0.5
December	10.7	10.7	16.7	22.6	22.6	0.7

b) Peak flow analysis and maximum volume frequency analysis

The frequency of extreme events (floods) was assessed by fitting probability distributions to annual maximum flows derived from the daily stream flow. Maximum volume frequency analysis curves, with proper caution, may be regionalized, and are useful in the study of water supply and storage requirements. Volume curves, relating time to the maximum 1-day, 3-day, 7-day, 30-day and 90-day, discharge was extracted from daily discharge time series (Table 31). The volume curves are important for reservoir design at feasibility and detailed design stage.

Table; Peak flows and maximum volume frequency analysis

	10%	25%	50%	75%	90%	(75-25)/50
1-day maximum	15.08	19.65	72.62	114.9	115.9	1.312
3-day maximum	13.95	18.4	68.69	112.8	115.2	1.375
7-day maximum	13.69	17.1	60.02	108	113	1.514
30-day maximum	11.1	12.85	48.03	82.66	84.23	1.454
90-day maximum	5.725	7.47	32.55	69.17	74.76	1.896
Number of zero days	0	0	0	0	0	0
Base flow index	0.1409	0.1616	0.2711	0.5957	0.688	1.601

c) Environmental Flow Components

The Indictors of Hydrologic Alteration (IHA) software version 7.1 calculated parameters for five different types of Environment Flow Components (EFCs): low flows (Table 31.), extreme low flows, high flow pulses, small floods and large floods. High-flow pulses included any water rises that do not overtop the channel banks. These pulses provide important and necessary disruptions in low flows. During drought periods, rivers drop to very low levels **(Extreme Low flows)** that can be stressful for many organisms, but may provide necessary conditions for other species, flows during such period represent the extreme low flows. These low-flow levels are sustained by groundwater discharge into the river Low flows are the dominant flow condition in most rivers. In natural rivers, after a rainfall event has passed and associated surface runoff from the catchment has subsided, the river returns to its base- or low-flow level.

During **small floods**, fish and other mobile organisms are able to move upstream, downstream, and out into floodplains or flooded wetlands to access additional habitats such as secondary channels, backwaters, sloughs, and shallow flooded areas. Extreme floods **(Large floods)** – will typically re- arrange both the biological and physical structure of a river and its floodplain. These large floods can literally flush away many organisms, thereby depleting some populations but in many cases also creating new competitive advantages for some species.

The EFC extreme low flow threshold is **2.57 m^3/s with the extreme low peak indicated as 1.435 m^3/s** while the extreme high flow threshold was **36.75 m^3/s.** The annual extreme low peak was **estimated to occur** for duration of 3days while the high flow peak was estimated for duration of 6days.

Table: Environmental flow components (EFC)-Extreme Low Flows, High flows, small floods and Large Floods

EFC Parameters	Medians	Coefficient of Dispersion
Extreme low peak	1.453	
Extreme low duration	18.5	
Extreme low timing	193	
Extreme low freq.	0	0
High flow peak	36.75	0.1437
High flow duration	3	0.5
High flow timing	54	0.1844
High flow frequency	1.5	6.167
High flow rise rate	6.915	1.043
High flow fall rate	-6.653	-0.6295
Small Flood peak	96.42	
Small Flood duration	97	
Small Flood timing	29	
Small Flood freq.	0	0
Small Flood rise rate	5.738	
Small Flood fall rate	-3.072	
Large flood peak	115.9	
Large flood duration	84	
Large flood timing	332	
Large flood freq.	0	0
Large flood rise rate	3.409	
Large flood fall rate	-1.587	

Table: FDC Shift curves for River Ntungwe

%	No Change	A	B	C	D	E	F
0.01	123.90	122.60	110.30	69.01	51.19	36.84	27.73
0.1	122.60	110.30	69.01	51.19	36.84	27.73	18.10
1	110.30	69.01	51.19	36.84	27.73	18.1	12.89
5	69.01	51.19	36.84	27.73	18.10	12.89	11.30
10	51.19	36.84	27.73	18.10	12.89	11.3	8.62
20	36.84	27.73	18.10	12.89	11.30	8.62	7.33
30	27.73	18.10	12.89	11.30	8.62	7.33	4.67
40	18.10	12.89	11.30	8.62	7.33	4.67	2.89
50	12.89	11.30	8.62	7.33	4.67	2.89	2.84
60	11.30	8.62	7.33	4.67	2.89	2.84	2.83
70	8.62	7.33	4.67	2.89	2.84	2.83	2.83
80	7.33	4.67	2.89	2.84	2.83	2.828	2.83
90	4.67	2.89	2.84	2.83	2.83	2.827	2.83
95	2.89	2.84	2.83	2.83	2.83	2.826	2.82
99	2.84	2.83	2.83	2.83	2.826	2.824	2.82
99.9	2.83	2.83	2.83	2.83	2.824	2.823	2.82
99.99	2.83	2.83	2.83	2.82	2.823	2.822	2.82

KARUNDI RIVER

Karundi River with a catchment area of 25.96 sqkm discharges into river Chiruruma about 60km after the abstraction point. This makes up for some of the discharge after abstraction for irrigation and before the river flows into the park. From available rainfall data for a period of 2010 to 2018 the mean monthly flow was determined. The flow for River Karundi was found to vary from 0.0341m^3/s in the dry periods of June and July and 2.57 m^3/s wet seasons of April respectively.

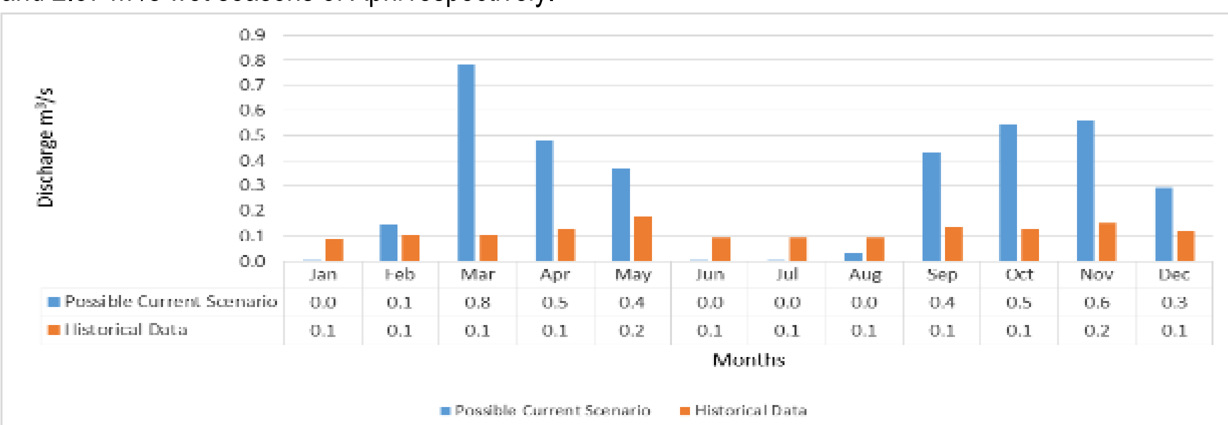


Figure ; River Karundi hydrograph

The total flow was determined by using the rainfall runoff in relation to the base flow index. The rainfall data was analyzed and the runoff at different levels of exceedance was determined considering 20% as the wet period, 50% as the moderate conditions and 80% as the very dry conditions. The moderate conditions were used to determine the low flows and later the total flow. The base flow index was obtained from the IHA software which also provides the base low index at different levels of exceedance. The low flow for Karundi was found to be 0.0341m^3/s as represented in the schematic diagram **Figure** 8.

Figure; showing Karundi flows

MONTHS	wet	normal	dry	catchment yield 20%	catchment yield 50%	catchment yield 80%	Low flow 50%(m3/s)	Base flow index	Total flow(m3/s)
	Runoff 20%	Runoff 50%	Runoff 80%						
Jan	57.5	19.0	0.0	1,492,792.4	492,412.6	367.6	0.1900	0.48	0.3664
Feb	90.9	32.7	14.5	2,360,520.3	848,289.9	375,766.0	0.3273	0.48	0.6312
Mar	114.2	95.8	78.1	2,964,108.0	2,486,126.1	2,027,416.8	0.9592	0.48	1.8499
Apr	162.4	133.2	47.8	4,215,746.5	3,457,317.8	1,239,756.8	1.3338	0.48	2.5725
May	74.7	51.7	36.7	1,939,125.8	1,341,178.8	953,438.6	0.5174	0.48	0.9979
Jun	18.6	1.8	0.1	482,941.6	45,865.6	1,299.4	0.0177	0.48	0.0341
Jul	20.1	1.9	0.0	521,078.3	50,293.3	237.6	0.0194	0.48	0.0374
Aug	71.9	34.8	3.6	1,865,458.9	903,819.1	94,591.2	0.3487	0.48	0.6725
Sep	122.3	87.0	43.3	3,174,943.2	2,258,164.3	1,124,796.9	0.8712	0.48	1.6802
Oct	140.3	96.3	54.4	3,641,818.1	2,500,736.9	1,412,131.4	0.9648	0.48	1.8607
Nov	127.4	71.9	56.2	3,308,129.2	1,865,458.9	1,458,154.5	0.7197	0.48	1.3880
Dec	78.6	45.4	29.2	2,039,377.1	1,178,376.0	757,889.7	0.4546	0.48	0.8768
Annual total	1463.4	993.9	607.7	37,988,825.6	25,801,644.0	15,775,632.4			

RIVER MASHEKWE

River Mashekwe with a catchment area of 55.5sqkm discharges into river Mitano after the abstraction point. This makes up for some of the discharge after abstraction for irrigation and before the river flows into the park. From available rainfall data for a period of 2010 to 2018 the mean monthly flow was determined. The flow for River Mashekwe was found to vary from 0.059m^3/s in the dry periods of June and July and 6.971m^3/s wet seasons of April respectively.

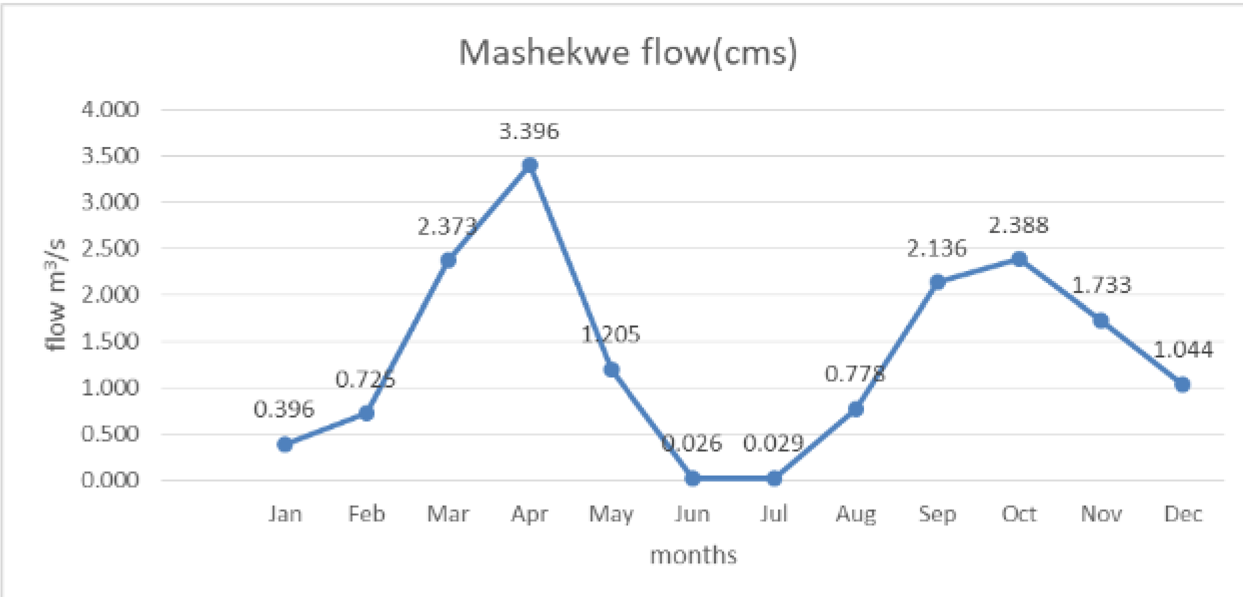


Figure ; Mashekwe hydrograph

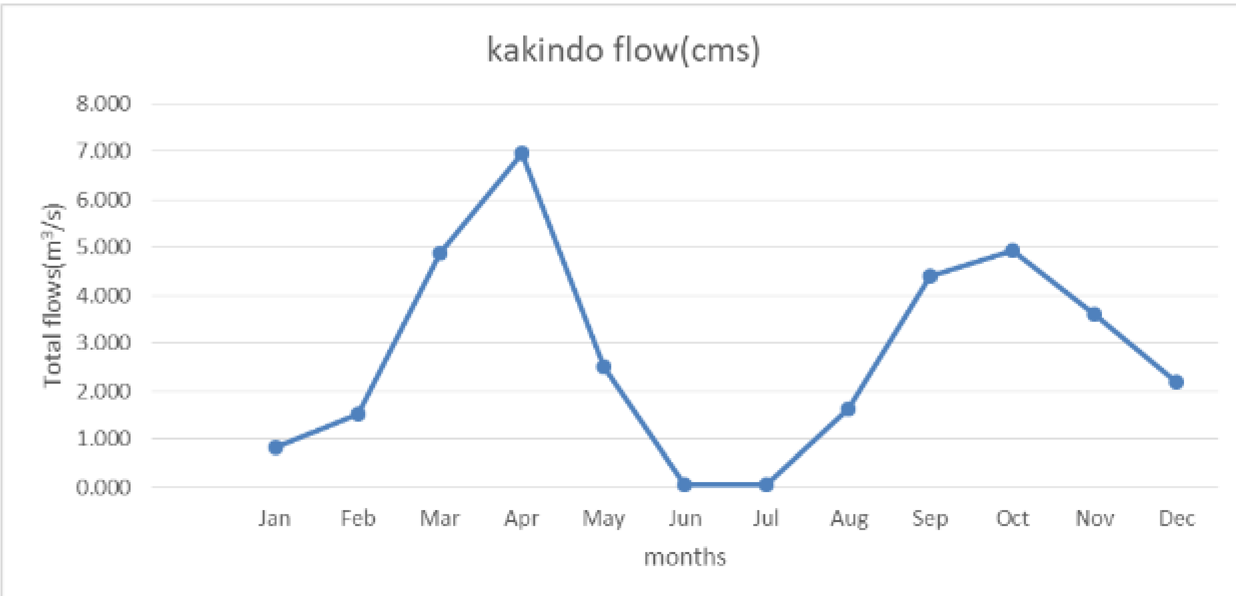
The total flow was determined by using the rainfall runoff in relation to the baseflow index. The rainfall data was analysed and the runoff at different levels of exceedance was determined considering 20% as the wet period, 50% as the moderate conditions and 80% as the very dry conditions. The moderate conditions were used to determine the low flows and later the total flow. The base flow index was obtained from the IHA software which also provides the base low index at different levels of exceedance. The low flow of Mashekwe was obtained as 0.026m^3/s as represented on the schematic **Figure 11**.

Table; showing Mashekwe flows

MONTHS	Runoff			catchment yield 20%	catchment yield 50%	catchment yield 80%	low flow 80%	Normal Flow 50%
	20% wet	50% Normal	80% Dry					
Jan	46.9	13.7	0.0	2,603,972.74	760,187.63	164.36	0.293	0.396
Feb	77.5	25.1	10.1	4,306,969.23	1,392,834.40	562,033.05	0.537	0.725
Mar	99.4	82.1	65.6	5,520,015.92	4,557,880.29	3,646,265.95	1.758	2.373
Apr	145.5	117.4	38.2	8,079,045.53	6,522,679.66	2,121,069.03	2.516	3.396
May	62.5	41.7	28.5	3,472,438.10	2,313,657.88	1,585,737.75	0.893	1.205
Jun	13.4	0.9	0.0	743,890.27	50,613.90	51.62	0.02	0.026
Jul	14.6	1.0	0.1	809,718.05	56,486.28	2,857.98	0.022	0.029
Aug	59.9	26.9	2.1	3,327,868.32	1,494,426.91	118,100.85	0.577	0.778
Sep	107.1	73.9	34.3	5,947,552.90	4,103,184.25	1,904,534.46	1.583	2.136
Oct	124.2	82.6	44.1	6,899,847.93	4,587,123.96	2,449,178.30	1.77	2.388
Nov	112.0	59.9	45.7	6,218,481.40	3,327,868.32	2,537,407.94	1.284	1.733
Dec	66.1	36.1	22.1	3,669,858.35	2,005,208.87	1,228,900.04	0.774	1.044
Annual total	1463.4	993.9	607.7	81,281,453.18	55,205,579.16	33,753,776.44	12.027	16.229

5.3 RIVER KAKINDO

Kakindo River with a catchment area of 111.5sqkm discharges into river Mitano after the abstraction point. This makes up for some of the discharge after abstraction for irrigation and before the river flows into the park. From available rainfall data for a period of 2010 to 2018 the mean monthly flow was determined. The flow for River Kakindo was found to vary from 0.059m^3/s in the dry periods of June and July and 6.971m^3/s wet seasons of April respectively.



Figure; Kakindo flows

The total flow was determined by using the rainfall runoff in relation to the baseflow index. The rainfall data was analysed and the runoff at different levels of exceedance was determined considering 20% as the wet period, 50% as the moderate conditions and 80% as the very dry conditions. The moderate conditions were used to determine the low flows and later the total flow. The base flow index was obtained from the IHA software which also provides the base low index at different levels of exceedance. The low flow for Kakindo was obtained as 0.059m3/s as shown in the schematic.

Table; SHOWING KAKINDO FLOWS

MONTHS	wet Runoff 20%	normal Runoff 50%	dry Runoff 80%	catchment yield 20%	catchment yield 50%	catchment yield 80%	50%	Total flow(m^3/s)
Jan	48.6	14.5	0.0	5,416,022.6	1,613,008.4	86.1	0.622	0.84
Feb	79.7	26.2	10.8	8,891,211.9	2,925,864.7	1,198,750.0	1.129	1.523
Mar	101.8	84.3	67.7	11,356,075.5	9,401,616.9	7,545,483.7	3.627	4.895
Apr	148.3	120.1	39.7	16,539,401.7	13,389,146.5	4,425,745.2	5.166	6.971
May	64.5	43.2	29.8	7,190,957.9	4,821,024.3	3,324,105.3	1.86	2.51
Jun	14.2	1.0	0.0	1,579,007.9	113,949.0	400.4	0.044	0.059
Jul	15.4	1.1	0.0	1,716,273.1	126,738.4	4,739.0	0.049	0.066
Aug	61.8	28.1	2.3	6,895,935.8	3,135,694.7	259,812.7	1.21	1.633
Sep	109.6	76.0	35.7	12,223,385.2	8,476,420.4	3,980,702.4	3.27	4.413
Oct	126.9	84.9	45.7	14,153,126.7	9,461,083.6	5,098,893.8	3.65	4.926
Nov	114.6	61.8	47.4	12,772,675.4	6,895,935.8	5,279,683.4	2.66	3.59
Dec	68.1	37.6	23.2	7,593,584.6	4,187,704.2	2,586,775.5	1.616	2.18
Annual total	1463.4	993.9	607.7	163,164,640.0	110,819,850.0	67,757,435.0	24.9	33.6

1. Introduction

1.1 Background

The government of Uganda is prioritizing development of formal irrigated agriculture systems in the country to provide water for irrigation in areas with unreliable water sources to increase agricultural production and farmer's resilience to climate change. The government has also secured funds towards undertaking feasibility studies, Environmental and Social Impact Assessments (ESIA) and a Resettlement Action Plan (RAP) for development of Matanda irrigation scheme in Kanungu district. This will foster government's efforts to promote modernization of Agriculture that aims at increasing incomes and improving the quality of life of the poor subsistence smallholder famers, which will further ensure food security and gainful employment.

The project aims at increasing productivity and farmers' resilience to climate change. Following increasingly unreliable and erratic rains, the government of Uganda has prioritized development of irrigated agriculture, hence location of the Matanda irrigation scheme in Kanungu district which is prone to drought.

An Integrated Pest Management Plan (IPMP) is part and parcel of improved good agricultural practices (GAPs) designed to support this setting up of irrigation facility and ensure sustainable management of pests and diseases to complement the water management through irrigation.

A Pest Management Plan must prioritize Integrated Pest Management (IPM) which is an environmentally sustainable and farmer-based management approach involving the deployment of cultural and natural pest control methods including but not limited to sanitation, natural pest control using biopesticides (natural enemies), pest-resistant crops, deployment of cultural management, and, as a last resort, using pesticides judiciously[1]. These strategies can be deployed based on the local circumstances with the farmers having flexibity of deploying a mix of interventions. The principle of IPM is based on understanding of agro-ecological principles, monitoring interactions among crops, pests, and natural enemies of pests, and selecting and implementation of adequate control measures.

1.2 Objectives

The general objective of this task is to develop an Integrated Pest Management Plan (IPMP) that will promote sustainable pest management in the Matanda Irrigation Scheme command area through good agricultural practices (GAPs). The specific objectives are to:

i. Provide baseline information on agriculture, current pest issues and pesticides management practices in the project area as well as the upstream and downstream areas.
ii. Analyze potential impacts of the project and develop screening procedures (including checklists) to be used for screening potential environmental and social impacts due to the project.
iii. Develop guidelines for development of appropriate methods to promote an Integrated Pest Management (IPM) approach that will minimize the need for chemical pesticides during project interventions.
iv. Assess pest management capacities and propose an associated capacity building plan.
v. Provide an implementation strategy, costs, and monitoring plan.

[1] Adapted from USDA/ARS1993

2. Methodology

2.1 Baseline Survey

The specific objectives of the baseline pest study survey were to;

i. Assess the pre-project situation regarding the current pest status, prevalence, severity, occurrences, types of crops grown, agricultural practices, common weeds, and their control, use and source of inputs and their costs,
ii. Determine and evaluate the type of technical support that the farmers receive, and
iii. Understand farmers' knowledge on pesticides, their safe use, dangers, use of PPE, and disposal of containers.

The baseline survey adopted the use of both quantitative and qualitative methods of enquiry and was carried out in different but integrated phases.

Engagements were made with key district officials, focus groups, and individuals with the aim of identifying the key issues facing farmers ranging from drought, pests and diseases, and weeds.

- The **key informant interviews** (KIIs) were conducted with District Agricultural Officer/Production Officer, District Vet. Officer, Community Development Officer, District Environment Officer, District Engineer, and Water Engineer, NGOs, CBOs, input dealers, Sub county Chief, Parish Chiefs, Sub county Agricultural Extension Officer, and Sub county Community Development Officer using key informant interview checklist.

Figure: Meeting with Kanungu District Senior Agricultural Officer

- **Focus groups discussions** (FGDs) were conducted with farmer cooperative societies, Miller traders, and farmer production groups using designed FGD checklists.

Figure: Focus Group Discussions being conducted

- For **household interviews**, farmers were interviewed by enumerators priorly trained to use a formal semi-structured household questionnaire and mobile device for data capture.

Figure: Individuals/ households being interviewed

- **Direct observation** enabled the capture of on the spot observations and acted as the basis of triangulation of data sources.

- **Photography**: For illustrations purposes photographs of interventions and beneficiaries were taken to augment collected data using tools like GPS to get coordinates of places visited and key Scenarios.

- **Literature review:** A wide range of literature was consulted during this study, including the Second Five-Year Kanungu District Local Government Development Plan (2015/2016 - 2019/2020), National Development Plan III, Agricultural Sector Strategic Plan (ASSP), Agricultural Chemicals (Control) Act, 2007, National Agricultural Policy, 2013, Seeds and Plant Act 2006, and Plant Protection and Health Act, 2015 among others.

3. BASELINE INFORMATION ON AGRICULTURE AND PEST MANAGEMENT

3.1 Farmland tenure and cropping practices

3.1.1 Land holding

Kanungu is generally hilly and lies in the rift valley, with the land highly fragmented due to traditional practice of inheritance and high population density. Parts of district lies in Queen Elizabeth National Park and Bwindi Impenetrable National Park (wildlife heritage sites) having woodlots established with exotic species like pine and eucalyptus. The amount of land owned by farmers varies with Sub counties with farmers in Kihihi averagely owing 11 acres of land while in Nyakinoni and Nyamirama, the average acreages owned by households were 5 and 4.7, respectively. Of this land holding, farmers in Kihihi, Nyakinoni and Nyamirama have cultivated 4.8, 2.5 and 3 acres, respectively in the current farming season. Generally, wide-scale subsistence farming is practiced on the slopes and the valleys hence making the areas prone to disasters like landslides, soil erosion and floods.

Table 3. 1: Amount of land owned and cultivated in the Matanda command area

Sub County	Acres owned on average	Acres cultivated this season on average
Kihihi	11.0	4.8
Nyakinoni	5.0	2.5
Nyamirama	4.7	3.0

3.1.2 Land tenure system

While in Nyakinoni and Nyamirama, the main land tenure systems are customary, with land being either family or ancestral (90.5 and 57.1%, respectively), 90% of the respondents in Kihihi had a freehold tenure over their land. In Nyamirama, 4.8% were living on and using church land.

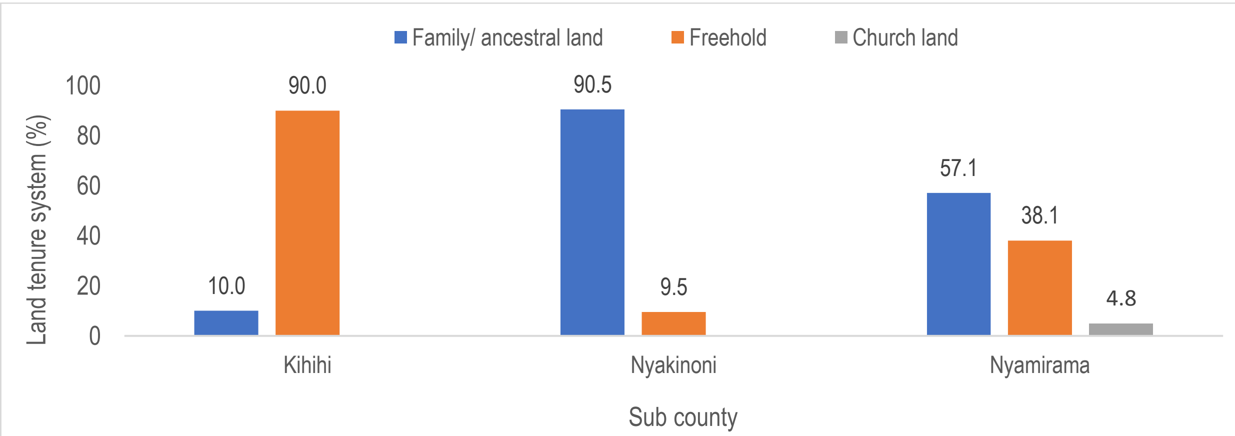


Figure 3. 1: Land tenure system in the Matanda irrigation command area

3.1.3 Cropping systems

Farmers in Matanda mainly practice mixed farming integrating crops with livestock (cattle, goats, sheep, pigs and poultry). Regarding crop production, intercropping is carried out with several crops grown simultaneously on the same field. Farmers in the 3 Sub counties grow up to 6 crops simultaneously as shown in Figure 2. Land preparation is carried manually as well as with oxen and tractors. There is significant herbicide use during land preparation.

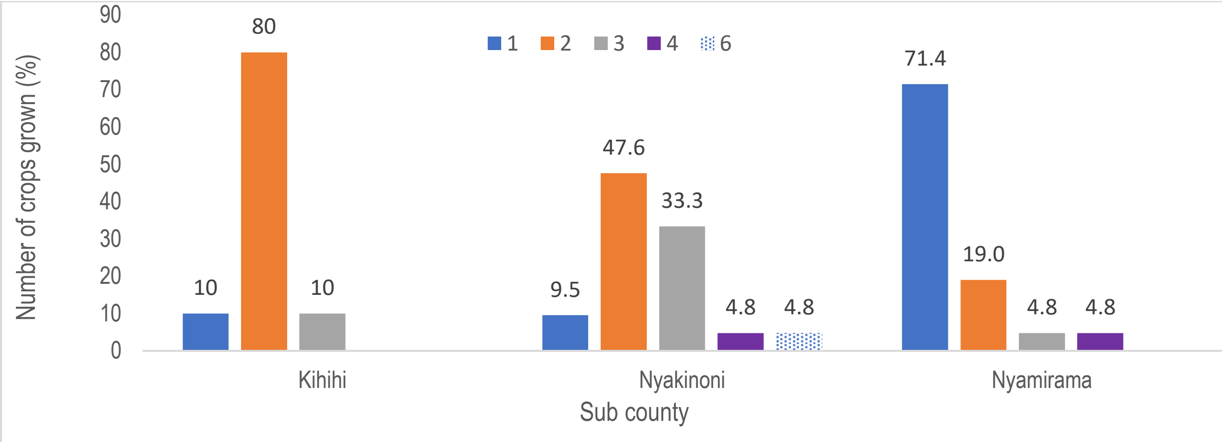


Figure 3. 2: Number of crops grown per household in the Matanda irrigation command area

The main crops grown in the catchment area determined in terms of the percentage of farmers growing the specific crops either singly or along with other crops include maize (70%) and coffee (90%) in Kihihi, beans (76.2%) and finger millet (61.9%) in Nyakinoni, and groundnuts (33.3%), coffee (33.3%) and beans (23.8%) in Nyamirama. Other crops grown include bananas, fruit trees, tobacco, soy, yams, sweet potatoes, and sorghum.

Table 3. 2: The main crops grown in the Matanda command area

Sub county	Maize	Coffee	Cassava	Finger millet	Beans	Groundnuts	Tomato	Rice	Potatoes	Vegetables	Other crops
Kihihi	**70.0**	**90.0**	0.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	20
Nyakinoni	23.8	23.8	4.8	**61.9**	**76.2**	14.3	9.5	14.3	19.0	4.8	0
Nyamirama	14.3	**33.3**	9.5	0.0	**23.8**	**33.3**	14.3	9.5	0.0	4.8	0

Regarding crop acreages, in Kihihi coffee is averagely grown on 2.3 acres of land while maize and finger millet are cultivated on averagely 2 acres a piece. In Nyakinoni, coffee, maize, beans, tomato, groundnuts, and rice are cultivated on 0.9 to 1.1 acres of land. In Nyamirama, coffee, maize, cassava, beans, groundnuts, tomato, rice, and vegetables are grown on at least 1 acre of land. However, it should be noted that some of this land is simultaneously cultivated with several crops.

Table 3. 3: Acreages of different crops in Matanda

Sub county	Acreage of crops									
	Maize	Coffee	Cassava	Finger millet	Beans	Groundnuts	Tomato	Rice	Potatoes	Vegetables
Kihihi	**2.0**	**2.3**		**2.0**	0.4					
Nyakinoni	**1.0**	**1.1**	0.6	0.8	**0.9**	**0.9**	**0.9**	**0.9**	0.4	0.6
Nyamirama	1.4	**1.8**	1.2		1.2	1.3	1.3	1.3		1.0

3.1.4 Crop production challenges

Farmers are faced with a range of production challenges, which range from biotic, abiotic to marketing and support system challenges. The main challenges identified at Kihihi included drought (35.7%), crop pests (21.4%) and marketing challenges (14.3%). In Nyakinoni, the main challenges were crop pests (29.3%), crop diseases (25.9%), drought (22.4%) and marketing challenges (12.1%), while in Nyamirama, the key constraints to production included drought (29%), crop diseases (25.8%), crop pests (24.2%), and lack of or fake inputs like seed, fertilizer and pesticides (12.9%). The fact that drought, and crop pests and diseases stand out as major crop production challenges justify the implementation of an irrigation system as well as design of an IPMP to support farmers in the Matanda irrigation area. Other production challenges encountered by the farmers included loose fragile soils, poor road network, and transport constraints. Unpredictable weather results in late planting season which coincides with the outbreak of pests in the dry season resulting to poor yields.

Table 3. 4: Main production challenges encountered by farmers in the Matanda command area

Sub county	Drought	Lack of inputs	Crop pests	Crop diseases	Lack of access to seeds	Flooding	Marketing challenges	Land shortage	Shortage of labour	Inadequate access to extension services	Lack of financial support
Kihihi	**35.7**	7.1	**21.4**	7.1	3.6	0.0	**14.3**	0.0	10.7	0.0	0.0
Nyakinoni	**22.4**	0.0	**29.3**	**25.9**	0.0	0.0	**12.1**	1.7	3.4	3.4	1.7
Nyamirama	**29.0**	**12.9**	**24.2**	**25.8**	3.2	1.6	0.0	0.0	3.2	0.0	0.0

3.2 Status of crop pests and diseases

Farmers were asked to describe the pests and diseases affecting their fields and, in some cases, where known, they were asked for the local names of the pests and diseases. The pest and disease identification was guided by the identification guide in Appendix 2.

3.2.1 Main crop pests

The main crops affected by pests in Kihihi Sub county are beans, coffee and maize and the main pests are caterpillars, stem borers and fall army worm, beetles and weevils, and leaf miners.

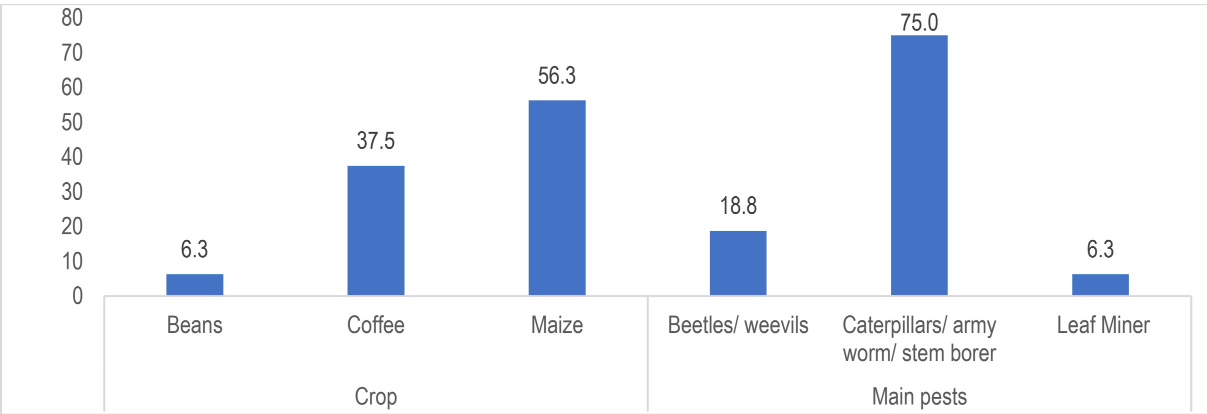


Figure 3. 3: Crops affected by pests and the pests affecting crops in Kihihi Sub county

In Nyakinoni, the crops mainly affected by pests are coffee and beans, while these are affected by a range of pests including mainly aphids, beetles/weevils, and coffee twig borer. Other pests affecting crops in Nyakinoni include leaf miners, scales, white flies, and grasshoppers.

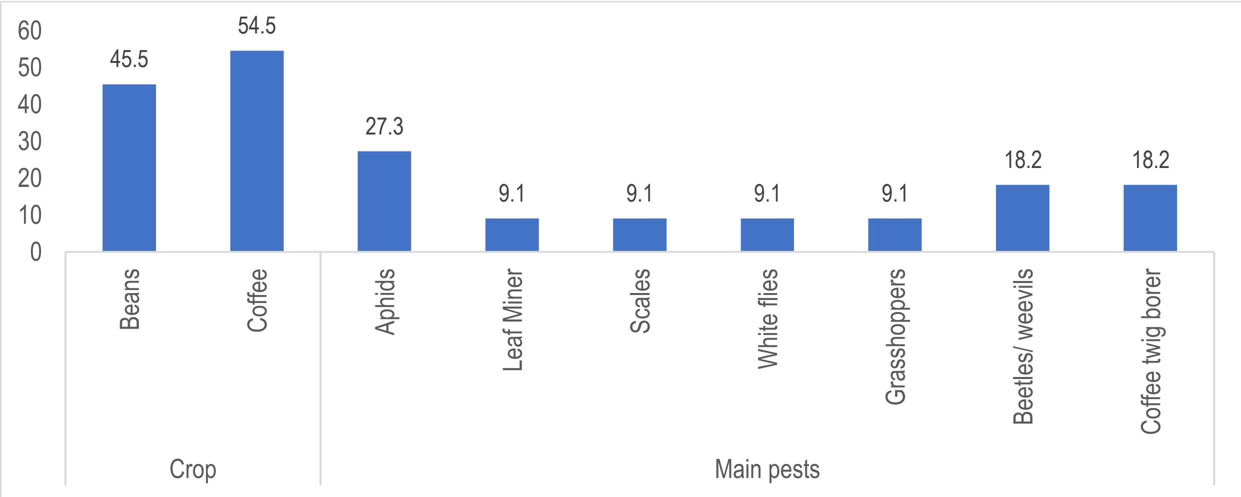


Figure: Crops affected by pests and the pests affecting crops in Nyakikoni Sub county

Several crops are affected by pests in Nyamirama including coffee, groundnuts, maize, beans, tomatoes, cassava, rice, and cabbage. The main pests affecting these crops include, among others, leaf miners, caterpillars, army worms and stem borers, aphids, beetles, weevils, whiteflies, scales, grasshoppers, and coffee twig borer.

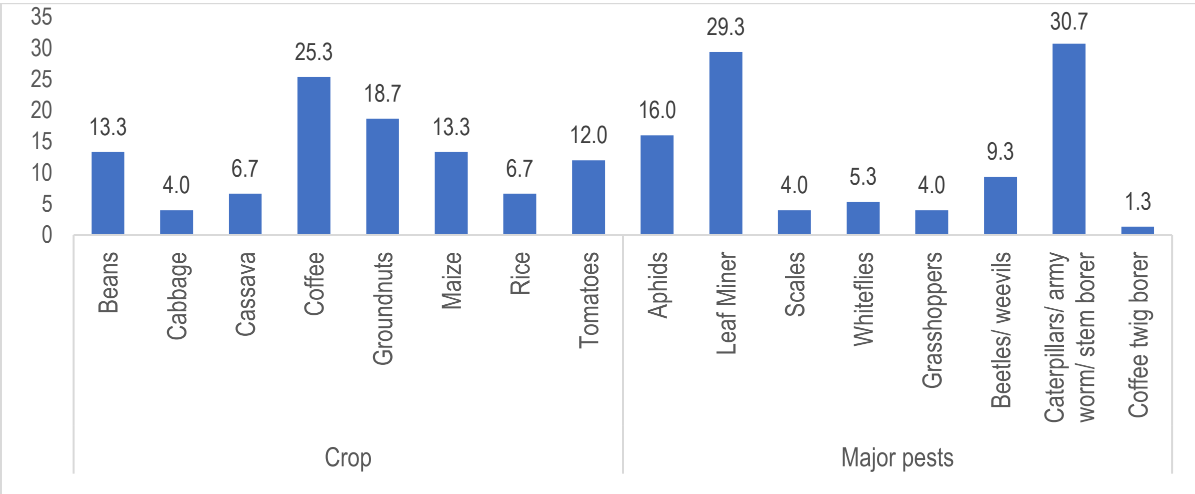


Figure: Crops affected by pests and the pests affecting crops in Nyamirama Sub county

Table : Pests observed by the team in the Matanda command area

No	Crop	Pest	Scientific name	Damage	Control
1	Coffee	Black coffee twig borer	*Xylosandrus compactus Eichhoff*	Infected twigs dry and die	Spray with insecticide, pruning
2	Banana	Banana weevil	*Cosmopolites sordidus*	Boring of pseudo stems and toppling	Good husbandry practices, weeding mulching
		Nematodes	*Radopholus similis*	Causes root and corm tissue cavities that evolve to form necrotic lesions affecting the uptake water and nutrients	Plant-parasitic nematode control has been based on chemical soil fumigants and nematicides (Candido *et al.* 2008)
3	Maize	Fall army worm	*Spodoptera frugiperda*	Larvae consume foliage. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact. By the second or	Managed using insecticides, cultural practices (early planting and early maturing varieties), host plant resistance, and biocontrol.

No	Crop	Pest	Scientific name	Damage	Control
				third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward.	
		Stalk borer	*Busseola fusca*	Stem borers destroy the central leaves (dead-heart) and cause the drying of the panicle (white head)	Managed using cultural practices, host plant resistance, biocontrol, and synthetic pesticides.
		Weevils	*Sitophilus zeamais*	Egg hatches in a few days into a soft, white, legless, fleshly grub which feeds on the interior of the grain kernel. The grub changes to a naked white pupa and later emerges as an adult beetle.	Management includes proper storage sanitation, use of protective pesticides and fumigation.
4	Beans	Aphids	*Aphis fabae*	Large numbers of aphids cause stunting of the plants. Beans also suffer damage to flowers and pods which may not develop properly	Main management involves biocontrol using natural enemies (lady beetle larvae and adults, lacewing larvae and adults, hover fly, parasitic wasps) and use of selective pesticides.
		Bean weevil	*Acanthoscelides obtectus*	Adults lay eggs on seeds, and the larvae chew their way into the seed. When ready to pupate, the larvae create an exit hole, then return to their feeding chamber.	Mainly cultural management involving good store hygiene, and removal of infested residues from last season's harvest. When small lots of beans are stored, daily turning of the storage container can significantly reduce infestation.
5	Rice	Stalk borer	*Chilo plejadellus*	The moths lay eggs on rice leaves and the resulting larvae then bore into and feed on the stem. While feeding, they cause damage to the central shoot, and prevent it from producing a panicle.	Management includes destroying crop residues, planting early, and applying insecticides to coincide with larval emergence.
		Birds	Several species	The chewing of the grain by perching birds on the panicles results in crop loss.	Management includes use of "bird boys" who scare away birds, use of bird tape over the rice plants, use of noise makers, use of chemical repellants for example chilli extracts, decoy birds, and use of flags, scare crows, or bird kites.
		Rodents/rats		After sowing, rodents can consume the entire seed or seedling. Upon emergence of tillers, rodents bite off the tillers near the base. Rice is most susceptible to rodent damage	Use of traps and of rodenticides.

No	Crop	Pest	Scientific name	Damage	Control
				from the booting (reproductive) stage to harvest.	
6	Cassava	Mealy bugs	*Phenacoccus manihoti*	It sucks sap and thus damaging the cassava plant by causing deformation, defoliation, and stunted growth which leads to the death of the plant.	Use of pesticides and biological control.
8	G/nuts	Aphids	*Aphis craccivora*	The sucking of sap by aphids weakens the plant, causing poor and stunted growth, leaf curling and distorted leaf growth, wilting and reduced resistance to drought conditions, all resulting in yield losses. Indirect damage includes production of honey dews and sooty molds and transmission of rosette virus	Control measures include cultural practices (like early planting), chemical control, biocontrol, and host plant resistance.
9	Tomatoes	Aphids	*Myzus persicae*	Aphids suck plant sap, causing leaves to curl and stunts plants; excreting honeydew, which causes sticky, shiny leaves to turn black because of a sooty-mold fungus growth. They also spread the tomato yellow top virus	Managed using cultural methods and chemical and botanical pesticides.
		Leaf miner	*Tuta absoluta*	Symptoms include puncture holes in fruits, mines (pale dead layers) in the leaves. abnormal shaped fruits, frass (powdery waste), decay due to secondary infection of the flesh, and exit galleries in fruits.	Cultural control: ploughing, manuring, irrigation, crop rotation, solarization, and the elimination of symptomatic leaves and destruction of infested tomato plants, chemical control, use of semiochemicals (pheromones), biological control, and host plant resistance.
		Thrips	Thrips tabaci	The primary damage is the vectoring of tomato spotted wilt virus. High numbers of thrips cause damage with their feeding, which distorts plant growth, deforms flowers, and causes white-to-silvery patches on emerging leaves that often have tiny black fecal specks in them.	Avoid planting tomatoes next to onions, garlic, or cereals. Treatment with foliar insecticide sprays early in the season and continuing through the season.
10	General	Variegated grasshoppers	Zonocerus variegatus (L.)	Fruit, leaf, growing point and inflorescence feeding, growing point dieback, and death of plant	The management of the grasshopper is through physical methods, use of chemicals, and biological control.

Common observed pests – Pictorials

Table : Pictures of pests observed in the Matanda command area

Crop	Pest	
Pineapple		***Pinepple mealybug*** **(Dysmicoccus brevipes)** The pineapple mealybug damages pineapple by direct feeding causing chlorotic areas, rotted bottoms, and mealybug stripe (streaks of discoloration with underlying tissue collapse). The feeding weakens the plant, increasing susceptibility to other pests and diseases like black spot, black sooty mold and other molds. The pineapple mealybug often vectors pineapple mealybug wilt-associated virus (pineapple wilt, mealybug wilt, or edge-wilt).
Maize/cereals		***Fall army worm*** *(details above)* Larvae consume foliage. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact. By the second or third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward.
Tomato		**Tomato leaf miner** (details in table above)
Citrus		**Citrus aphids (*Toxoptera aurantia)*** Aphids feed on flower and leaf buds and on the underside of leaves, causing leaves to curl toward the stem. Aphids can all transmit citrus tristeza virus. Aphids also secrete honeydew. The honeydew eventually attracts other pests such as ants or prevent leaves from acquiring proper sunlight for photosynthesis. Control involves use of biocontrol, regulated chemical control and resistant varieties.

Crop	Pest	
		**Leaf miner *(Phyllocnistis citrella)*** They form squiggly lines on the leaves as the first sign and the leaves then become distorted, inhibiting their photosynthesizing ability. The trees become stunted and unhealthy; and yields decline. When fully grown, the larvae will curl the leaf around for protection while they pupate. Control methods include biological control, organic control methods, use of petroleum spray oil (horticultural oil) to deter the moth from laying new eggs.
		**Psyllids (*Diaphorina citri)*** The citrus psyllid feeds on citrus leaves and stems and can infect citrus trees with a bacterium that causes citrus greening disease. Control is through biological control methods and use of organic pesticides.
Banana		**Weevils *(Cosmopolites sordidus)*** The larvae tunnel into the corm resulting in rots, stopping the flow of nutrients to the leaves resulting in premature death of plants. The tunneling also weakens the plants so they are easily blown over; leads to suckers withering and dying; and results in production of small bunches of undersize fruit. Control measures include quarantine, biocontrol using natural enemies, cultural and chemical control.
Watermelon		**Aphids *(Aphis gossypii)*** Green aphids feed near the tips of runners or in growing points. They cluster in numbers on the underside of growing leaves, distorting, and curling the leaves, and produce a large amount of honeydew. The fruits become coated with the sticky secretion, creating an environment favorable for the development of a sooty mold. They also vector several viruses for example watermelon mosaic virus. Control options include reflective mulches, biological control, cultural control, and organic pesticides.

Crop	Pest	
		**Scale insects (White peach scale) *Pseudaulacaspis pentagona*** Scales cause damage by feeding on twigs, branches and fruit, injecting toxins into the plant as they do so; With heavy infestation, gumming may occur on the bark and twigs or entire branches can be killed; scales produce a white waxy coating which eventually turns black (black cap stage). Management can be through biocontrol using natural enemies; selective pesticides; use of horticultural oils when dormant which effectively kill scales without damaging natural enemies.

<u>Effectiveness of Pest Management Measures</u>

According to the farmers, the different management options have varying levels of effectiveness. The farmers using local concoctions indicated that this method was effective, while chemical sprays were mostly fairly effective, which could arise from fake, counterfeit and adulterated chemicals. Meanwhile destruction of affected plants was indicated to be either very effective or effective, which gives the impression that this can significantly reduce pest infestation if diligently implemented.

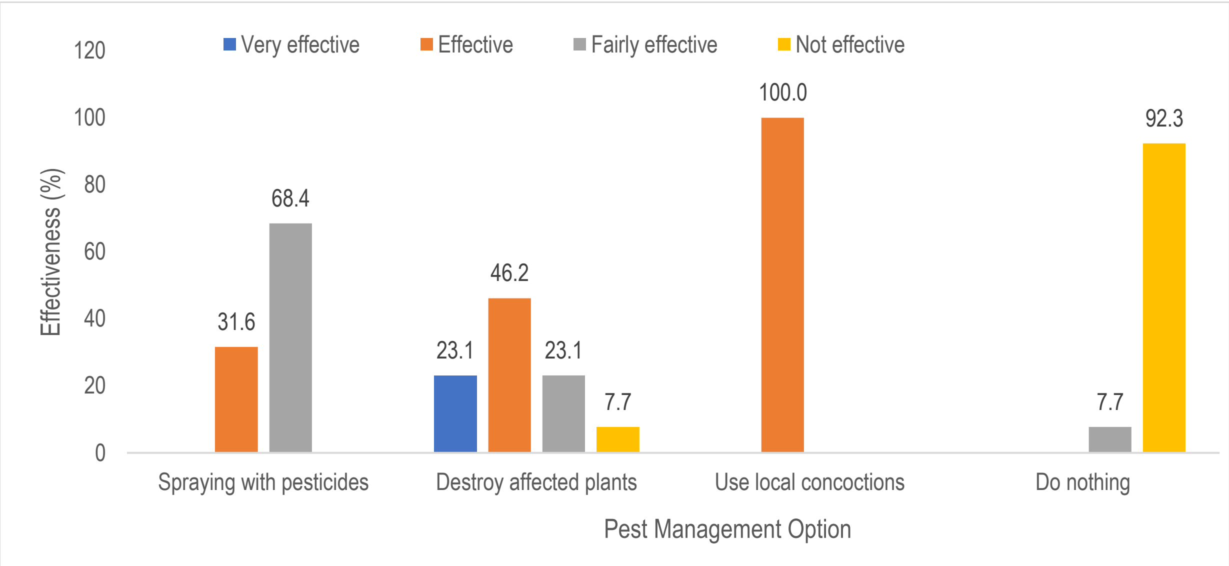


Figure: Effectiveness of different pest management options being deployed by farmers in Matanda

3.2.2 Main diseases

The main crops facing disease challenges in Kihihi are maize and coffee with the main disease symptoms observed on these crops including viruses and leaf spot symptoms.

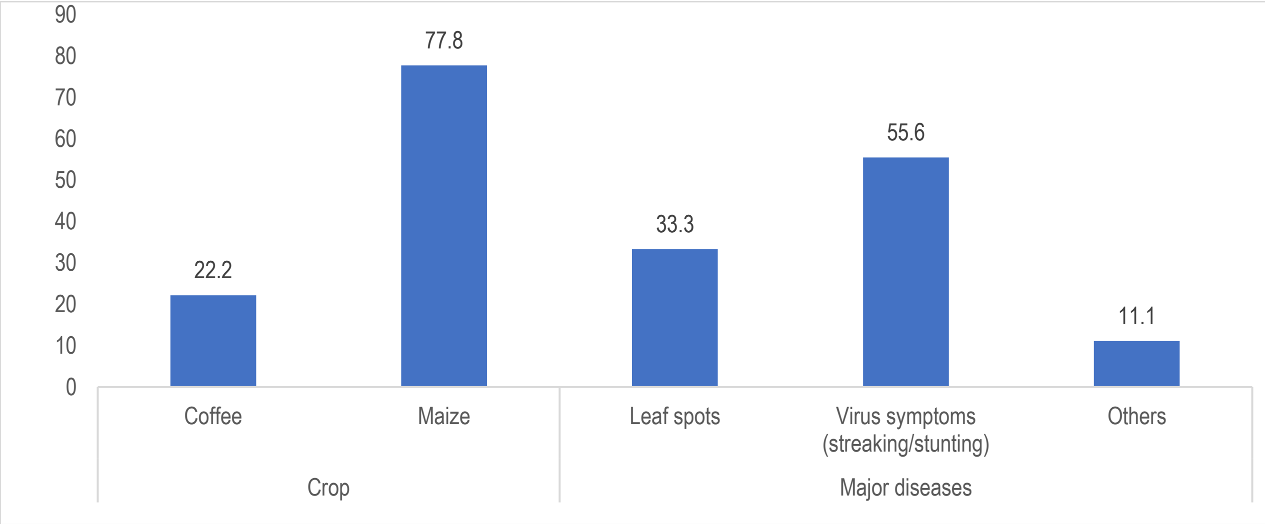


Figure: Crops affected by diseases and the main diseases affecting crops in Kihihi Sub county

In Nyakinoni, diseases are mainly observed on coffee and beans and these diseases include leaf spots, fruit rots, virus symptoms, rusts, wilts, and blights.

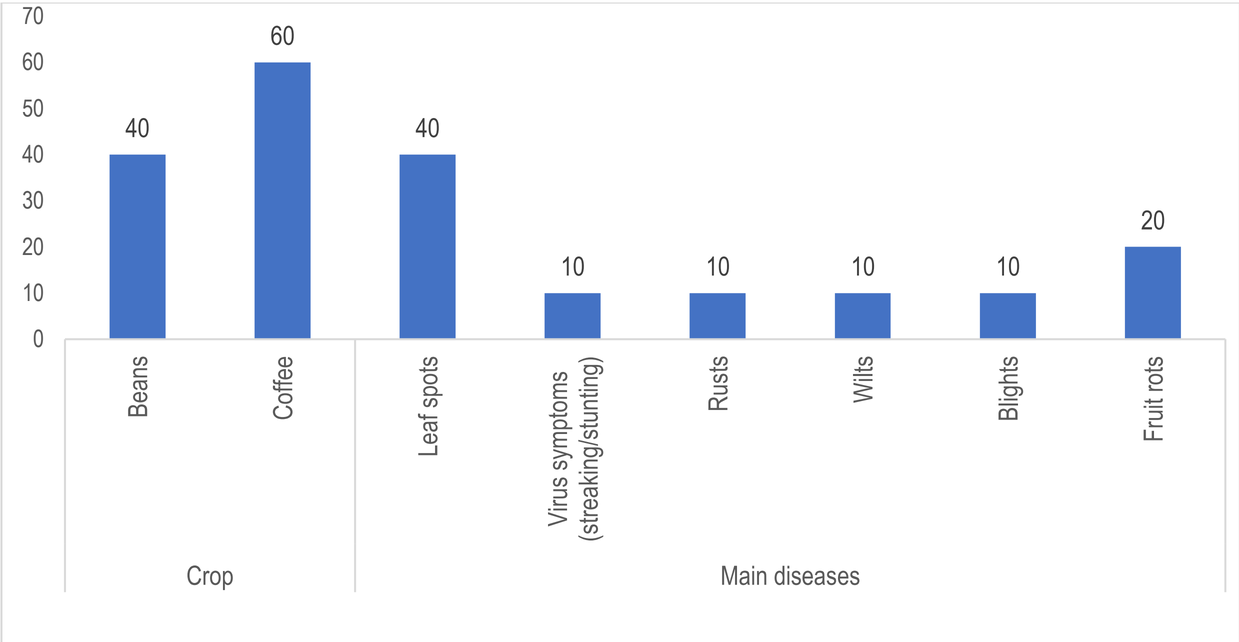


Figure: Crops affected by diseases and the main diseases affecting crops in Nyakinoni Sub county

In Nyamirama, the crops affected by diseases included groundnuts, coffee, tomatoes, beans, cassava, maize, cabbage, and rice. The main symptoms observed on these crops include virus symptoms, leaf spots, blights, wilts, fruit rots and rusts.

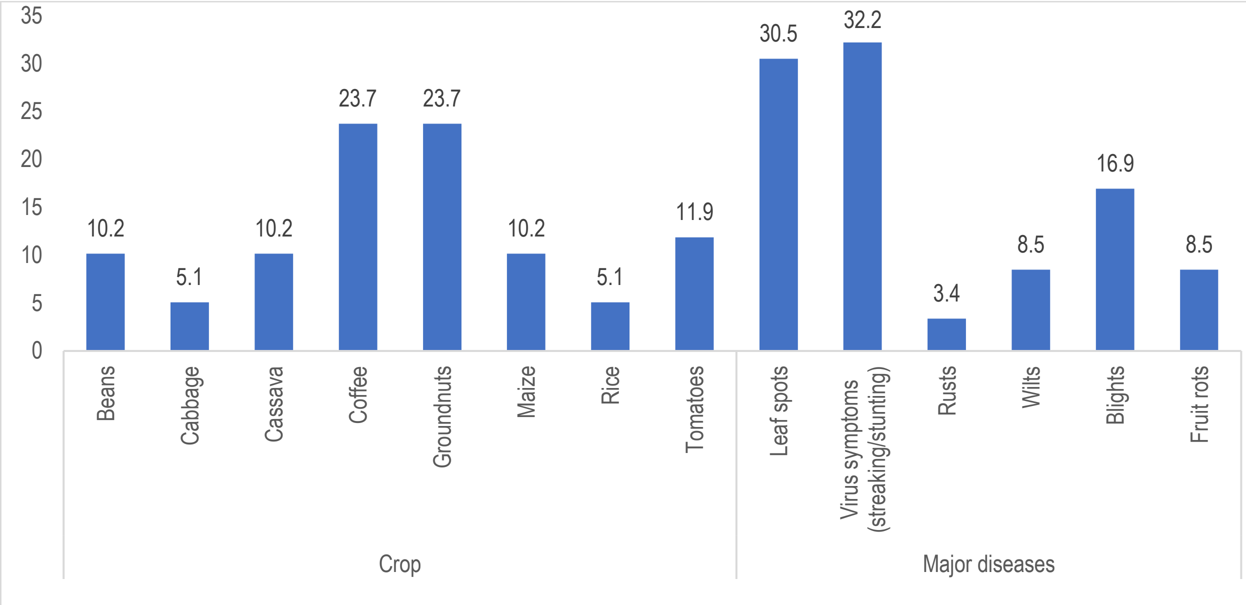


Figure: Crops affected by diseases and the main diseases affecting crops in Nyamirama Sub county

Table: Common diseases observed by the team in the Matanda command area

No	Crop	Disease
1	Maize	Maize streak
		Blast
2	Banana	Banana bacterial wilt
		Fusarium wilt
		Black sigatoka
3	Groundnuts	Rosette
		Cercospora leaf spot
5	Coffee	Coffee leaf rust
		Coffee berry disease
		Coffee wilt
6	Cassava	Cassava mosaic
7	Rice	Rice blast
8	Beans	Leaf rust
9	Tomatoes	Late and early blight Bacterial wilt

Table: Pictorial of common diseases observed by the team in the Matanda command area

Crop	Disease	
Cabbage		***Bacterial Soft Rot*** Initially, bacterial soft rots cause the formation of water-soaked spots, which enlarge over time and become sunken and soft. Interior tissues beneath the spots become mushy and discolored, with the discoloration ranging anywhere from cream to black. Seepage from affected areas is common.

Crop	Disease	
Maize		***Turcicum leaf blight*** An early symptom includes slightly oval, water-soaked, small spots produced on the leaves, which grow into elongated, spindle-shaped necrotic lesions. They may appear first on lower leaves and increase in number as the plant develops and can lead to complete burning of the foliage.
Coffee		***Cercospora leaf spot*** Common symptoms of this disease include "brown eye-spots" with a slight yellow halo on the leaves and brown, sunken, oval-ish blotches with a slight purplish halo on the cherry. These blotches can resemble sunburn. Young fruit tend to ripen prematurely.
		***Bacterial bilght of coffee*** Lesions appear on leaves with water-soaked margins at start of infection. Leaves eventually dry up and roll inwards turning brown. Dead and dried leaves do not shed but remain attached to the plant. Symptoms occur on secondary or tertiary branches and in severe cases the heads may be affected. On twigs the terminal bud is attacked. Infection then extends downwards, resulting in dieback. Flowers and pinheads shrivel and turn black.
Tomato		***Early blight*** Initially, early blight causes dark brown (or black) spots on the leaves (starting from the leaves at the bottom of the plants). Afterwards, the affected leaves turn yellow and either dry up or fall off the plant. Later on, lesions appear on the fruit.
Banana		***Black sigatoka*** Early leaf symptoms are tiny reddish-rusty brown flecks most evident on the lower leaf surface. These lengthen, widen, and darken forming reddish-brown leaf streaks. The early streaks run parallel to the leaf veins. The streaks broaden and become visible on both leaf surfaces. The streaks expand and become more oval shaped and the centre of the lesion becomes sunken and turns grey over time. A yellow halo may develop around the edge of the lesion.

Crop	Disease	
Mango		***Anthracnose*** Anthracnose symptoms occur on leaves, twigs, petioles, flower clusters (panicles), and fruits. On leaves, lesions start as small, angular, brown to black spots that can enlarge to form extensive dead areas. The lesions may drop out of leaves during dry weather. The first symptoms on panicles are small black or dark-brown spots, which can enlarge, coalesce, and kill the flowers before fruits are produced, greatly reducing yield. Petioles, twigs, and stems are also susceptible and develop the typical black, expanding lesions found on fruits, leaves and flowers.
Passion fruit		***Collar rot*** Collar rot symptoms appear as cracks in passionfruit stems just above soil level. The cracks become larger and the diameter of the stem increases. Later, rots start from the tunnels, and destroy the collar region. The rots cause the stems to break, but even if that does not happen, the rots cause the leaves to turn pale green and fall, the branches to die back and, eventually, the death of the plant.

Effectiveness of disease control measures

The two most effective disease management options according to the farmers include chemical spray and removal of diseased plants. Local concoctions and destruction of alternative hosts are also indicated to be effective in disease management. An integrated disease management approach shall consider a combined use of the effective control methods.

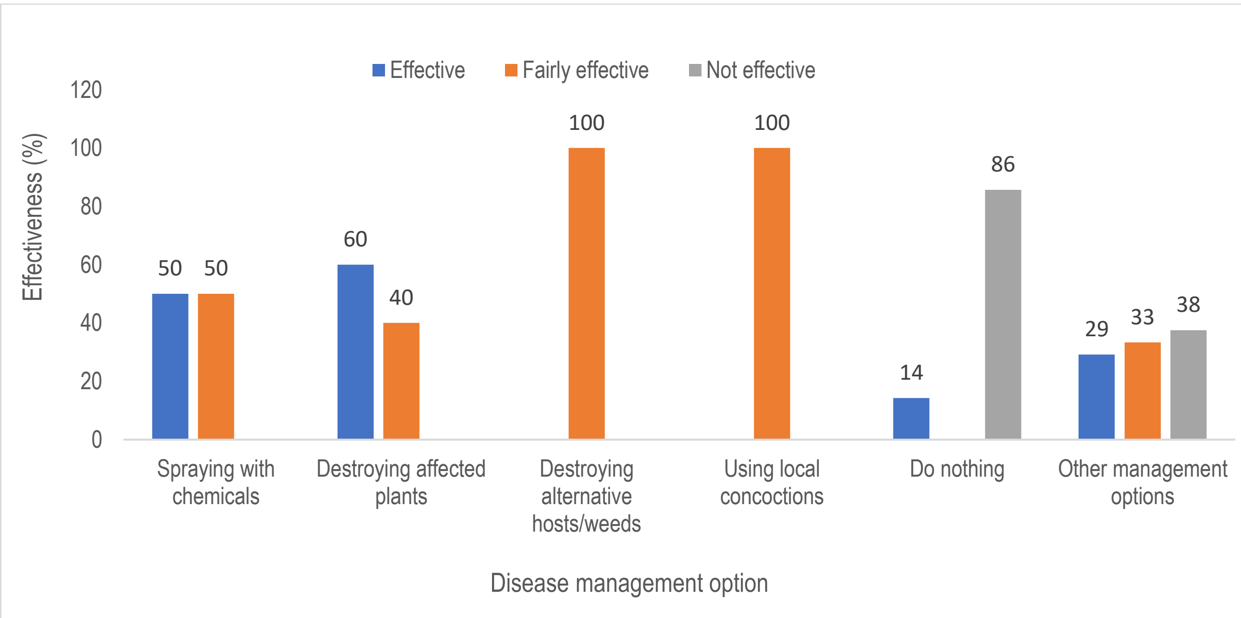


Figure: Effectiveness of different disease management options in Matanda

3.3 Weed Management

The main weeds observed in the Matanda command area include grasses and legumes. These are notorious and compete with crops for nutrients. Examples of the specific weeds (Table 9) that were identified in the catchment area are highlighted in table.

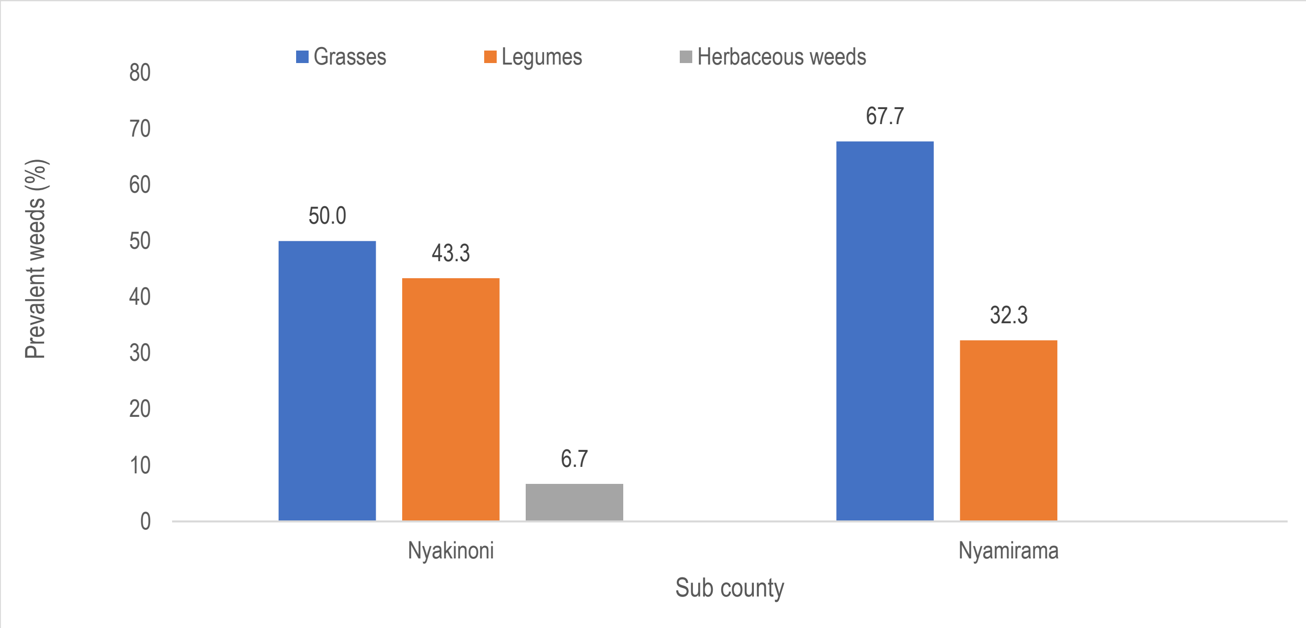


Figure: Weed categories identified in the Matanda command area

At least twelve (12) predominant weed species were identified in Matanda and the grasses were the most pronounced. The different weed species require specific management options to either eradicate them or minimize their impact on crops.

Table: Weeds observed in the Matanda command area

No	Common name	Scientific name	Local name	Weed category
1	Nut grass	*Cyperus rotundus*		Grass
2	Couch grass	*Digitaria scalarum*	Orumbugu	Grass
3	Blackjack	*Pidens pilosa*	Obukurura	Herbaceous
4	Guinea grass	*Panicum trichcladum*		Grass
5	Sword grass	*Imperata cylindrical*	Omushojira	Grass
6	Wild finger millet	*Eleisine indica*		Grass
7	Star grass	*Cynodon dactylon*		Grass
8	Goats grass	*Galinsoga parviflora*		Grass
9	Wondering jew	*Commelina banghalensis*		Herbaceous
10	Tick berry (lantana)	*Lantana camara*		Herbaceous

3.3.1 Management of grass weeds in Matanda

The commonest weed management option deployed by farmers for grasses in Matanda is hand weeding or uprooting, which is realistic on small pieces of land. Other options deployed include weeding using hoe/slasher and use of herbicides, which become very handy with increased acreages. However, herbicide use needs to be regulated to avoid harmful and unwanted effects on crops and farmers.

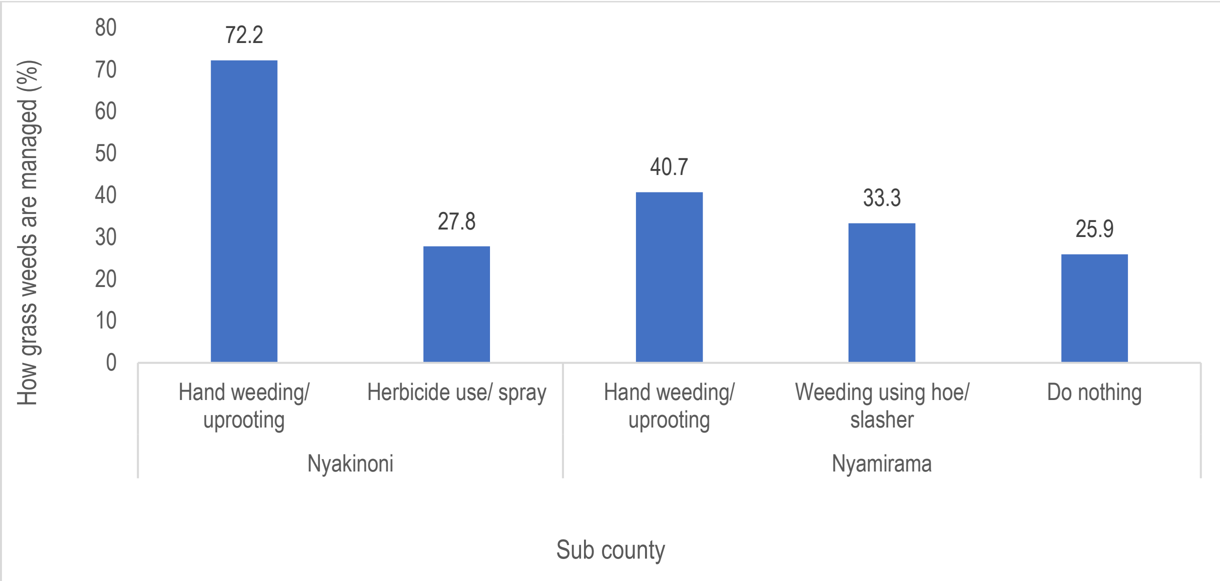


Figure: Grass weed management options deployed in the Matanda command area

3.3.2 Management of legume weeds in Matanda

The commonest method for managing leguminous weeds in Nyakinoni involves uprooting while in Nyamirama, it involves weeding using hoe and slasher. The approach deployed is dependent on type of weed, the intensity of the weeds, nature of soils and the land size. Herbicide use is minimal and only deployed in Nyakinoni.

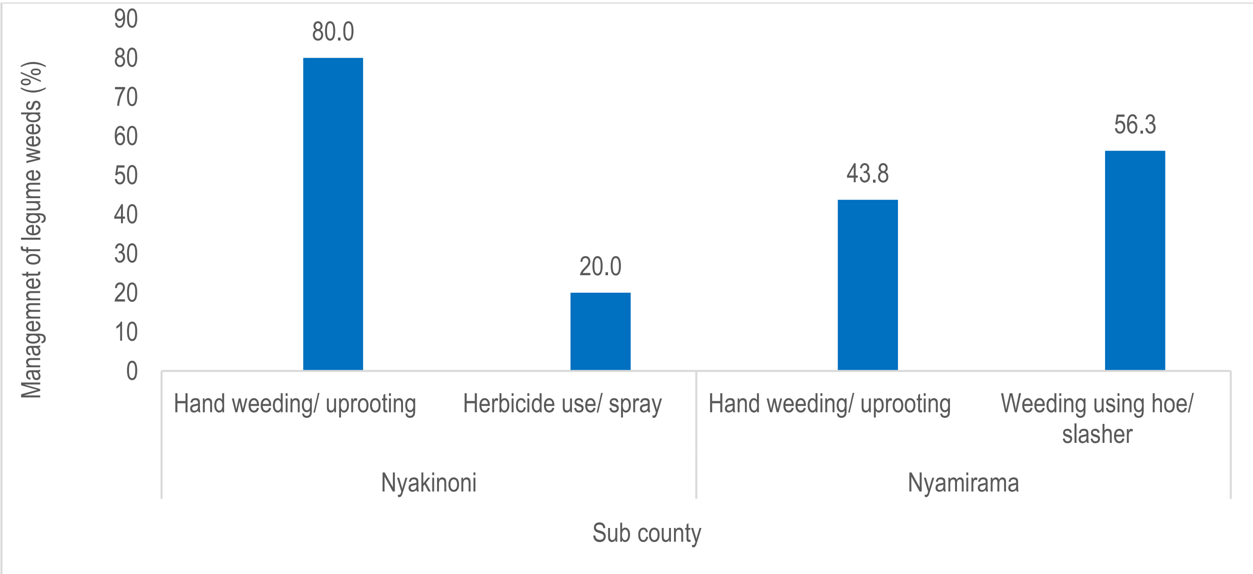


Figure: Legume weed management options deployed in the Matanda command area

3.3.3 Management of herbaceous weeds in Matanda

Herbaceous weeds are only actively managed in Nyakinoni and this involved uprooting and weeding using hoes and slashers.

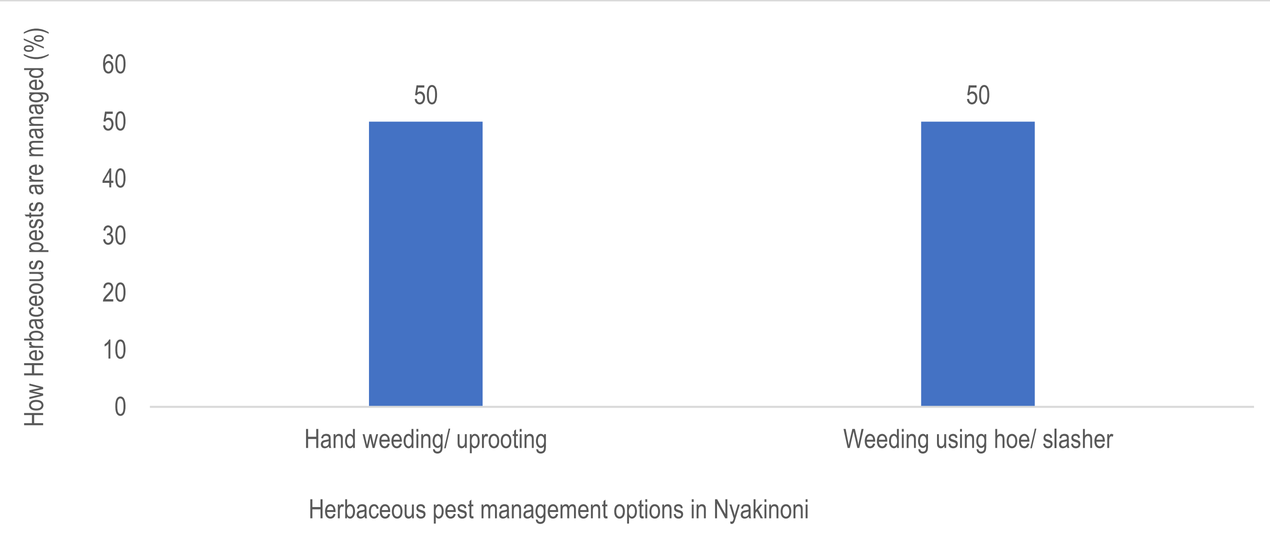


Figure: Herbaceous weed management options deployed in Nyakinoni Sub county in the Matanda command area

3.4 Post-harvest handling

3.4.1 Post-harvest handling methods

The most predominant post-harvest management approach in Matanda involves storage of produce in sacks and this is the only approach used in Kinoni Sub county. Other very minimally used options include improved storage and chemical treatment during storage, which each require special skills to handle effectively and safely.

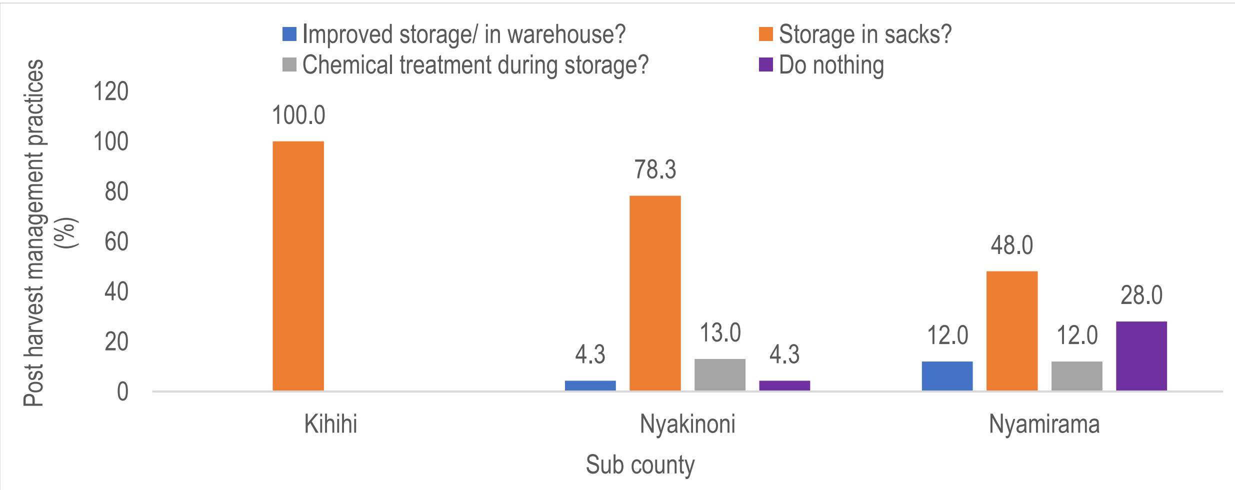


Figure: Post-harvest handling methods deployed in the Matanda command area

3.4.2 Post-harvest handling challenges

The farmers concurred that even though they save their produce in bags, these storage facilities are not effective for long storage of produce resulting in deterioration. The farmers also attribute some of their post-harvest challenges to post-harvesting equipment.

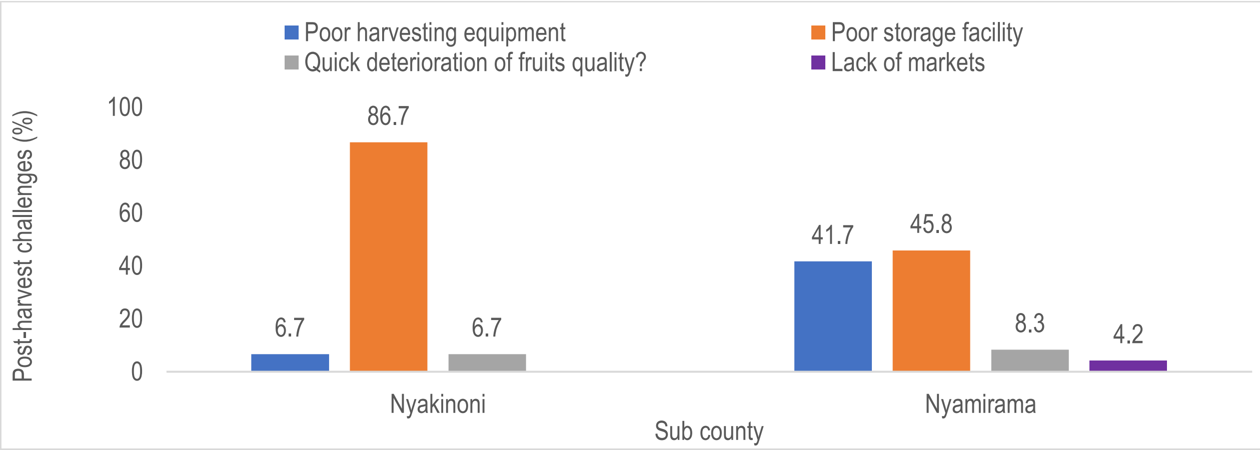


Figure: Post-harvest handling challenges encountered in the Matanda command area

3.5 Organic Agriculture

3.5.1 Farmers practicing organic farming

Organic farming which involves mostly use of natural and traditional farming practices with non or minimal use of agrochemicals is carried out mostly due to lack of resources to acquire inputs rather than for a niche market. Farmers often cultivate their crops and leave the rest to nature due to their low-income status. In Nyakinoni, 70% practice organic farming, while in Nyakinoni and Nyamirama, 42.9% a piece practice organic farming as shown in Figure 17.

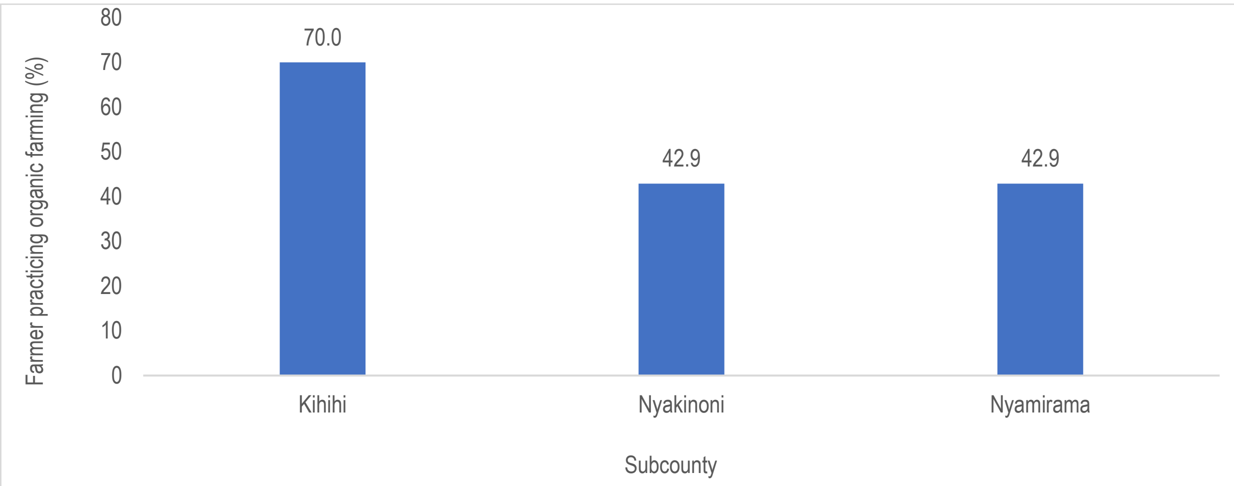


Figure: Farmers practicing organic farming in the Matanda command area

3.5.2 Organic farming practices and their effectiveness

The predominant organic farming practices in Kihihi and Nyamirama are the use of local concoctions for pest and disease management while in Nyakinoni, the predominant one is sanitation. Other approaches include minimal use of selective chemicals, use of botanicals and biocontrol agents.

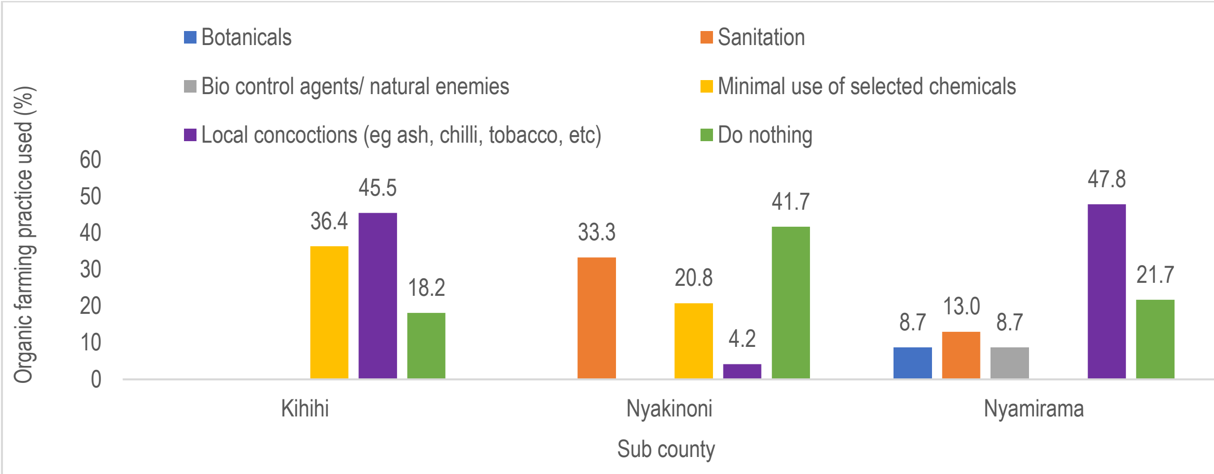


Figure : Organic farming practices deployed in the Matanda command area

From the farmers, the most effective organic farming practices include sanitation, followed by regulated use of selective chemicals. Others include use of bio-control agents and local concoctions as shown in Table 10.

Table: Effectiveness of organic farming practices deployed in the Matanda command area

Organic management practice	Level of effectiveness (%)			
	Very effective	Effective	Fairly effective	Not effective
Sanitation	63.6	27.3	9.1	0.0
Bio control agents/ natural enemies	33.3	33.3	33.3	0.0
Minimal use of selected chemicals	38.5	46.2	15.4	0.0
Local concoctions (e.g. ash, chili, tobacco, etc.)	10.0	35.0	40.0	15.0

3.6 Cost of Pest Management

3.6.1 Pesticides, Fungicides and Herbicides used

A range of pesticides, fungicides and herbicides were found to be deployed by farmers on various crops. The insecticides being widely used by the farmers include Dudu acelamectin, Rocket, Tufgor, Lava, DDforce and Duducyoer. On the other hand, the fungicides include Indofil, Agrozeb, Fungocil, Oshothane, Striker, Eureka, Top laxly, Toplite and Ridomil. The common herbicides include Weed master, Agrothoate, Force up, Butanil 70 S and 2,4-D.

A key component of the label of the chemical according to the *Insecticides Rules, 1971*, is a color mark which represents the toxicity of the chemical, with chemicals categorized by color as extremely toxic (red), highly toxic (yellow), moderately toxic (blue) and slightly toxic (green).

The quantities and frequency of pesticide and fungicide application depending on the commodities and pest and disease condition being managed.

Table: The different agro-chemicals being used in the Matanda command area

Insecticides	Color mark	Fungicides	Color mark	Herbicides	Color mark	Fertilizers
Dudu Acelamectin	Yellow	Indofil	Green	Weed master	Blue	NPK
Rocket	Yellow	Agrozeb	Green	Force up	Green	CAN
Tufgor	Red	Fungocil	Blue	Butanil 70 S	Green	UREA
Lava	Red	Oshothane 80 WP	Blue	2,4-D	Yellow	DAP
DDforce	Red	Striker	Blue			
Duducyper	Blue	Eureka 72%	Green			
Agrothoate	Yellow	Top-laxyl	Blue			

		Toplite	Yellow			
		Ridomil Gold	Green			

The agro-inputs are supplied by small agro-input shops within the trading centre. In as much as the Agricultural Chemicals (Control) Act, 2007 is concerned, the Board and Inspectors have the responsibility of ensuring correct and safe use of approved agro-chemicals. Also, the Kanungu District trict Production Officer (DPO) points out the role of the district in strengthening agricultural advisory / extension services to farmers, and ensuring quality of agro chemicals, inputs, their safe use, and disposal by farmers. However, it is not certain how regular the agro-input stores are monitored to ensure they are supplying genuine and not expired products.

Figure: An agro-input shop that supplies agrochemicals to farmers

It should be noted that the chemicals are mostly identified by their commercial names and thus the names other than the active compound are used.

Figure : One of the commonly used pesticides, dudu-acelamectin (left) and a pheromone trap for attracting pests (right).

3.6.3 Challenges with pest management

Some typical challenges of pest management with the farmers are attributed to inadequate education on the use and application of pesticides. Broadly the following are some of the challenges that are encountered in pest management:

i) Lack of knowledge on which specific pesticide is to be deployed on different crops and for managing specific pests and diseases.

ii) Most of the farmers do not have personal protection equipment (PPE) during the spraying of chemicals, which predisposes them to harmful effects of pesticides.

iii) Farmers lack technical knowledge and have inadequate support thus get information from their colleagues, which are at times erroneous.

iv) Alongside the lack of technical support, farmers often over dosage and apply a lot of chemicals, which can stress the plants.

v) Some farmers do not observe the pre-harvest interval, spraying too close to harvest, thus contaminating the crop after harvest, exposing people to health hazards.

vi) Some of these chemicals are adulterated and at times without labels.

vii) Some farmers use expired chemicals which are mostly ineffective thus causing the risk of pesticide resistance.

viii) Some farmers mix different chemical pesticides together without understanding the effect of their interactions.

3.6.4 Cost of Pesticides/Fungicides

The prices of these chemicals range from as low as UgX 20,000 and rise to as high as UgX 800,000 per farmer per season. The cost of the chemicals is dictated upon by various factors including acreage under crop, pest and disease severity, frequency of application, source of chemicals and distance from source of chemicals.

Table: Cost per household of Chemical Deployed at Matanda

Name of crop	Pesticides/ fungicides used	Average cost per season (UgX)
Beans	Carbendazim	57,000
	Rocket	26,000
Coffee	Dudu cyper	70,000
	Immidaclop	333,333
	Dithane m46	225,000
	Ridomil	30,000
	Confidor	240,000
Groundnuts	Carbendazim	200,000
Maize	Dudu cyper	20,000
	Rocket	20,000
	Diathene	50,000
	Doom	30,000
Rice	Propiconazole	150,000
Watermelon	Tafgor	800,000
	Dithane m45, Copper	600,000

3.6.5 Cost of herbicides

The main herbicides deployed by farmers in Matanda include weed master round up, Striker, and 2,4D. The herbicides are mostly deployed once in a year and cost the farmers between UgX 25,000 and UgX 300,000. The costs are dependent on acreage to be treated, severity of weeds, type of herbicide and source of herbicide among others.

Table: Herbicide Cost per household in Matanda

Name of crop	Herbicides used	Average expenditure on herbicides
Beans	Weed master	85,000
Coffee	Weed master	300,000
G nuts	Weed master	250,000
Maize	Roundup	28,000
	Weed master	90,000
	Striker	25,000
Rice	2,4D	200,000
	Weed master	320,000

3.7 Animal Pests and Diseases

3.7.1 Animal diseases

The main animal diseases identified in the Matanda command area include east coast fever (ECF), trypanosomiasis (nagana), brucellosis, heart water, anaplasmosis, mange, Babesiosis and African swine fever in pigs.

3.7.2 Parasites

The prevalent parasites include worms, ticks, tsetse flies, tapeworms, round worms, liver fluke as shown in the table below:

Table: Livestock Pests and Diseases observed at Matanda

No	Animal	Disease	Parasites
1	Cattle	Lumpy skin disease, foot and mouth disease, trypanosomiasis, (nagana), East coast fever	Ticks, liver fluke, tsetse flies
2	Goats	Lumpy skin disease, fever, cough, foot, and mouth disease, mastitis, pneumonia	Intestinal worms, ticks
3	Sheep	Foot and mouth	Worms, ticks
4	Pigs	Swine fever, mange, lumpy skin disease	Worms, lice, ticks
5	poultry	Newcastle, coccidiosis, Gumboro, Smallpox	Mites, hawks

The respondents indicated that they use among others, vaccines, acaricides, dewormers, and antibiotics to manage mainly lumpy skin, Gumboro, swin fever and worms in the different livestock categories.

The District Local Government has promoted the management of livestock pests and diseases especially among exotic and indigenous cattle breeds through vaccinations, regulating movement and providing advisory services to farmers. They further protect consumers by inspecting slaughter places and products. Below are some investments made by the District Local Government in the management of pests and diseases.

- Two disease control structures (crushes) constructed at Birakwates place on outskirts of Kihihi town and Kihihi Sub-county.
- 8205 cattle vaccinated for lumpy skin disease and black leg disease.
- 107415 birds vaccinated for Newcastle and Gumbolo disease.

3.7.3 Indigenous knowledge in management of pests and diseases

Farmers use their indigenous knowledge for pest control e.g. they use tephorasia to control mange in animals, they set fire on banana plantations to control weeds. And manual labor to control couch grass.

3.7.4 Cost of livestock pest and disease management

Five tick-borne livestock diseases are particularly important including East Coast Fever, bovine anaplasmosis, bovine babesiosis, theilerioses, and heart water. The economic impact of ticks and the diseases they transmit is enormous. Depending on the tick species involved, the livestock management practices followed, the tick-borne diseases present, and the environmental conditions of an area, cattle are treated at periodical intervals with any one of over 30 available acaricide brands.

Vaccination is according to the District Development Plan focused on lumpy skin disease and black leg in cattle and New castle and Gumboro diseases in poultry with thousands of livestock and poultry being vaccinated by the Local Vet Officials.

Livestock pest and disease management costs vary depending on the type of livestock, number of animals/birds, type of chemical and supplier of the chemicals and these costs vary per farmer between UgX 67,000 and UgX 730,000. It should be noted that the level of chemical use among livestock farmers varies greatly dependent on the level of investment in the enterprise and occurrence of pest and disease outbreaks.

Table : Cost of livestock pest and disease management in Matanda

Name of Animal	Cost of acaricides (Ugx)	Cost of vaccines (Ugx)	Cost of drugs (Ugx)	Cost of body wash drugs (Ugx)	Cost of dewormers (Ugx)	Total costs
Pigs	5,833	7,500	22,833	12,500	27,167	75,833
Cattle	20,000	40,000	30,000	10,000	15,000	115,000
Goats	24,000	-	10,000	-	33,000	67,000
Poultry	150,000	323,333	223,333	23,333	16,667	736,667

3.8 Chemical waste disposal

The waste disposal practice of farmers is risky as the farmers mostly throw the chemical residues and their containers in the toilets or just leave them in the fields (do nothing about them). These have a high risk of being swept into water bodies thus contamination water for drinking.

Table: Methods of Chemical Waste Disposal in Matanda

Sub county	Do nothing	Throw in the toilet	Pour in the water streams	Pour in soak pits	Throw in the dust bin/ rubbish pit
Kihihi	20.0	0.0	0.0	0.0	80.0
Nyakinoni	14.3	0.0	0.0	0.0	85.7
Nyamirama	28.6	38.1	4.8	9.5	19.0

Poor disposal of chemical waste can also result in buildup of resistance by pests and disease-causing organisms to these chemicals. It also predisposes, especially the children to the risk of poisoning should they pick up these containers and eat residues.

Figure: Inappropriate disposal of agro-chemical containers within the fields

4. Legal and Institutional Framework on Pests

4.1 Acts and Policies

The National Development Plan III

The National Development Plan III, with respect to management of pests and diseases in agricultural production systems of Uganda, is projecting to support the production, testing and commercialization of pesticides, acaricides, and herbicides. The strengthening systems for management of pests, vectors and diseases will be achieved through i) Developing and equipping infrastructure and facilities for disease diagnosis and control; ii) Developing human capacity for management of pests, vectors and diseases; and iii) investing in agricultural drugs manufacture and distribution.

Agriculture Sector Strategic Plan (ASSP) 2020/21 - 2024/25

The third Agriculture Sector Strategic Plan (2020/21 - 2024/25) aims to transform Uganda's agricultural sector from subsistence to commercial agriculture, through the identification and promotion of priority commodities, including coffee, dairy, fish, livestock, and a range of staple crops. This transformation includes the effective management of the constraints to enhancing the production and productivity of these commodities including among others, pests and diseases.

The 2015/2016 – 2019/2020 Sector Strategic Plan on the other hand focused investment to the specified priority and strategic commodities across their entire value chains. Areas of investment included research; extension; pest, vector, and disease control; provision of inputs; promoting sustainable land use and soil management; post-harvest handling; improving markets access and value addition. The investment strategy was targeted to achieve the following objectives:

1. Increasing agricultural production and productivity,
2. Increasing access to critical farm inputs,
3. Improving agricultural markets and value addition, and
4. Improving service delivery through strengthening the institutional capacity of MAAIF and its agencies.

These clearly show the central role of pest management and associated agro-inputs in the Agricultural Sector Strategic Plan.

National Agriculture Policy, 2013

The second objective of the National Agriculture Policy, 2013 expects to increase incomes of farming households from crops, livestock, fisheries, and all other agriculture related activities and in line with pest management, the following will be the areas of implementation

- Provision of vaccination services for animal vector disease control;
- Stocking of vaccines and essential drugs for all notifiable diseases; and
- Strengthening capacity for pest, weed, disease, and vermin control at all levels.

Agricultural Chemicals (Control) Act, 2007

The Act controls and regulates the manufacture, storage, distribution, and trade in, use, importation, and exportation of agricultural chemicals and for other related matters. The "agricultural chemicals" includes plant protection chemicals, fungicides, insecticides, nematicides, herbicides, miticides, bactericides, rodenticides, molluscides, avicides, fertilizer, growth regulators, wood preservatives, bio-rationals, biopesticides, bio-fertilizers or any other chemicals used for promoting and protecting the health of plants, plants products and by products. This Act provides the Board and Inspectors with the responsibility of ensuring correct and safe use of approved agro-chemicals.

It is indicated that almost 80% of the shops at the ‘container village’, which is the hub for sale of agrochemicals are not registered to deal in agro-inputs. Dealers often sell anything counterfeited, doctored, or adulterated. Some sell pesticides, herbicides and fungicides that have long been banned.

Plant Protection and Health Act, 2015

The Act consolidates and reforms the law relating to protection of plants against destructive diseases, pests and weeds, to prevent the introduction and spread of harmful organisms that may adversely affect Uganda's agriculture, the natural environment and livelihood of the people, to ensure sustainable plant and environmental protection, to regulate the export and import of plants and plant products and introduction of new plants in accordance with international commitments on plant protection so as to protect and enhance the international reputation of Ugandan agricultural imports and exports, to entrust all plant protection regulatory functions to the Government, and for other related matters.

Section 23 (f) empowers the inspectors to inspect areas and plant material under cultivation, in storage or transit for purposes of detecting and reporting the existence, outbreak or spread of pests and make a report on them to the Commissioner and 23i) develop and test quick phytosanitary pest and disease diagnostic procedures. Section 13 (1) provides for Contingency measures for the containment of outbreak of pests. Where there is sufficient evidence that field crops in any part of Uganda are in danger of serious damage by outbreak of pests, the Minister may, by statutory declaration bring into force in such areas all rules made under section 9, and any other measures stipulated under this Act, to contain the outbreak of pests.

The Seed and Plant Act, 2006

This Act provides for the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials and for other related matters.

The act provides for the establishment of a number of administrative units, including (i) the National Seed Board under MAAIF, (ii) National Variety Release Committee- a technical committee which includes, among others, an entomologist, pathologist and weed scientist, and (iii) National Seed Certification Services Committee responsible for designing and implementing seed certification standards, methods and procedures.

The National Environment Act, 1995

The National Environment Act (Cap 153) enforces the constitutional of Ugandans to a clean and healthy environment. The Act establishes National Environmental Management Authority (NEMA) as the apex Government agency for environmental management in Uganda. The Act prohibits discharge of hazardous substances into the environment without following NEMA guidelines, illegal traffic in hazardous wastes, and pollution contrary to established standards. It provides standards for effluent and waste management. This Act complements the Agricultural Chemicals Act in regulating the use and disposal of pesticides.

The National Advisory Services Act, 2001

This Act provides for the establishment of the National Agricultural Advisory Services (NAADS), whose role is to promote market-oriented agriculture, and to regulate provision of advice and information services to farmers.

The Local Governments Act, 2015

The Cap 243 of this Act provides for decentralization at all levels of local governments to ensure good governance and democratic participation in, and control of, decision making by the people. Under this act the District and Lower Local Councils may make ordinances and bylaws agricultural development and environmental protection in their areas of jurisdiction, including management of pests.

4.2 Relevant Entities

Various entities will be involved in various aspects related to pest management provided for in the various policy and strategic documents and their roles include farmer support and extension services, quality assurance, monitoring and evaluation.

4.2.1 Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)

The mandate of the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) is "To promote and support sustainable and market oriented agricultural production, food security and household incomes". The Ministry provides overall supervisory role concerning agricultural production and development and its functions are to:

a. Formulate, review, and implement national policies, plans, strategies, regulations, and standards and enforce laws, regulations, and standards along the value chain of crops, livestock, and fisheries,
b. Control and manage epidemics and disasters and support the control of sporadic and endemic diseases, pests, and vectors,
c. Regulate the use of agricultural chemicals, veterinary drugs, biological, planting and stocking materials as well as other inputs,
d. Support the development of infrastructure and use of water for agricultural production along livestock, crop, and fisheries value chains,
e. Establish sustainable systems to collect, process, maintain and disseminate agricultural statistics and information,
f. Support provision of planting and stocking materials and other inputs to increase production and commercialization of agriculture for food security and household income,
g. Develop public infrastructure to support production, quality / safety assurance and value-addition along the livestock, crop, and fisheries commodity chains,
h. Monitor, inspect, evaluate, and harmonize activities in the agricultural sector including local governments,
i. Strengthen human and institutional capacity and mobilize financial and technical resources for delivery of agricultural services, and
j. Develop and promote collaborative mechanisms nationally, regionally, and internationally on issues pertaining to the sector.

4.2.1.1 Department of Crop Protection

The department of crop protection in the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) is responsible to support sustainable crop pests and diseases control for improved food security and household incomes in Uganda. Other roles include issuance of import and export phytosanitary certificates for live plant material and horticultural crops, as well as for plant pest prevention or eradication programmes. The department is also responsible for enforcing regulations on registration and the use of pesticides and other agrochemicals. The key functions of this department include:

a) Formulating, reviewing, and implementing policies, legislations, standards, plans, guidelines, and strategies for controlling the spread of crop pests and diseases in Uganda,
b) Conducting field and laboratory investigations of crop pests and disease outbreaks,
c) Controlling crop pests and diseases in Uganda,
d) Monitoring outbreaks and prevalence of crop pests and diseases in Uganda and including the neighboring countries,
e) Conducting surveillance, collection, collation and dissemination of crop pests and disease epidemiological data,
f) Guiding MAAIF, local governments (LGs), and other stakeholders on crop pests and diseases control strategy,
g) Supporting field extension staff, NGOs and LGs on crop pests and disease control, and
h) Managing the provision and monitor the availability & use of major agricultural chemicals in control of crop pests and disease epidemics.

The Pesticide and Fertilizer Control Unit (PFCU) under Crop Protection Department has the following functions:

i) Initiate formulation and review of policies, laws, regulations strategies and plans related to agro-chemicals and their use in Uganda
ii) Inspection, monitoring and enforcement of regulations and standards for compliance and to take the necessary action in cases of non-compliance
iii) Equip, operate, and build capacity to operate the Pesticide Analytical Laboratory to establish accurate pesticide residues in plants used for food and other food and feed items
iv) Develop and participate in pesticide residue monitoring plan to ensure adherence to the official Maximum Residue Levels (MRLs)
v) Conduct tests and efficacy field trials on agricultural chemical formulations to compliance to approved specifications and quality the registration process
vi) Participate in national, regional, and international fora to promote sound management of agricultural chemicals
vii) Secretary to the National Agricultural Chemicals Board and its subsidiary body, the Agricultural Chemicals Control Technical Committee Build capacity for inspection and certification of agro-chemical trade in Uganda and assessing and seeking solutions to the trade constraints and use of the agro-chemicals
viii) Establishing a database of registered and approved products, dealers, and premises
ix) Ensure that the public and the farming communities and dealership communities have access to information on safe and responsible use of agricultural chemicals and that the necessary training programs are in place.

The Control of Crop Epidemics Section (CCES) has the following functions:

i) Surveillance for weeds, pests and diseases that are of epidemic proportions,
ii) Mobilizing and organizing researchers, Local Government Staff, Local NGOs, and farmers to control weeds, epidemic pests (including migratory pests) and diseases,
iii) Purchasing Equipment, agro-chemicals and mobilizing stand-by funding to intervene in case of outbreaks of a weeds, pests, or diseases,
iv) Forecasting, and providing an early warning on epidemic pests and diseases and sending alert messages to the stakeholders to be ready for outbreaks,
v) Liaising with regional and international organizations in weed, pest and disease forecasting, monitoring and management,
vi) Training and building capacity for the Department, Local Governments and farming communities in pest and disease epidemic control,
vii) Creating awareness for weeds, crop pests and diseases, their management and follow up,

viii) Keeping and updating a database of information on epidemic pests and diseases and their control,
ix) Formulating guidelines based on the Crop Protection act 1962, to guide lower administrative units to make by-laws to improve pest and disease control strategies in the affected districts.

The role of MAAIF in the implementation of the Matanda IPMP will, among others, include:

- Liaising with Uganda National Bureau of Standards (UNBS) to ensure the importation of pesticides allowed for use in Uganda and ensure they are of high quality
- Liaising with the National Environment Management Authority (NEMA) and Government Analytical Laboratories (GAL) to monitor pesticide contamination
- Monitoring the condition of pesticide storage and transport through its inspectors
- Working with NAADS link-up with the district and Sub counties to ensure safe disposal of pesticide containers.

4.2.2 National Agricultural Research Organization (NARO)

The National Agricultural Research Organization (NARO) is the apex body for guidance and coordination of all agricultural research activities in Uganda. It is comprised of a secretariat, the National Research Institutes (NARIs), and the Zonal Agricultural Research and Development Institutes (ZARDIs). The National Agricultural Research Organization (NARO) provides research oversight and generation of new knowledge in resolving challenges of agriculture (including pests and diseases). The NARIs are mandated to do research on issues of strategic national importance (priorities), while ZARDIs address priorities that are articulated through participatory processes at the zonal level. The pest management related research generating various management options is carried out in the various commodity institutes and the adaptation of these technologies in the Matanda area are undertaken by Kachwekano ZARDI.

4.2.3 Kanungu District Local Government

The District Local Government and the Sub county Local Governments are responsible for implementing, coordinating, and monitoring implementation of Government initiatives at the Local Level. Kanungu district Local Government and the 3 Sub counties of Kihihi, Nyakinoni and Nyamirama are solely responsible for the local implementation of agricultural activities including pest management. The Ministry of Agricultural, Animal Industries and Fisheries offers technical backstopping and capacity building of district and Sub county authorities so that they can better deliver regulatory and quality assurance services. The district agricultural officers are responsible for agricultural activities at district level, while advisory services are provided by the extension officers based at the Sub counties. The District also runs plant clinics under the CABI Plantwise Program, which supports in pest detection as well as improving pest management advisory services.

4.2.4 Farmer Associations

The Uganda National Farmers Federation (UNFFE) and District Farmers Associations (DFAs) provide support to farmer associations through lobbying and advocacy. The NAADS programme has supported the formation of several farmers associations in Uganda, focusing on strategic agricultural enterprises. Farmer associations attract support in terms of inputs and extension support from various sources including the Government, NGOs and the private sector and enable farmers to have a strong bargaining power in the market. In the implementation of the IPMP, the farmer's task forces which are usually set up in response to the emergence of disease epidemics or pest outbreaks using their power to lobby and advocate, will and can play a role in mobilizing their communities to reject fake agro-inputs from different suppliers and enforce safe disposal of chemical waste and waste containers.

4.2.5 The Private Sector

The Private Sector has the role of making available resources, inputs and facilities that spur agricultural production and development. Private Sector actors in agriculture include agro-input suppliers, traders, and processors. The Uganda National Agro-Input Dealers Association (UNADA) is an association for input dealers whose objectives are to; (i) establish and enforce a code of fair business conduct for members and keep members informed of the legal codes regulating the industry, and (ii) actively contribute to the modernization of Uganda's agriculture, and participate in projects aimed at bringing development to the agricultural sector.

Organizations of traders exist especially for commercial crops such as coffee, tea, cotton, flowers, vegetables, and fruits to organize value chain actors. For example, the Uganda grain council is focused on establishing standards for grain marketing in the country, including management of post-harvest pests, quality standards and processing. The Export Promotions Board (UEPB) is the national focal point for export promotion and development. The effectiveness of pest management at the Matanda command area is anchored on the effective participation of all these players and existence of personnel, facilities, and logistics for the different players to utilize.

5. Pest and Disease Impact

We used the CABI report on Crop Pests and Disease Management in Uganda: Status and Investment Needs[2] to determine the economic impact of the different identified crop pests. It should be noted that the different pests and diseases have differing yield and economic penalties and thus their effective management would translate to significant economic gains.

Table: The Yield/ and or Economic Losses associated with different Crop Pests and Diseases Identified in Matanda

Major Pest/Disease	Yield and/ or Economic loss	Management Recommendations
Coffee		
Black Coffee twig borer [BCTB]	Cause losses approximately US$40.1 million of coffee foreign exchange earning annually (Kagezi et al., 2014).	- Regular field inspection for any new infestation - Field sanitation: Pruning and burning of infested twigs and branches; clean weeding; stumping coffee trees if infestation is high; reduction of excess shade tree cover - Use of adequate fertilizer and irrigation to ensure vigorous plants - Maintenance of the recommended spacing between individual plants to minimize humidity levels - Spray using Malathion and Permethrins. Caution with agrochemical use (i) use of protective gear including masks, gloves, googles and protective clothing to prevent exposure to harmful chemicals (ii) train users on proper handling, storeage and disposal to minimize risk of accidental ingestion, inhalation and dermal contact (iii), schedule spraying to non-windy days and avoid spraying during peak human activities (iv) practice precise dosing to avoid over application which leads to pesticide resistance and environmental contamination and, (v) maintain buffer zones around water bodies and sensitive ecosystems and residential areas to prevent contamination.
Coffee leaf rust,	Causes approx. 10 - 50% yield loss on susceptible coffee varieties (Silva et al., 2006). Severe on Arabica coffee at mid and low altitude (1500 masl and below) where crop losses can reach 50% (Luzinda et al., 2015).	- Cultural practices including open pruning to reduce humid conditions; regular stumping; good weeding and soil fertility management to ensure strong and healthy trees - Application of copper-based fungicides every 3 weeks starting at the onset of rains for a maximum of 5 sprays per season - Alternatively, curative, or systemic fungicides may be used
Coffee wilt	Caused losses of US$580 million from 1997 to 2007 (Phiri & Baker, 2009).	- Uproot and burn infected coffee trees on site as soon as symptoms appear - If more than 70% of coffee trees are affected, uproot and burn all coffee trees in the farm and replant with resistant/tolerant coffee germplasm - Restrict movement of infected planting materials, coffee husks and soil - Disinfect farm tools that have been used in an infected garden using flames or Jik solution (5%)

[2]CABI, 2016. Crop pests and disease management in Uganda: status and investment needs. Final Report

Major Pest/Disease	Yield and/ or Economic loss	Management Recommendations
		- When pruning or handling plants, start with the healthy-looking plants first - Avoid wounding of plants e.g. during weeding - Plant resistant varieties - Allow a fallow period of 6 months to 2 years before replanting with susceptible coffee seedlings - Paint cut stem and branches with copper-based fungicides to reduce infection
Banana		
Black sigatoka or black leaf streak	Loss of 37% in bunch weight (Tushemereirwe 1996).	- Use of resistant cultivars - Cultural practices to reduce humidity in the field e.g. correct spacing or plant density, good field sanitation; absence of weeds; and good drainage - Good fertilization of banana plants to enhance leaf production and reduce disease impact
Banana bacterial wilt	BXW causes yield losses of up to 90%. Potential national loss is estimated at US$ 360 million per annum (World Bank, 2008 as cited in MAAIF, 2010).	- Early removal of male buds - Disinfection of cutting tools - Use clean planting material - Combination of cultural practices including de-suckering, monocropping, weeding, de-trashing, manure application, mulching & soil/water conservation
Fusarium wilt	Entire plots of susceptible varieties can be completely wiped out (Tushemereirwe et al., 2000).	- Use of resistant varieties - Sanitation (removal of affected plants; providing adequate drainage; composting household refuse prior to its application to soil) - Use of clean planting materials
Banana weevil	Causes yield losses of up 40%.	- Regular monitoring of weevil infestation - Sanitation of field by removing and destroying the dried leaves and plant debris - Use of healthy, un-infested suckers - Washing and dipping of the suckers in a solution of Chlorpyriphos and malathion - Routine soil sterilization through application of carbofuron - Cut the banana plant after harvest at the ground level and treat surface with carbaryl (1g/liter) or chlorpyriphos (2.5 ml/lit) at the cut surface - Use of resistant cultivars/ varieties
Nematodes	Yield losses of 50% (Speijer & Kajumba 1996, Kashaija et al. 2004)	- Fallowing of field for 10-12 months if infested with burrowing nematode - Removal or plough-in of weeds - Use of cover crops that produce chemicals in the soil that reduce nematode populations, e.g. *Crotalaria* (sunnhemp) or *Tagetes* (marigold) or *Panicum maxicum*. - Improved soil fertility using organic manure to increase root development and stimulate natural biological control. - Improve soil drainage in high rainfall areas. - Treat planting material first by cutting out all obvious signs of corm infection, and then with hot water at 52-55°C for 15-20 minutes - Use plants from tissue culture if these are available and affordable - Carry out crop rotations with passion fruit (*Passiflora edulis*) or pineapple (*Ananas comosus*) in rotations between crops of banana. - Deploy resistant varieties - Nematicides may be used as a last resort as they are expensive and have adverse environmental effects.

Major Pest/Disease	Yield and/ or Economic loss	Management Recommendations
Tomato		
Tuta Absoluta (tomato)	Annual loss of US$800,000 (Pratt et al., 2016).	- Use of pheromone traps and/ or sticky traps - Use of chemical pesticides that are approved tomatoes in Uganda e.g. Dudu acelamectin, Coppermate, Dimethoate and Mancozeb. - - The Safety cautions will include (i) use of protective gear including masks, gloves, googles and protective clothing to prevent exposure to harmful chemicals (ii) train users on proper handling, storage and disposal to minimize risk of accidental ingestion, inhalation and dermal contact (iii), schedule spraying to non-windy days and avoid spraying during peak human activities (iv) practice precise dosing to avoid over application which leads to pesticide resistance and environmental contamination and (v) maintain buffer zones around water bodies and sensitive ecosystems and residential areas to prevent contamination. - Use of bio-rationals for example neem extract - Biocontrol using parasitoids and entomopathogens (biopesticides) - Crop rotation with non-solanaceous crops - Field sanitation (removal and destruction of crop residue and affected crops) - Planting of pest free seedlings
Thrips	21% pod yield loss (Gadad, et al. 2014)	- Cultural practices (avoid planting tomatoes next to onions, garlic, or cereals) - Treatment with insecticides early in the season and continuing through the season
Late and early blight	Up to 100% loss (Tumwine, et al. 2002)	- Growing of resistant/tolerant cultivars - Cultural control (use of pathogen-free seed, removing and burning affected leaves, or use of seed from disease-free plants) - Rotation of tomatoes with non-related crops for at least two years. - Control alternative host weeds such as black nightshade and hairy nightshade, and volunteer tomato plants - Fertilizer application to maintain vigorous growth - Chemical control - Practice staking and mulching - Spray with copper fungicides - Avoid wetting plants for protracted periods
Bacterial wilt	Yield losses vary from 0 to 91% in the tomato (Yuliar et al. 2015)	- Cultural practices - Resistant cultivars - Crop rotation, multi-cropping - Soil amendment
Maize		
Fall army worm	450,000 tonnes of maize worth $192.8 million per annum (MAAIF, 2017)	- Use of pheromone traps - Use of approved pesticides - Spray with botanicals like neem and pyrethrum extracts - Biological control through conservation and establishment of natural enemies - Field sanitation

Major Pest/Disease	Yield and/ or Economic loss	Management Recommendations
Stem borer	Annual losses of US$19.4m	- Intercropping with pulses - Early planting - Planting of early maturing varieties - Destruction of crop residues (make compost, burn or feed livestock) - Use of neem neem seed cake during planting - Use botanical pesticides
Weevils	Grain loss of 20 - 90% worldwide Cugala et al. 2007)	- Treat grain with inert dust such as ash from wood or rice husk. - Take grain out of storage and dry for about three days to kill weevils - Sieve to remove adult weevils - Store grain in undamaged sacks or airtight sacks, e.g. hermatic bags - Biological control - Use of chemical sprays - Cultural practices (good store hygiene, cleaning the store between harvests, removing, and burning infested residues, fumigating the store to eliminate residual infestations and the selection of only uninfected material for storage) - Harvesting the maize as soon as possible after it has reached maturity - Use of resistant cultivars - Botanical pesticides like neem extract
Maize streak	Approx. USD 16.1 million. (Pratt et al., 2016).	- Grow resistant maize lines - Cultural Control (avoid planting downwind, rotation practices, create a 10-m barrier of paved ground, and removal of the remnants of previous crops) - Grow resistant varieties like Longe 1, Longe 4, Longe 5, Longe 2H, Longe 3H - Chemical insecticides to manage the vectors
Beans		
Bean weevil	Losses estimated at about 70% (Nahdy, 1990; Songa and Rono, 1998; Mulungu et al., 2007)	- Sanitation (eliminate potential sources of weevils in production areas) - Use of pest tolerant cultivars - Harvest early before splits appear in pods - Drying seeds thoroughly before storage - Tumble seeds in a sack or roll in a drum to crush eggs and stop new larvae from penetrating the seed - Boil used storage sacks in hot water and dry in the sun before reuse - Inspect stored seeds for signs of infestation
Rice		
Stalk borer	Yield losses of 10 and 100% (Alibu et al. 2016)	- Destroy crop residues - Plant early - Use of push-pull technology - - Use of pheromone traps and lures - - Biological control using parasitoids - Apply insecticides (Permethrin, Deltamethrin or Lambda-cyhalothrim) as a last resort in a regulated fashion to coincide with larval emergence. Caution with agrochemical use; i) use of protective gear including masks, gloves, googles and protective clothing to prevent exposure to harmful chemicals (ii) train users on proper handling, storage and disposal to minimize risk of accidental ingestion, inhalation and dermal contact (iii), schedule spraying to non-windy days and avoid spraying during peak human activities

Major Pest/Disease	Yield and/ or Economic loss	Management Recommendations
		(iv) practice precise dosing to avoid over application which leads to pesticide resistance and environmental contamination and, (v) maintain buffer zones around water bodies and sensitive ecosystems and residential areas to prevent contamination. (vi) using expired chemicals (vii) Keep agrochemicals out of the reach of children
Rice blast	Rice Blast was causes up to 100 % yield (MAAIF, 2014)	- Cultural practices (destruction of infested residue, use of non-infested seed, water seeding, continuous flooding, and avoiding excess nitrogen) - Proper seed sampling and testing - Use resistant cultivars - Use a protectant fungicide so that the panicles is protected as it emerges from the boots
Cassava		
Mealy bugs	Losses of 80% (Herren and 385 Neuenschwander 1991)	- Biocontrol using exotic natural enemy (*Epidinocarsis lopezi*) - Treatment using dimethoate (Rogor) a systematic insecticide - Use of mealybug-free cuttings - Use of mealybug resistant cassava varieties - Crop rotation to reduce mealybug population
Cassava mosaic	Losses estimated at 600 000 tonnes worth USD 60 million per year (Legg & Thresh, 2000).	- Inspect plants regularly for disease symptoms - Remove (rogue) and destroy plants showing symptoms - Use of resistant varieties - Use clean planting materials - Avoid planting cassava towards the end of the rains
Groundnut		
Rosette	Can cause up to 100% yield loss (Busolo-Bulafu, 2004)	- Deploy host plant resistance such as Serenuts 2-14 series and Igola 1. - Timely planting as soon as there is enough water in the soil - Appropriate spacing (1.5ft x 0.5ft for erect types and 2ft x 0.65ft for spreading types) - Intercropping with beans or sorghum - Chemical control with insecticides, such as dimethoate Caution with agrochemical use - Always wear protective gear when handling and spraying chemicals - Use the correct dosage of chemicals as provided by the manufacturer - Avoid using expired chemicals Keep agrochemicals out of the reach of children
Cercospora leaf spot	60% loss (Mugisha et al. 2004)	- Use of host resistance - Fungicide spray using chlorothalonil and carbendazim **Caution with agrochemical use** - Always wear protective gear when handling and spraying chemicals - Use the correct dosage of chemicals as provided by the manufacturer - Avoid using expired chemicals - Keep agrochemicals out of the reach of children

6. Integrated Pest Management

According to the World Bank[3], Integrated Pest Management (IPM) is a knowledge-intensive and farmer-based management approach focusing on and encouraging natural control of pest populations by anticipating pest problems and preventing pests from reaching economically damaging levels. The appropriate techniques used among others include use of natural enemies, pest-resistant crops, deployment of cultural management, and, as a last resort, using pesticides judiciously[4].

Different IPM strategies can be deployed based on the local circumstances with the farmers having flexibity of deploying a mix of interventions. The principle of IPM is based on understanding of agro-ecological principles, monitoring interactions among crops, pests, and natural enemies of pests, and selecting and implementation of adequate control measures.

6.1 Principles of Integrated Pest Management

The World Bank sets the following guiding principles for IPM implementation:

- **Grow a healthy crop**. This focuses on the deployment of cultural practices and resistant varieties to ensure a healthy crop.
- **Manage the agro-ecosystem.** Involves deployment of non-chemical practices to make the field and the crop inhospitable to the insect pest species and hospitable to their natural enemies. This also sets conditions that prevent the buildup of weeds and diseases.
- **Decisions to apply external inputs as supplementary controls are made locally, are based on monitoring of pest incidence and are site-specific**. These external inputs may include predators or parasites (bio-control), labor to remove the pest manually, pest attracting lures, pest traps, or pesticides. Pesticides are only to be used if economically viable non-chemical pest control inputs are not available or have failed to control the pest.

6.2 Features of Integrated Pest Management[5]

The main features of IPM, which majorly involves the use of non-chemical methods of pest and control, include the following:

* ***Biological controls.*** The use of natural enemies, often called *beneficials,* including parasites, predators, and insect pathogens.
* ***Cultural and crop or livestock management controls****.* These include practices of tissue culture, use of disease-free seed, trap crops, cross protection, cultivation, refuse management, mulching, field sanitation, crop rotations, grazing rotation, and intercropping.
* ***Strategic controls.*** Planting location, timing of planting, and timing of harvest.
* ***Genetically based controls.*** This includes deployment of insect- and disease-resistant varieties and root stock. Environment-friendly chemical interventions are sometimes included in biological controls, such as the use of semiochemicals, including pheromones and feeding attractants, and biopesticides (for example, specific and beneficial friendly insecticides).

Integrated pest management often combines natural forms of control integrated with ecological interaction advantages in farming systems. It focuses on economically derived rules for the application of pesticides. There is distinction between pesticide use in IPM and conventional pest control, where possible IPM relies on pesticides

[3] The World Bank, 1997. Integrated Pest Management Strategies and Policies for Effective Implementation

[4] Adapted from USDA/ARS1993

[5] Vandeman et al, 1994

that target specific pests, can be applied at lower rates, and are less toxic to beneficial organisms. New IPM methods are being developed where biological materials such as pheromones and feeding attractants lure the target pest to the pesticide. Under this new system, application rates, timing, and frequency are chosen to minimize effects on biocontrol agents. Pesticides that can be substituted for each other are interchanged to slow the development of pest resistance to pesticides.

6.1 The IPM Steps

The Agricultural Sector Development Plan (ACDP) of MAAIF[6] has laid down four key steps to be followed in implementing the IPM strategy:

1- Set Action Thresholds

The point at which the pest populations or environmental conditions indicate that pest control action must be taken must be established before taking any pest control action. The level at which pests will become an economic threat is the critical criterion to guide pest control decisions.

2- Monitor and Identify Pests

This ensures that the IPM program will monitor pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification will avoid use of pesticides when they are not really needed or use of the wrong kind of pesticide.

3- Prevention

This involves managing the crop to prevent pests from becoming a threat and includes use of cultural methods, such as crop rotation, pest-resistant varieties, and planting pest-free rootstock. These control methods are expected to be very effective and cost-efficient and present little to no risk to people or the environment.

4- Control

Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, the IPM program will then evaluate the proper control method both for effectiveness and risk. Effective, less risky pest controls will be chosen first to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications, and action thresholds indicate that less risky controls are not working, then additional pest control methods will be employed, such as targeted spraying of pesticides. Broad-based spraying of non-specific pesticides will only be conducted as a last resort.

6.2 IPM Practices

In line with the ACDP PMP, the following IPM measures/practices are recommended for adoption by all farmers where feasible:

6.2.1 Pest Preventive Measures

This involves removing and or burning diseased plants or affected portions of the plant. It also involves phytosanitary measures, such as physical removal of pests, affected plant parts, infected plants (virus-infected plants, severely disease-infected or pest-infested plants).

[6] MAAIF 2014, Agriculture Cluster Development Project Pest Management Plan

6.2.2 Use of Host Resistance and Early Maturing Varieties

Choosing to grow resistant and/or early maturing varieties can help to reduce pest problems. Resistant varieties eliminate or slow down the rate of disease development and associated losses in yields. Early maturing varieties of crop reach maturity and are ready for harvesting sooner than normal varieties, which helps them escape the stage of pest buildup. Use of early maturing and resistant crop varieties minimizes or eliminates the need to use chemical pesticides.

6.2.3 Biological Control

This is a method that takes advantage of the fact that organisms depend or even feed on each other for survival. Thus, biological control ensures that pests are reduced by organisms which are their natural enemies. Biological control could be considered as the first line of control for pests and diseases to keep down the pest populations, provided the bio-control agents exist for the given pests and diseases. Some widely used biocontrol agents include *Trichoderma s*pp.*, Pochonia chlamydosporia, Pseudomonas fluorescens* and other antagonistic microorganisms. Conditions for successful introduction of biological control agents include the following:

- The environment is suitable for the population to flourish.
- The biocontrol agent should virtually feed only on the weed or pest species itself, and not on crop plants.
- The control agents must not be native to the area.

6.2.4 Cultural Practices

Cultural control methods include:

- Crop rotation - Crop rotation helps to prevent pest populations building over a number of years.
- Intercropping,
- Field sanitation,
- Seed bed sanitation,
- Manipulation of spacing,
- Mulching,
- Use of pest-resistant crop varieties,
- Managing sowing, planting, or harvesting dates,
- Water/irrigation management,
- Practices to enhance the buildup of naturally existing predator populations,
- Hand-picking of pests or hand-weeding,
- Use of traps or trap crops.

6.2.5 Chemical Control

Chemical control is an additional measure, and its application should be undertaken with utmost care as per applicable standards governing safe applications of agrochemicals (e.g. FAO Guidelines) to ensure safety of the environment and the farmers. Agro-chemicals to be used should be registered for use in Uganda as well as acceptable for procurement under World Bank Safeguard Policies. Chemical control needs to take into consideration the Register of Agricultural Chemical Registered under Section 4 of the Agricultural Chemicals (Control) Act, 2006 as of 4th March 2016 and the WHO classification of chemicals[7]. Under the World Bank OP 4.09 on Pesticide Management, specific requirements that govern the use of pesticides on projects include (i) a pest management plan must be developed and integrated into the ESMF and ESMP, (ii) promoting Integrated Pest Management that reduce resilience on chemical pesticides (iii) developing a criteria for selecting pesticides (iv) and capacity building and training and (v) continuous stakeholder engagement on pesticide use (vi) the

[7]The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009

pesticide management plan should be disclosed in line with World Bank Environmental and Social safeguards policies.

In Uganda, chemicals are registered with specifics of the registered supplier, commercial name of the chemical, active ingredients, hazard status (irritant, harmful, corrosive, poisonous, etc), and handling instructions. Aside from these the chemicals should have expiry dates and pre-harvest intervals (PHI) indicated. The extension workers and researchers need to take note that pests and disease-causing agents are in constant evolution and thus the chemical control methods should be dynamic and in either combinations or alternations to avoid pesticide resistance. Other criteria for choice of pesticides should include the pre-harvest interval, residual effect and mode of action.

Table 6.1:Criteria for chemical pestcides selection

Criteria for chemical pesticides selection	
Safety	Questions to ask include; i. What is the toxicity level of the pesticide, ii. How mobile is the pesticide, iii. What fashion can the pesticide be distributed (through air, soil, water, etc.), iv. What is the residual life of the pesticide, v. What are the environmental hazards listed on the label?
Species specificity	Not all pesticides are the same and will exhibit one or more of the following qualities: They may work on contact, or can be locally systemic or completely systemic. They may have curative properties, or only work as protectants. They could be organic, synthetic, mineral, biological, synthetic/organic or combinations of the above. Preference for one or more of these qualities will help select one product over another. This is especially important to look for before using the chemicals since certain pesticides only affect the target pest or disease. Try to avoid getting broad spectrum pesticides that have potential to kill or harm many beneficial species along with the pest. If such a pesticide is the only option, try doing spot treatments to reduce the likelihood of affecting non-target organisms.
Effectiveness	For pesticides, it is a bit difficult to measure effectiveness because it can vary depending on where the chemicals are being applied. But famers in the command area may use interpretivism judgment (by experience or previous education).
Endurance	Plant's endurance to the effects of a pesticide may vary. Watch for success in pest control: if it at first seems to work well but then later populations grow despite continued use, there may be some built up resistance.
Circumstances of pesticide need	Choosing a pesticide should be determined based on circumstances. Pesticides vary in their speeds of interaction. If it is an emergency, a shorter lived, fast acting and more acutely toxic material may be necessary. But a longer lasting, slow acting and less toxic material (such as boric acid) may be better for chronic pest problems.
Cost	Determination of cost often is done by measuring money (dollars, Ugandan shillings) per volume-some new materials that are effective in lower doses may be more expensive than older pesticides that need larger amounts to do the job. A small container of more concentrated material may seem more expensive, but may be as effective as three times that much in another kind of pesticide. Most cost-effective in the short and long term should be selected.
Considering the environmental, safety, efficacy and financial concerns of purchasing and applying pesticides (as provided above), the following steps will be helpful for selecting the appropriate pesticide.	
a) *Correctly identify the pest.* Without correct identification, control measures are at best a gamble. b) *Decide how much pest activity can be tolerated. It may not be possible to completely eliminate the pest, but one may be able to keep the population down to a comfortable level.* c) *Read the product label*. Verify if the particular identified pest is listed.	

d) *Read the "Precautionary Statements*". Be aware of the potential health and environmental risks.
e) *Have appropriate application equipment*? Most pesticides require specific application devices to be applied safely, evenly and at the proper rate.
f) *Review the rates*. Calculate how many gallons of spray mixture the product will make. If it's packaged in a quantity greater than the farmer can use within a two-year period, choose another product or a smaller package.
g) *Look for alternative uses on other turf and ornamental pests'* common in the command area landscape. Multiple landscape uses may provide advantages for one product over another.
h) *Check the chemical group or class*. Rotating two or three materials from different chemical classes will reduce the chances of building resistance.
i) *Check for ease of use*. Some products are very concentrated and may require difficult-to-use measuring, handling or safety equipment.
j) *Calculate the cost per gallon of mixed spray*. If more than one product meets the criteria, select the material with the lowest cost per gallon of mixed spray.

Cautions for chemical pesticides use

- **Read the Pesticide Label;** Follow its directions for use, registrations, storage, and disposal to the letter. Signal words on labels indicate the toxicity levels.
- **Secure (if required) written recommendations**; Obtain these from a licensed pest control advisor for use of the pesticide.
- **Personal Protective Equipment (PPE);** Make sure that all safety equipment, such as gloves, goggles, respirator, hat, etc. are available and worn when the pesticide is used.
- **Equipment;** Make sure the equipment to be used for application of pesticide is correctly calibrated and appropriate for the job at hand.
- **Quantity of application;** Buy only what you need in a season; mix only what you need today. Pesticides may have a limited shelf life, and stored pesticides can be a hazard.
- **Spot treat**; This will keep material confined to the area requiring treatment. Consider the treatment area. Are there sensitive areas near the treatment area? Does the area slope towards a vulnerable area like a stream, garden, well, or playground? Are valuable plants nearby that could be affected by drift?
- **Keep records;** What pesticide was used and for what? How much was used? Be sure to list all pertinent information about the treatment for future reference about what was done. Material safety data sheets should also be filed.
- **Monitor for pests after the application**; Post-treatment monitoring can help determine the method's success.
- **Disposal;** Do not put pesticides down toilets, sinks, or other drains or gutters. Follow the manufacturer's directions for proper disposal.

6.3 Factors affecting the economic feasibility of pest control measures

When choosing a pest management method, a number of factors have to be considered as laid down below.

6.3.1 Nature of the site or region

- The feasibility of the method given the area and scope of the problem.

6.3.2 Possible health and safety effects

- Consider potential health effects of the materials or methods, both to the applicator and the public especially in line with the WHO classification of chemicals[8],
- Equipment operation safety issues for both the operator and the public,
- Farmer safety and injury issues involved with carrying out the method.

6.3.3 Possible environmental effects

- Consider the potential negative effects of the material or method to non-target organisms,
- Environmental effects from potential bioaccumulation,
- Potential impacts to non-target plants and other organisms from materials or methods,
- Potential impacts to threatened or endangered species,
- Possible introduction or establishment of invasive plants,
- Water pollution.

6.3.4 Costs

- Costs of the material or method,
- Application and labor costs,
- Length and quality of pest control,
- Feasibility of using a particular method or product,
- Costs associated with not treating, or delaying treatment.

6.3.5 Characteristics of the product

- Target pests and target sites of the product being used,
- Possible residual effect, decomposition pathways, rates, and breakdown products,
- Product formulation and package size,
- Leachability, solubility, and surface and soil bonding characteristics of the product,
- Ease of cleaning equipment after use,
- Positive and negative synergistic effects of pesticide combinations,
- Post-harvest interval.

6.3.6 Other special considerations

- Application equipment availability,
- Method of delivery,
- Current and anticipated weather conditions,
- Previous pesticide applications to the site and the interval between treatments,
- Possible development of pest resistance to a particular management method or material,
- Yield and quality effects,
- Severity of damage,
- Pest spectrum,
- Frequency of pest problem,
- Technical effectiveness of the (bio-) control agent,
- Output price,
- Risk,
- Timely availability,

[8] The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009

- Benefits and cost of alternative programs,
- Community and regional organization.

6.4 Some available Pest and Disease Management Options proposed for Matanda

Below are some of the options recommended for use by the farmers in Matanda command area for managing the prevailing pests and diseases.

Table: 6.2 Major crop pests and diseases in Uganda and available management options

Crop	Major Pest/Disease	Available management options
Coffee	Coffee wilt disease [CWD]	• Uproot and burn infected trees. • Restrict movement of infected planting materials, coffee husks and soil. • Disinfect farm tools that have been used in an infected garden using flames or hypochlorite/Jik solution (5%). • Start pruning or handling plants with the healthy-looking plants. • Avoid wounding of plants e.g., during weeding. • Plant disease resistant varieties. • Use fallowing for a period of 6 months to 2 years before replanting with susceptible coffee seedlings. • Paint cut stem and branches with copper-based fungicides to reduce infection.
	Black Coffee twig borer [BCTB] (*Xylosandrus compactus* (Eichhoff))	• Regularly monitor fields for infestation. • Field and plant sanitation (pruning and weeding). • Advise your neighbors to also control BCTB to prevent re-infestation of your field. • Promote vigorous growth using fertilizer and irrigation. • Spray field with Imidacroprid pesticide.
Banana (*Musa* spp.)	Bacterial Xanthomonas wilt [BXW] (*Xanthomonas campestris* pv. *musearum*)	• Early removal of male buds • Use clean planting material • Use a combination of cultural practices (desuckering, monocropping, weeding, de-trashing, manure application, mulching & soil/water conservation)
	Black sigatoka or black leaf streak *(Mycosphaerella fijiensis)*	• Use of resistant cultivars • Cultural practices (correct spacing or plant density; good field sanitation; absence of weeds; and good drainage) • Fertilizer application
	Banana weevil *(Cosmopolites sordidus)*	• Field sanitation (destruction of crop residues) • Planting clean planting materials without any visible tunnels • Hot water treatment of trimmed suckers • Applications of neem powder to reduce weevil numbers • Use appropriate insecticides
Cassava *(Manihot esculenta)*	Cassava mosaic disease [CMD]	• Inspect plants regularly for disease symptoms • Remove (rogue) and destroy diseased plants • Planting of resistant varieties • Use clean planting materials

Maize	Maize Lethal Necrosis (MLND)	• Use resistant maize varieties • Avoiding use of home saved seed from previously infested MLN fields and seed from unknown sources • Improvement of soil fertility using manure and inorganic fertilizers • Avoiding planting of maize near grasses e.g. sorghum, millet, nappier. These are alternative hosts to MLN transmitting insects • Crop rotation with non-host crops like potato or legumes • Field sanitation (removal and destruction of weeds, volunteer maize crops and MLN infected maize crops)

Crop	Major Pest/Disease	Available management options
	Striga	• Seed treatment with herbicide • Improvement of soil fertility using practices such as legume rotation and intercropping and fertilizer use
	Aflatoxins	• Use healthy improved and early maturing seed varieties • Dress seeds with appropriate agro-chemicals before planting • Carry out crop rotation with non-host plants • Harvest the crop at maturity and maintain the right moisture content
	Fall armyworm	• Use of pheromone traps • Use of pesticides including Permethrin and Lambda-Cyhalothrin These should be sprayed early in the morning or late evening when caterpillars are feeding actively. • Use of biopesticides including *Metarhizium anisopliae*, Metarhizium *rileyi (Nomuraea rileyi)*, *Beauveria bassiana* or *Verticilium lecani* • Deployment of biocontrol agents
	Stem borers	• Intercropping with pulses • Early planting and planting early maturing varieties • Destroy crop residues • Use of neem pesticide
Rice	Bacterial blight	• Use of resistant varieties • Cultural practices
Beans	Angular leaf spot	• Use fungicides • Use of resistant varieties • Biological control • Cultural practices (intercropping, crop rotation, optimum plant spacing and use of soil amendments)
	Aphids (*Aphis fabae, A. craccivora*)	• Regular field monitoring to detect early attacks • Biocontrol using agents such as green lacewings (Chrysopidae), various lady beetles, the minute pirate bug, syrphid flies and parasitic wasps • Observe recommended time of planting • Application of wood ash in case of a heavy attack • Application of recommended insecticide when necessary
Tomato	Bacterial wilt	• Use of clean planting material • Soil amendment using organic matter such as plant residue, animal waste, and simple organic compounds • Use of biological control agents
	Tuta Absoluta	• Use pheromone traps • Chemical management • Crop rotation with non-solanaceous crops • Field sanitation • Crop rotation • Planting pest free seedlings
	Blights	• Remove and burn affected leaves • Crop rotation • Field sanitation • Use of clean disinfected seeds • Mulching • Spraying with fungicides • Grow resistant cultivars where available

Crop	Major Pest/Disease	Available management options
General	Rodents	• Weeding for fields • Regular surveillance • Trapping • Use of recommended rodenticide.
	Birds	• Monitoring of birds • Scaring

Chemical control may under some circumstances be unavoidable in pest management. However, this needs to take into consideration the chemicals approved and registered in the Register of Agricultural Chemical Registered under Section 4 of the Agricultural Chemicals (Control) Act, 2006 as of 4th March 2016 and labelled as green or blue under the the WHO classification of chemicals[9]. Only the chemicals labelled as green or blue by the WHO classification of chemicals shall be permitted under the ICRP.. The extension workers and researchers need to take note that pests and disease-causing agents are in constant evolution and thus the chemical control methods should be dynamic and in either combinations or alternations to avoid pesticide resistance. Other criteria for choice of pesticides should include the pre-harvest interval, residual effect, and mode of action.

6.5 Indigenous Technical Knowledge (ITK) for Pest Management

Indigenous technical knowledge has been shown to be a rich source of innovation in pest management, but it tends to break down in the face of rapidly changing farming systems. In general, farmers' knowledge about specific pests tends to be influenced by the visibility of the causal relationship between pest and losses[10].This knowledge is not always complete or accurate-forexample, farmers may not be aware of the yield losses caused by viruses or of details of a pest's life cycle that indicate key points for intervention. A partnership between farmers and scientists will often yield practical information based on a mutual exchange of information.

6.6 Kanungu District Local Government Pest Management Plan

The Kanungu District Local Government in its Development Plan for 2015/2016 - 2019/2020 focuses on pest and disease management through conducting surveillance, promotion of disease tolerant varieties and operation of plant clinics, and ensuring access of farmers to quality agro-inputs by enlisting quality input dealers and linking farmers to these certified and quality assured agro-input dealers and seed stockists. The development plan focuses on management of epidemic diseases in livestock through vaccination. There are also extension services in crop, livestock, fisheries and entomology and creation of a multi stakeholder innovation platform for promotion of appropriate technologies including pest management technologies.

Table : 6.3 The Kanungu District Development Plan for Pest Management

Development Objectives	Development Outputs	Development Strategies	Interventions
1) Increase incomes of farming households and ensure food and nutrition security	2) Crop and livestock pests and diseases contained	3) Pest and disease management	1) Pest and disease surveillance and management
	4) Database for quality input dealers and stockists developed and maintained	5) Access to high quality inputs agro-input dealers and seed stockists	2) Database for quality input dealers and stockists

[9] The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009
[10] Bentley1989

Development Objectives	Development Outputs	Development Strategies	Interventions
	6) Quality agro-inputs and planting materials accessed by farmers	7) Promote technology development to address farmer needs	3) Linking farmers to certified agro-input dealers and seed stockists 4) Quality assurance monitoring visits
	8) Improved adoption rates appropriate technologies	9) Promote multi-stakeholder innovation platforms (MSIP)	5) Demonstration of appropriate technologies using quality inputs 6) Promote establishment of Farmer Field Schools

However, although the district had good pest management plans, the budget allocated for pest management related activities was too negligible in the 5-year plan as shown in Table 20. The key areas of implementation include provision of advisory services and conducting of plant clinics and disease surveillance.

Table: 6.4 The Kanungu District Development Plan for Pest Management

Activity	Budget
Provision of advisory services (crop, vet, fisheries, entomology, commercial services)	39,170,000
Conduct 4 plant clinics / one per quarter in Kanungu TC, Kihihi and Kambuga TC. Establish 17 cassava multiplication sites / one per Sub-county. Establish 8 banana mother gardens in 8 banana growing sub counties. Collection of agricultural data on quarterly basis. Registration and inspection of agro input shops.	5,672,000
Disease surveillance. Awareness raising radio programmes on need to vaccinate. Procurement of vaccines. Vaccination.	4,558,000

6.6 Integrated Pest Management Plan

6.6.1 Integrated Pest Management Plan Implementation Plan

The Pest Management Plan must prioritize Integrated Pest Management (IPM) which is an environmentally sustainable and farmer-based management approach involving the deployment of cultural and natural pest control methods including but not limited to sanitation, natural pest control using biopesticides (natural enemies), pest-resistant crops, deployment of cultural management, and, as a last resort, using pesticides judiciously[11]. These strategies can be deployed based on the local circumstances with the farmers having flexibity of deploying a mix of interventions. The principle of IPM is based on understanding of agro-ecological principles, monitoring interactions among crops, pests, and natural enemies of pests, and selecting and implementation of adequate control measures.

The areas of Integrated Pest Management Plan to be handled include capacity building of input suppliers, farmers, extension workers and IPM committees; Pest and disease surveillance; Advisory support; Livestock pest and disease management; Pesticide waste management; and IPMP project management, coordination, monitoring and evaluation as elaborated in Table 21.

[11] Adapted from USDA/ARS1993

Table: 6.5 IPMP Implementation Plan

Activity	Recommended practice	Action required	Monitoring indicators	Responsible agencies
Capacity Building / Training				
Capacity building of input suppliers	MAAIF and extension workers should provide training for input suppliers on safe production, marketing, and distribution of agro-chemicals	• Training of input suppliers • Inspection of the inputs for compliance • Inspection of the input supply facilities • The input dealers must be in possession of the approved and updated chemical list to avoid supply of deregistered chemicals	• Agro-input dealers trained • Certification of facilities • Certification of good practice • Possession of approved chemical list	MAAIF, UNADA, DLG, Sub county extension staff
Training of farmers on integrated pest and disease control	Farmers are trained on identification of pests and diseases and their integrated management	• Pest and disease identification and integrated management guides • List of pests and diseases • Appropriate and effective integrated management options for specific pests provided	• Farmers trained • Pest and disease lists produced • Integrated pest and disease management information materials available • Training guides	MAAIF, DLG, Extension workers
Training of extension workers	Extension workers updated on pest and disease identification and integrated management practices	• Pest and disease identification and integrated management guides • List of pests and diseases • Appropriate and effective integrated management options for specific pests provided	• Farmers trained • Pest and disease lists produced • Integrated pest and disease management information materials available • Training guides	MAAIF and NARO
Training of IPM committees	IPM Committees trained on pest identification and integrated management options	• Pest and disease identification and integrated management guides • List of pests and diseases • List of approved IPM practices	• Farmers trained • Pest and disease lists produced • IPM training guides	MAAIF, NARO, DLG
Pest and Disease Surveillance				
Plant pest and disease inspection and surveillance	Inspection of areas and plant material under cultivation, in storage or transit for purposes of detecting and reporting the existence, outbreak or spread of pests	• Need for capacity to readily carry out surveillance of pests and diseases and give alerts on outbreaks • Facilities and logistics to support inspection services	• Technical capacity reports • Surveillance reports • Pest and disease status reports	MAAIF, DLG, Sub counties, extension workers, farmers
Plant pest and disease diagnostics	Laboratory detection of pests and diseases	• Lab analytical capacity support • Generation of modern rapid diagnostics by research systems	• Lab analysis results • Pest and disease reports	NARO and MAAIF

Activity	Recommended practice	Action required	Monitoring indicators	Responsible agencies
		• Diagnostic kits available at the grass roots		
Support operations of the plant clinics	Build the capacity of extension workers to accurately detect pests and diseases and provide advisory services on their integrated management	• Training in pest and disease identification • Infrastructural and information support and updates	• IPM training manuals • Pest and disease identification guides	MAAIF, DLG and extension workers
Livestock pest and disease surveillance	Periodic surveys and record of all pest cases, including pest type, incidence, severity, host plants, location of infested gardens, period of infestation, etc.	• A rapid response mechanism for managing new pest infestations will be established.	• Technical capacity reports • Surveillance reports • Pest and disease status reports	Farmers, extension workers, project coordinator, DLG and MAAIF
Livestock pest and disease diagnostics	Laboratory detection of pests and diseases	• Lab analytical capacity support • Generation of modern rapid diagnostics by research systems • Diagnostic kits available at the grass roots	• Lab analysis results • Pest and disease reports	NARO and MAAIF
Advisory support				
Registration of pesticide / input suppliers	Identify and certify input suppliers carrying out good practice and dealing in genuine agrochemicals	• Register • Certification • Specifications and TORs	• Register • Certificates of registration • Input dealer list	MAAIF, UNADA, DLG
Farmer linkage to input suppliers	Provide guidance to farmers on genuine input/ agrochemical suppliers	• Guidance on quality agrochemicals • Registration of legitimate agro-input suppliers	• Agro-input supplier register • TORs for good practice • Certificate of registration and compliance	MAAIF, UNADA, DLG
Production and distribution of IPM information material	Development and distribution of user-friendly integrated pest management information materials	• Information generation and compilation • Publication of information compiled	• IPM materials produced • Number of materials shared	MAAIF, NARO, DLG
Sensitization campaigns	Sensitization of farmers and extension workers on prevailing pests and diseases, identification, and integrated management options	• Mobilization • Provision of advisory services • Pest and disease list	• Number of farmers reached and sensitized • Sensitization plan and program • Reports	MAAIF, NARO, DLG
Emergency response support	Sensitization of farmers and extension workers on emerging pests and diseases, identification, and management options	• Emergency reports • Farmer and extension mobilization • Emergency integrated pest management guide	• Emergency pest management reports • Farmer and extension mobilization for emergency response rediness	MAAIF, NARO, DLG

Activity	Recommended practice	Action required	Monitoring indicators	Responsible agencies
			• Emerging integrated pest management guide	
Extension service support	Extension workers updated on pest and disease identification and integrated management practices	• Retooling of extension workers in integrated pest management tools • List of pests and diseases • Appropriate and effective management options for specific pests provided	• Disease identification and integrated management protocols • Inventory of modern disease detection techniques • Integrated pest and disease management information materials available • IPM training guides	MAAIF, NARO, NGOs, and Sub counties
Livestock pest and disease management				
Vaccination campaigns	Design a vaccination pgoram with schedules for animals against the routine pests and diseases	• Design a vaccination program • Draw schedules for different areas • Awareness creation • Procurement of vaccines	• Number of animals vaccinated • Coverage of vaccination campaign • Vaccination certificates	MAAIF, DVO, DLG, Extension workers
Construction and equipping of dipping crushes	Construction of dipping facilities across the Sub counties in the Matanda command area	• Procurement of services to construct a crush • Dip animals • Ensure proper maintenance of the dipping facilities	• Cattle crushes constructed and maintained • Animals sprayed and dipped	MAAIF, DVO, DLG, Extension workers
Pesticide waste management				
Pesticide/ Chemical disposal support	• Proper disposal of pesticide containers by farmers and resellers • Follow disposal guideline • Where necessary incinerate • Qualified waste collection companies should support the collection and management of hazardous waste	• Design of pesticide disposal plan • Capacity building in safe chemical handling and disposal • Use guidance provided by input dealers • Qualified waste management companies need to offer advisory and collection services to farmers	• Pesticide waste disposal plan • Number of farmers and resellers aware of pesticide container disposal plan • Number of pesticide containers collected and disposed	MAAIF, NEMA, DLG, and private companies
Pesticide waste monitoring	Monitor pesticide residues in water, soils, and crop harvests and residues	• Design and implementation of a pesticide monitoring plan	• Pesticide monitoring plan • Pesticide residues measured in water, soils, and crop harvest	MAAIF, NEMA and DLG

Activity	Recommended practice	Action required	Monitoring indicators	Responsible agencies
PMP Project Management, Coordination and Monitoring				
Project coordination	Coordination of an integrated pest management plan project	• Coordination meeting • Constitution of pest management committee	• Number of coordination committee meetings • IPMP coordination committee in place	MAAIF and DLG
Monitoring and evaluation	Requirement for routine monitoring and evaluation of the implementation of the Integrated Pest Management Plan (IPMP)	• Monitoring of compliance to guidelines for input dealers, safe chemical use and disposal. This should be undertaken by extension workers and chemical and crop protection inspectors • Evaluation of the outcomes of capacity building activities	• Evaluation reports • Compliance and non-compliance records	MAAIF, DLG

6.9.2: Integrated Pest Management Plan Implementation Budget

This is the proposed budget for the implementation of a 3-year Integrated Pest Management Plan in the Matanda command area in line with the prevailing situation and the District Development Plan.

Table: 6.6 Integrated Pest Management Plan Implementation Budget

Activity	Budget (UgX)			
	Year 1	Year 2	Year 3	Total
Capacity Building/ Training				
Capacity building of input suppliers	10,330,000	12,396,000	12,396,000	35,122,000
Training of farmers on integrated pest and disease control	20,660,000	20,660,000	20,660,000	61,980,000
Training of extension workers	20,660,000	18,594,000	15,495,000	54,749,000
Training of IPM committees	10,330,000	10,330,000	10,330,000	30,990,000
Subtotal capacity building	**61,980,000**	**61,980,000**	**58,881,000**	**182,841,000**
Pest and Disease Surveillance				
Plant pest and disease inspection and surveillance	30,990,000	36,155,000	36,155,000	103,300,000
Plant pest and disease diagnostics	41,320,000	30,990,000	30,990,000	103,300,000
Support operations of the plant clinics	25,825,000	25,825,000	25,825,000	77,475,000
Livestock pest and disease surveillance	36,155,000	36,155,000	25,825,000	98,135,000

Activity	Budget (UgX)			
	Year 1	Year 2	Year 3	Total
Livestock pest and disease diagnostics	17,561,000	15,495,000	15,495,000	48,551,000
Subtotal Pest and Disease Surveillance	**151,851,000**	**144,620,000**	**134,290,000**	**430,761,000**
Advisory support				
Registration of pesticide/ input suppliers	7,231,000	5,165,000	5,165,000	17,561,000
Farmer linkage to input suppliers	10,330,000	8,264,000	5,165,000	23,759,000
Production and distribution of IPM information material	20,660,000	15,495,000	15,495,000	51,650,000
Sensitization campaigns	15,495,000	12,396,000	10,330,000	38,221,000
Emergency response support	5,165,000	5,165,000	5,165,000	15,495,000
Extension service support	20,660,000	20,660,000	20,660,000	61,980,000
Subtotal Advisory Support	**79,541,000**	**67,145,000**	**61,980,000**	**208,666,000**
Livestock pest and disease management				
Vaccination campaigns	51,650,000	51,650,000	51,650,000	154,950,000
Construction and equipping of dipping crushes	87,805,000	87,805,000	87,805,000	263,415,000
Subtotal livestock pest and disease management	**87,805,000**	**87,805,000**	**87,805,000**	**263,415,000**
Pesticide waste management				
Pesticide/ Chemical disposal support	36,155,000	25,825,000	25,825,000	87,805,000
Pesticide waste monitoring	51,650,000	46,485,000	46,485,000	144,620,000
Subtotal pesticide waste management	**51,650,000**	**46,485,000**	**46,485,000**	**144,620,000**
IPMP Project Management, Coordination and Monitoring				
Project coordination	25,825,000	25,825,000	20,660,000	72,310,000
Monitoring, evaluation, and learning	41,320,000	44,419,000	39,254,000	124,993,000
Subtotal IPMP Management, Coordination and Monitoring	**41,320,000**	**44,419,000**	**39,254,000**	**124,993,000**

Activity	Budget (UgX)			
	Year 1	Year 2	Year 3	Total
GRAND TOTAL	386,342,000	364,649,000	340,890,000	1,091,881,000

7. Recommendations

The ICRP Implementation Team shall undertake registration of the input suppliers is undertaken and ensure there is routine monitoring of these suppliers to ensure they comply with the quality requirements to avoid their unregulated use and adverse effects on health and the environment.

Kanungu District Production Department shall deploy Extension workers to undertake advisory services to farmers on pest management in an integrated fashion, with other practices preceding chemical control. Pesticide use shall be minimized and restricted to the blue and green-label chemicals based on the WHO classification of chemicals[12].

MAAIF and the Kanungu DLG shall guide farmers on safe chemical use including disposal of chemical waste in a manner that won't be harmful to the environment. Pesticide waste management is a major challenge with farmers dumping pesticide containers in their fields. There is a need to put in place a pesticide waste management and disposal plan at the District or Sub-county levels and facilitate the realization of these plans through sensitization, training, monitoring, and policy enforcement.

To ensure health and safety compliance and protection of farmers and thier environment, the following are the necessary cautions to be undertaken by the farmers; (i) use of protective gear including masks, gloves, googles and protective clothing to prevent exposure to harmful chemicals (ii) train users on proper handling, storage and disposal to minimize risk of accidental ingestion, inhalation and dermal contact (iii), schedule spraying to non-windy days and avoid spraying during peak human activities (iv) practice precise dosing to avoid over application which leads to pesticide resistance and environmental contamination and (v) maintain buffer zones around water bodies and sensitive ecosystems and residential areas to prevent contamination. As part of the IPMP strategies, farmers are encouraged to use non-chemical methods such as biological controls, crop rotation and resistant crop variaties, use pest monitoring techniques to apply pestcides only when thresholds are met to reduce unnecessary usage. Apply the pesticides that are approved by the regulatory authorities. The farmers should adhere to the instructions in the Materials Safety Data Sheets and label instructions regarding dosage, application and waiting time before harvesting.

As part of the IPMP implementation, the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), the National Agricultural Resaerch Organisation (NARO), and the National Agricultural Advisory Service (NAADS) shall build the capacity of farmers in various areas of production, post-harvest handling, organic farming, and ecological pest management. This is the only way to increase the utilization of effective integrated pest management.

MAAIF, District and Sub-county Local Governments shall enforce the existing policy, legal and regulatory framework on support integrated pest management and associated waste management. Emphasis shall be on the IPM principles especially application of few and harmless agrochemicals.

MAAIF and Kanungu DLG shall ensure that the Integrated Pest Management Plan is deployed systematically, starting with capacity building, then surveillance, advisory services and effective waste management in the project area.

[12] The WHO recommended classification of pesticides by hazard and guidelines to classification: 2009

APPENDIX R DESIGN ENVIRONMENTAL FLOW

1.1 Scheme hydrology

In-depth analysis based on catchment and river level behavior during environmental flow assessment was limited to section of river upper, middle and downstream of proposed Matanda take off point before the command area. These objectives include, but were not limited to, the following key thematic areas:

i. Identification of best suited, standard and internationally accepted methodology for assessment of environmental flow with respect to the proposed project and the river;
ii. Identification of current environmental flow scenarios of the river;
iii. On-site investigation to identify current water uses and future projection for fresh water demand;
iv. Hydraulic rating of the river stretch downstream of proposed intake to characterize the river habitat type;
v. Recommend a practical and reliable figure for environmental flow.

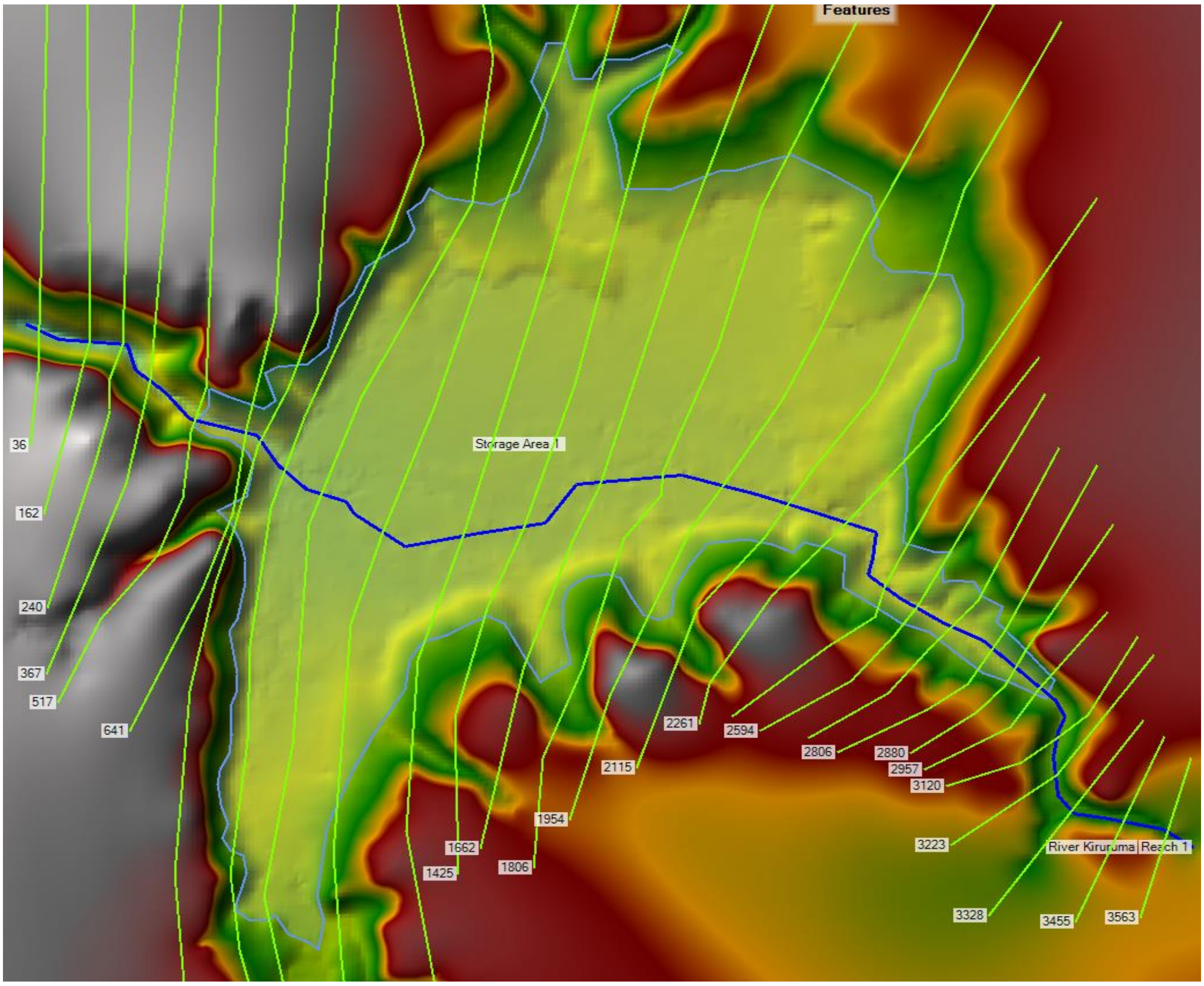
The downstream channel is mainly located in a narrow gorge on a rocky foundation and scour effects due to spillway operation are expected to be minimal. Nonetheless, a hydraulic model of the river and dam was developed, and model runs were carried out to simulate the flows. A hydraulic model has been generated for River Kiruruma to model water levels at key points, given below.

Software

HEC-RAS can be used to estimate the hydraulic conditions at critical locations downstream. Hydraulic computations have been performed with HEC-RAS 6.1 developed by the US Army Corps Hydrologic Engineering Center. This software is a 1D program that can be used to model subcritical, supercritical or transcritical flows in either steady or unsteady conditions by solving Saint-Venant's equations. The basic data requirements for hydraulic routing techniques include: flow data, channel geometry, roughness coefficients, and internal boundary conditions.

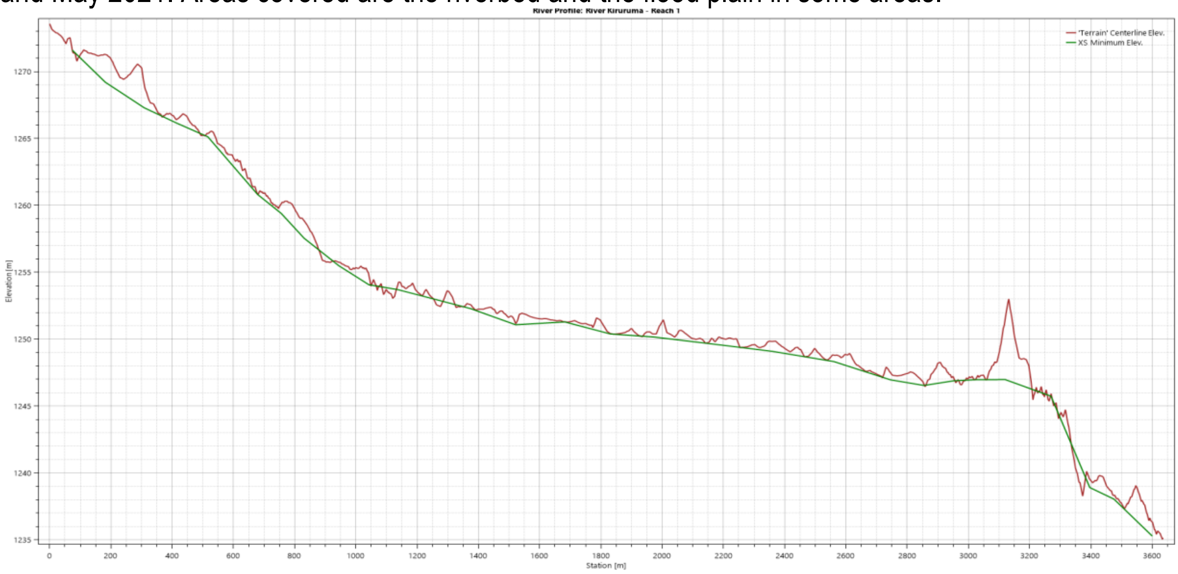
Model extents

An existing model covering the lower part and upper parts of proposed Reservoir site on river Kiruruma as captured during the topographic survey. This model has been completed towards the upstream (reservoir site). The hydraulic model covers ca 3.5 km of River Kiruruma. upstream boundaries are located respectively 1.5Km downstream of reservoir and approximately 500m below dam site and 2.1km upstream of the reservoir location. The hydraulic model is composed of 30 cross sections.



Topographical data

Topographical data used to draw the river's cross section is composed of a topographic survey completed in April and May 2021. Areas covered are the riverbed and the flood plain in some areas.



Boundary conditions

Relation between discharges and water elevation at downstream and upstream boundaries has been defined using the local friction slopes computed from the topographical data: Discharges entering the model have been applied at the upstream boundary.

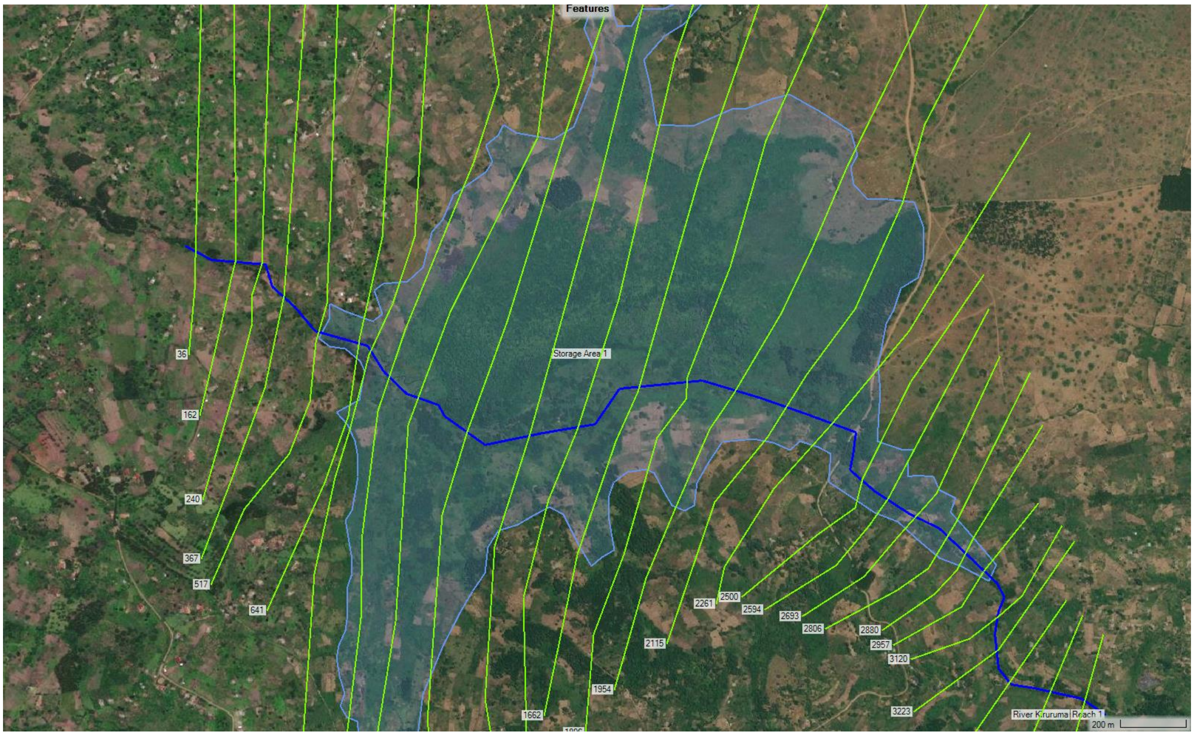
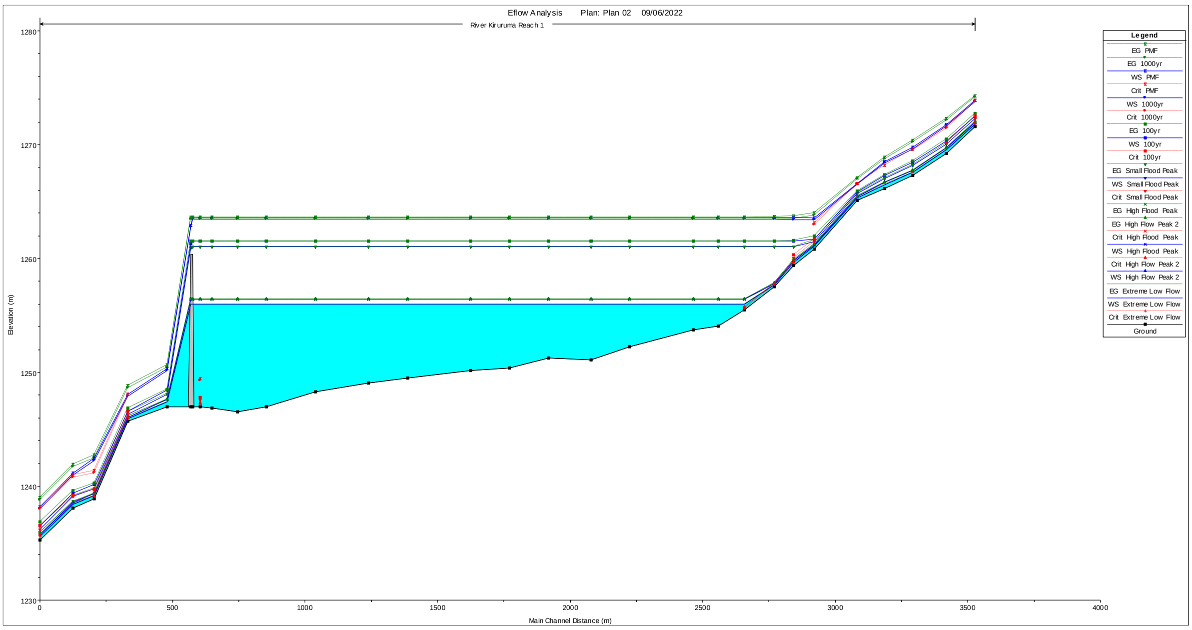


Figure 0-1: *Project area, flood inundation with reservoir*

Limitations

Topographical measurements made in the riverbed are rather simple, only allowing a rough characterization of the bed's geometry. The presence of huge vegetations in the riverbed is not taken into account in the topographical survey. The effect of such bed characteristics on hydraulics is commonly taken into account through riverbed's roughness in 1D modelling. This can be suitable especially when irregularities are small compared with the water depth for the whole flow range considered. In low flow conditions, such as those illustrated in the above picture, water depth is in the same magnitude as bed's irregularities. In such configuration, the assumption of constant roughness is not fulfilled and the flow cannot be considered as purely one dimensional. The hydraulic model can therefore hardly simulate natural flow conditions for low discharges, such as those measured during the field investigations.



Hydraulic Rating Approach (Habitat Characterisation)

The hydraulic rating approach conducted in this assessment is complimentary to the habitat characterization done through the comprehensive biodiversity assessment that covered from upstream of the proposed intake point to the confluence of R. Kiruruma with R. Mitano. This was determined to be the ZoI of the proposed abstraction. The changes in various cross-sectional hydraulic variables such as wetted perimeter or maximum depth, at cross-sections downstream the proposed intake point was assessed. Detailed hydraulic river system simulation was accomplished with HEC-RAS 6.2 software (River Analysis System, US Army Corps of Engineers - Hydrologic Engineering Center). The cross-sections were taken at points which could be accessed along the river. Hydrodynamic modelling with HEC-RAS model converted the EFC to water levels, flow velocity, water depth, and duration of submersion, which reflects on the time period over which the considered river wetted perimeter would remain inundated. Full model validation would not be accomplished largely due to inadequate data availability.

The assessment provided simple indices of available habitat in a river at a given discharge. The hydraulic rating method uses basic hydrologic, hydraulic and ecological data and expert opinion. The easily measurable hydraulic characteristics of the river are water depth, velocity and wetted perimeter. Hydraulic methods use the relationship between the flow, cross- section properties, ecological variables, and wetted perimeter to calculate EF. Breakpoints where habitat quality significantly degrades with reduction in discharge are identified in the habitat–discharge response curve.

The hydraulic analysis was limited to river profile of only 3423.87 m was drawn in HECRAS from upstream of reservoir area, through proposed dam site to a point 521.5m downstream of the dam to ascertain the flows variations. The hydraulic model considered the geometry of the river profile, the river roughness (manning values), EFC flow thresholds extracted from IHA model (indicating the extreme river discharges), longitudinal slope and river geomorphology. The manning values were based on the land cover within the flood plains and general geological set up of the area. Validation was only limited to observations during field visits.

1.2 Water Resources

A. Catchment hydrology

The district has many small rivers and streams like Ishasha, Nchwera, Kiruruma, Birara, Mitano and Lake Edward, which is the main source of fish besides fishponds. The district is also endowed with a number of wetlands, both seasonal and permanent, which serve as water reservoirs and other ecological functions. All wetlands in the project area are non-gazetted, invaded by the locals for crop growing such as rice, eucalyptus trees, among others. The proposed intake point for Matanda irrigation scheme drains an area of approximately 137.9 km^2. (Figure 0-2). The area stretches through the sub-counties of Kanungu TC, Rutenga, Rugyeyo, Kirima, Kanyantorogo, Kambuga and Katete. It is comprised of a number of small tributaries that join to form River Kiruruma. Appendix M and E presents the detailed baseline, ecological status and use of Kiruruma River.

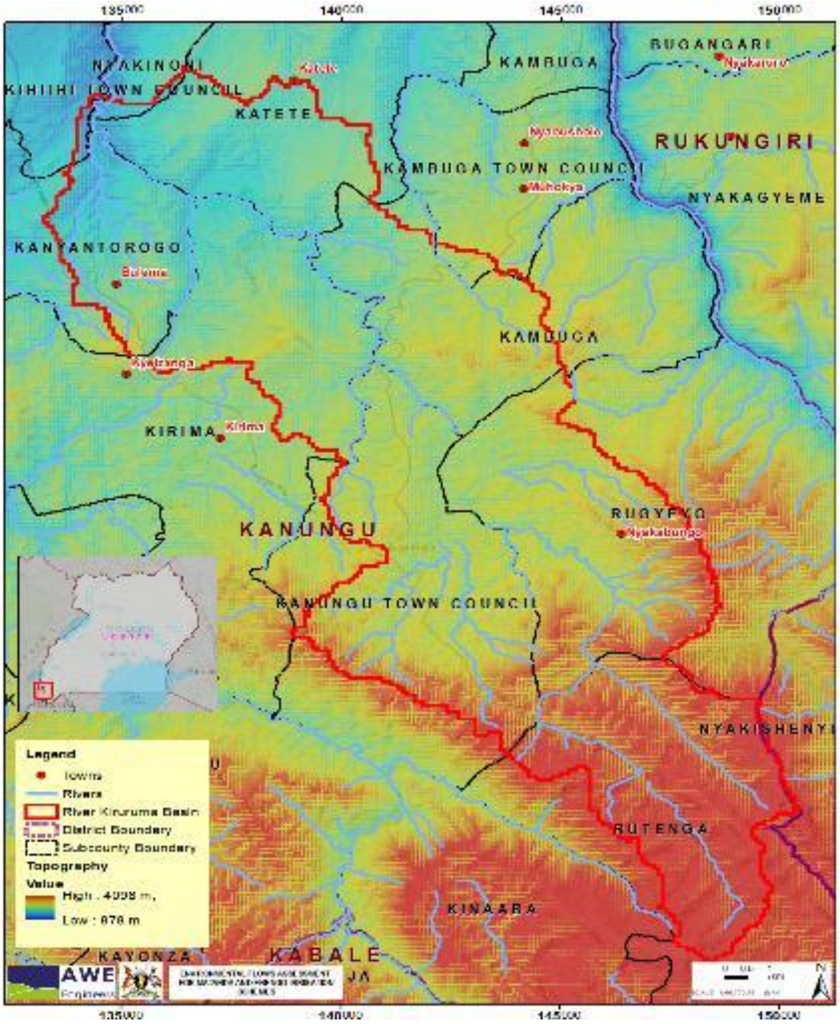


Figure 0-2: Delineated catchment area of River Kiruruma drainage basin

Table 2: Land cover distribution in the Kiruruma watershed

Land cover/Use	Acreage (sq. km)	Coverage (%) of total area
Closed Bush land	15.8	9.2%
Closed Grassland	8.3	4.9%
Dense Natural Forest	2.2	1.3%
Moderate Natural Forest	1.3	0.7%
Open Bush land	24.7	14.4%
Open Grassland	2.0	1.2%
Settlement	0.7	0.4%
Subsistence Cropland	116.0	67.9%
Swamps	0.001	0.001%

Overall, the proposed Matanda Irrigation scheme is located in a highland area with topography varying between 980 and 1180 m.a.s.l. Generally, the proposed command area is of a higher altitude in the south and southwestern (1,115 – 1,176 m.a.s.l) sloping towards the west and northwestern (990 – 1,029 m.a.s.l)

(Figure 0 5). The upper parts of the command area drain towards the west into R. Kasinga; profiles A-B, C-D and E-F). The middle parts of the command area are drained by R. Kiruruma on the east, R. Matanda in the middle, and R. Kasinga to the west (the hydraulic analysis was limited to river profile of only 3423.87 m) was drawn in HECRAS from upstream of reservoir area, through proposed dam site to a point 521.5m downstream of the dam to ascertain the flows variations. The hydraulic model considered the geometry of the river profile, the river roughness (manning values), EFC flow thresholds extracted from IHA model (indicating the extreme river discharges), longitudinal slope, and river geomorphology. The manning values were based on the land cover within the flood plains and general geological set up of the area. Validation was only limited to observations during field visits ; profiles G-H, I-J, and K-L) while the lower parts of the command area are drained by R. Karundi and R. Kiruruma.

The proposed upper dam site for Matanda irrigation scheme drains an area of approximately 137.9 km^2 (*Table 3* and *Figure 0-4*). The upper part of the catchment in the mountains is very steep with slopes greater than 70% though the slopes in most of the catchment are modest varying between 10-40% with an average slope of 24%. The catchment has an elongated shape with a length of 30km and width averaging 6.5 km. The maximum elevation in the catchment is about 2496m while minimum elevation 1237m.

Table 3: Key information about the study sites

Site	Area (km^2)	Minimum elevation (m)	Maximum elevation (m)	Slope	Channel length (Km)
Upper site	137.9	1237	2496	27.4	34.7

Figure 0-3 illustrates the river channel profile of Kiruruma River, starting from its source in the hills and ending near its confluence with Karundi River

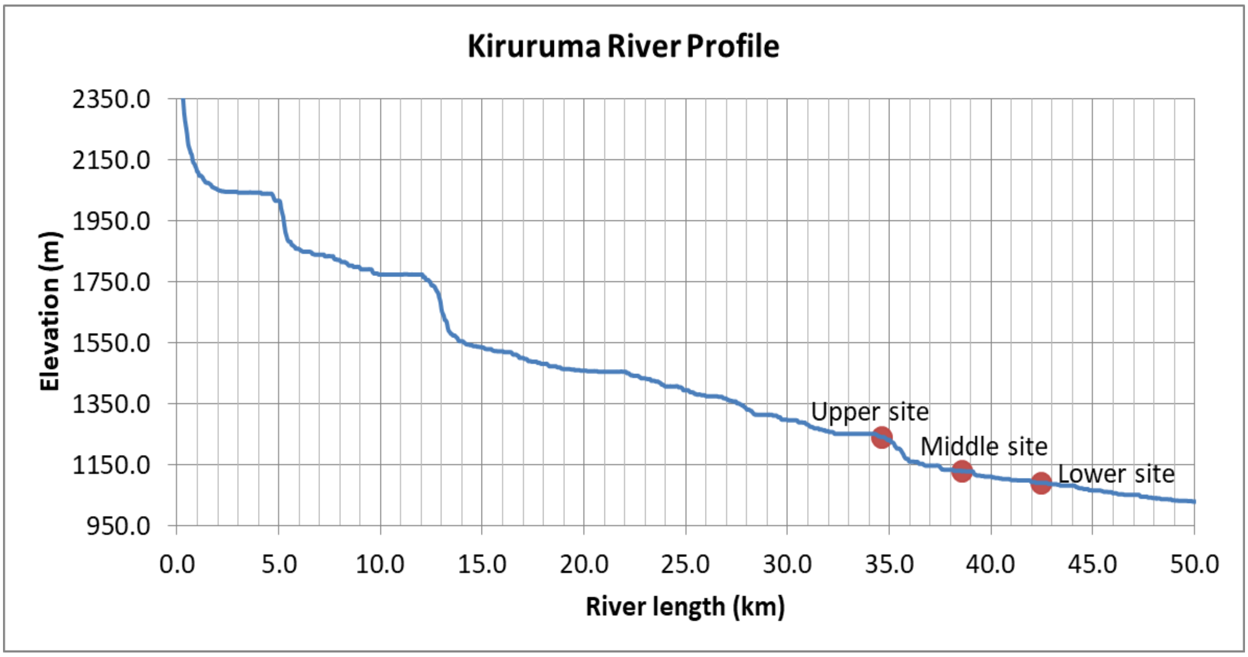


Figure 0-3: Kiruruma River channel profile

From the proposed abstraction point to the outflow of the anticipated command area, River Kiruruma drops through a vertical height of around 100 m. Given the horizontal distance traversed, the river could be classified as gently sloping. Even then, however, R. Kiruruma is still steeper in the upper and middle reaches than the lower reaches as it flows out of the command area (Figure 0-7). Consequently, the river would flow faster in the upper and middle reaches than in the lower reaches. However, the river would have a wider riparian zone as it spreads more in the flatter lower reaches in the northeastern part of the command area.

In the context of this e-flow determination, the Zone of Influence (ZoI) is considered as that part of the river where the water abstraction for the purpose of irrigation scheme development could affect the ecological functioning of the river if mitigation measures were not appropriately implemented. The ZoI for the proposed irrigation water abstraction, therefore, was considered as that part of the river downstream of the abstraction point to that point when substantial flows would be added to the river system. This is the river section between the proposed abstraction point and the point of confluence of R. Kiruruma, R. Rushaya and R. Mitano. Details of the current drainage network of the area are conceptually presented (Figure 0-8).

The proposed Irrigation scheme command area is drained by 10 rivers and streams. These include but are not limited to; R. Ishasha (2.53 m^3/s), R. Ibalya (1.33 m^3/s), R. Kiruruma (1.84 m^3/s), R. Karundi (0.56 m^3/s), R. Mashekwe (1.35 m^3/s), R. Kakindo (2.8 m^3/s), R. Rushaya (2.12 m^3/s), R. Mitano (15.45 m^3/s) all draining into R. Ntungwe (21.64 m^3/s). The proposed take off for the scheme is on R. Kiruruma, which has two tributaries – R. Karundi at the outflow end of the command area and R. Ibalya just before the proposed take off site. In terms of total stream flow contributions, R. Karundi contributes 23.3% of the R. Kiruruma flow just at the tail end outflow of the command area but in a wider outlook of flows, at the point of confluence of R. Kiruruma and R. Mitano, there would be a flow from R. Mitano, R. Mashekwe, R. Kakindo and R. Rushaya giving a literal combined flow of around nine times that of R. Kiruruma. This formed the basis of determination of the ZoI to be between the abstraction point and this point of confluence of R. Kiruruma and R. Mitano since there is substantial flow in the rivers.

R. Kiruruma water assessment considered low flow and flood regimes of the river and recommends a minimum Environmental Flow Requirement (EFR) of 0.58 m^3/s for low flow regimes. The low flow EFR took into consideration the extreme low flow thresholds based on flood duration curves, possible aquatic water needs based on the type of habitat and ecological class of the river stretch, domestic, livestock and wildlife, current and projected water users downstream of the proposed take off point. This study found the e-flow value of 0.58 m^3/s sufficient given the current field observations.

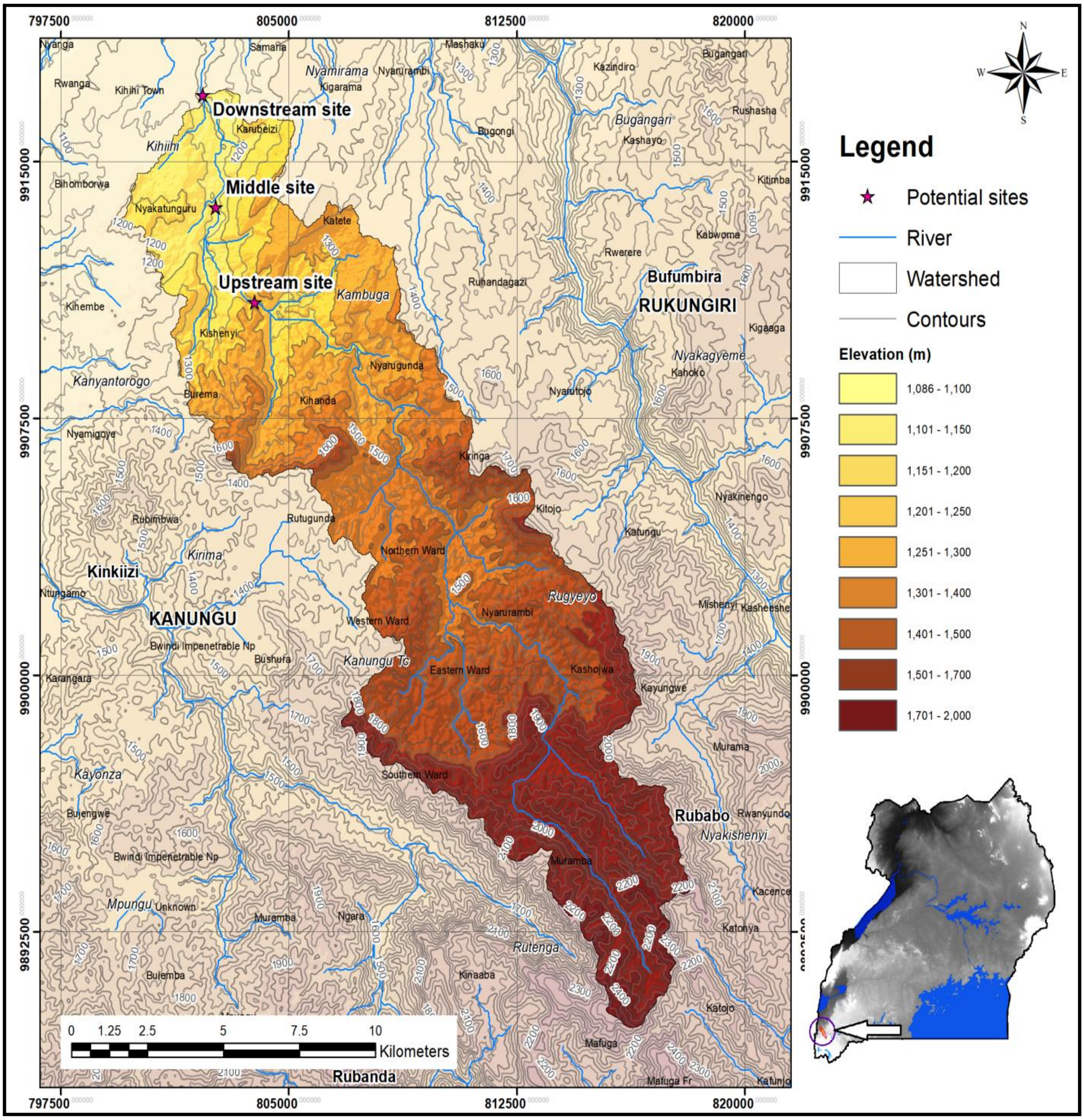


Figure 0-4: Catchment Topography based on the ALOS PALSAR 12.5m Digital Elevation Model

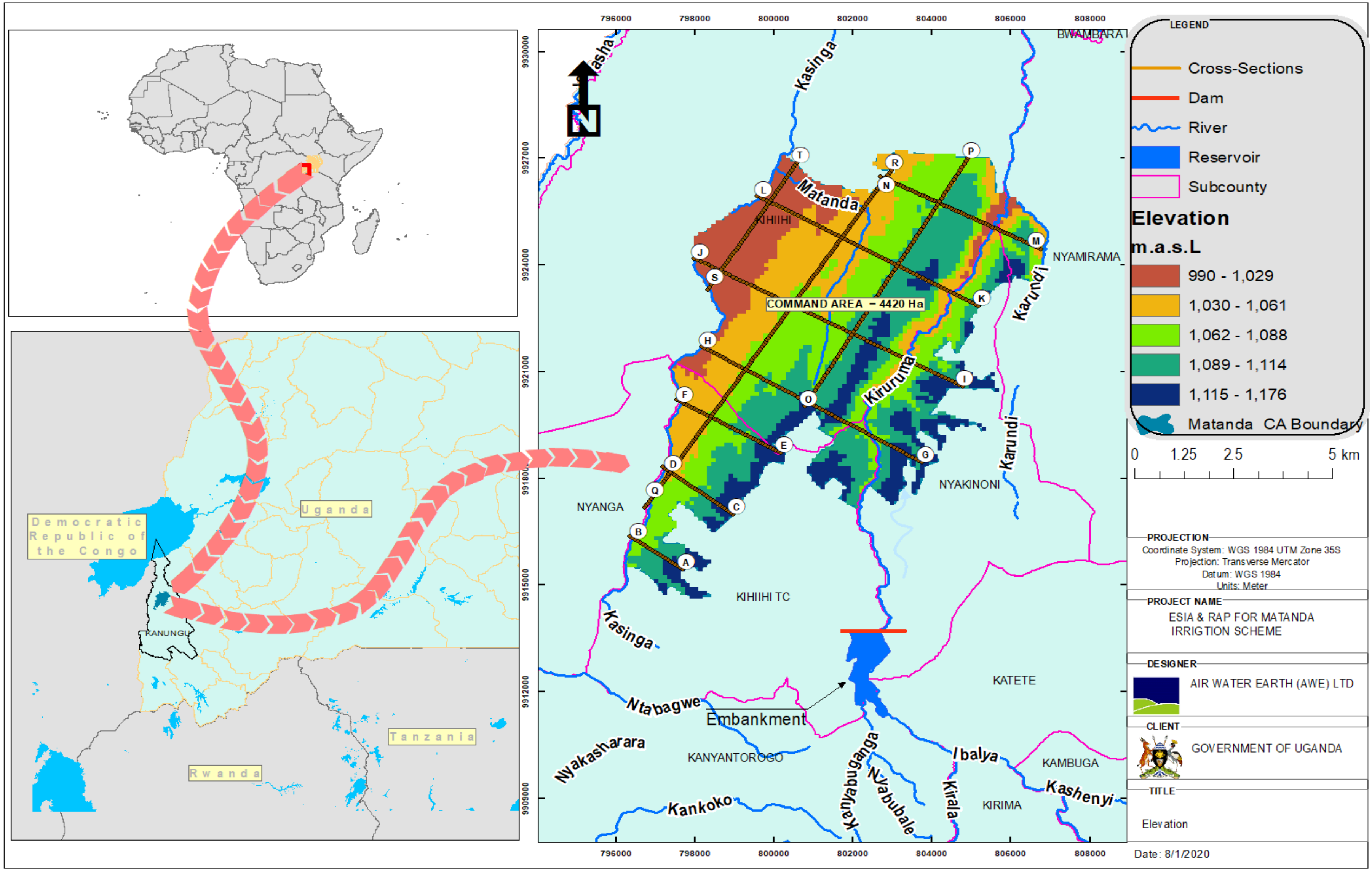


Figure 0-5: Drainage of the proposed Matanda Irrigation scheme command area based on Topology

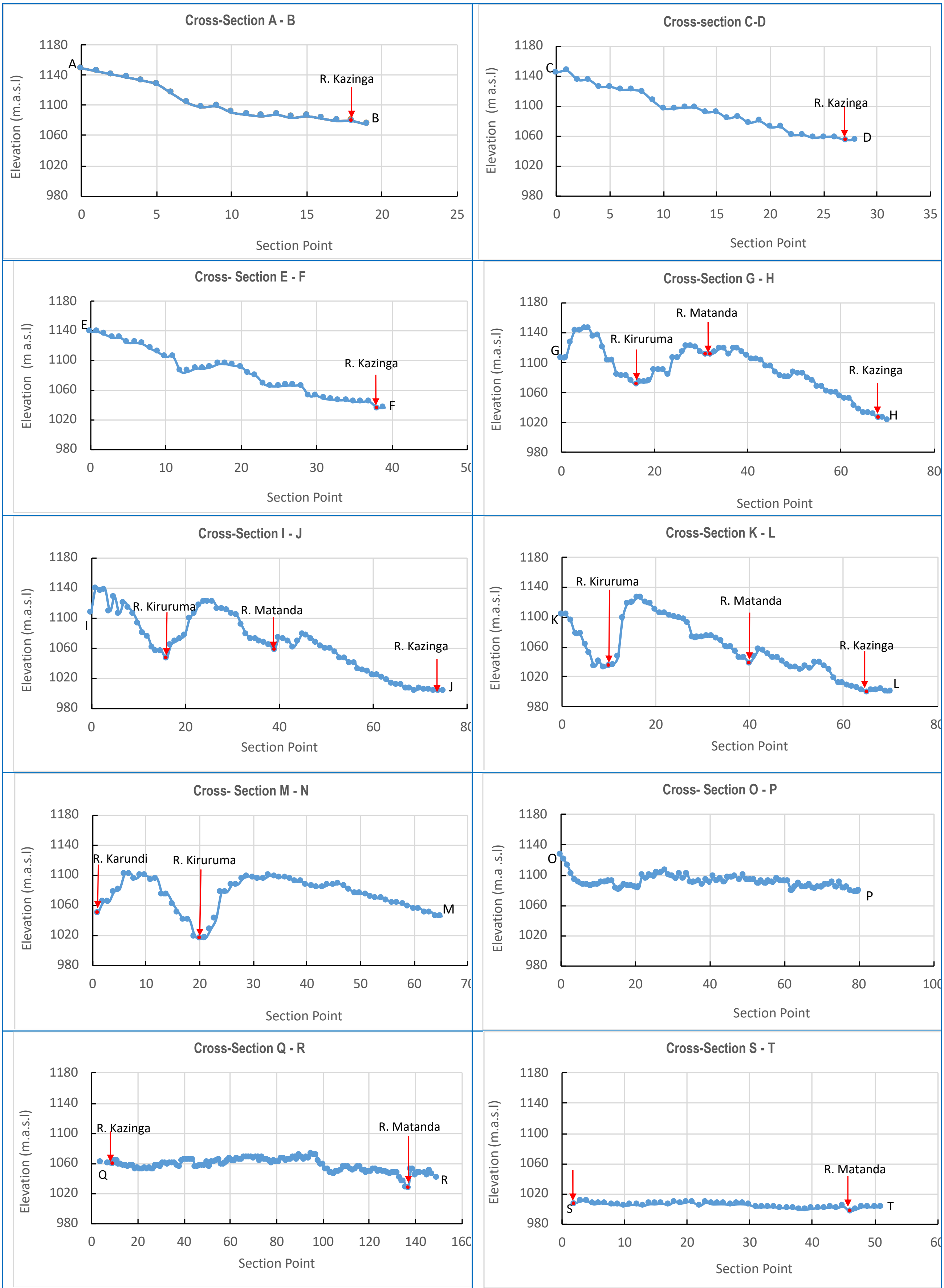


Figure 0-6: Hydrology of the proposed Matanda Irrigation Scheme command area

The hydraulic analysis was limited to river profile of only 3423.87 m was drawn in HECRAS from upstream of reservoir area, through proposed dam site to a point 521.5m downstream of the dam to ascertain the flows variations. The hydraulic model considered the geometry of the river profile, the river roughness (manning values), EFC flow thresholds extracted from IHA model (indicating the extreme river discharges), longitudinal slope, and river geomorphology. The manning values were based on the land cover within the flood plains and general geological set up of the area. Validation was only limited to observations during field visits.

Table 4: Estimated slopes downstream of the proposed Matanda Irrigation Scheme abstraction point

Xm	Ym	Slope (%) between segments
3421.5	1269.2	
3299.2	1267.4	1
3184.0	1266.3	1.0
3078.2	1265.0	1.2
2920.6	1260.8	2.7
2657.3	1255.5	2.0
2563.2	1254.1	1.5%
2459.7	1253.8	0.3
2224.6	1252.3	0.7
2071.7	1251.1	0.8
1914.2	1251.4	-0.2
1770.7	1250.3	0.7
1624.9	1250.2	0.1
1385.1	1249.5	0.3
1041.7	1248.4	0.3
851.3	1247.0	0.7
743.1	1246.5	0.5
578.5	1247.1	-0.3
477.4	1246.9	0.2
329.2	1245.7	0.9
206.9	1239.1	5.3
General Slope of Longitudinal Profile		
Delta X	3423.87	
Delta Y	33.85	
dy/dx	0.9890%	

From the proposed abstraction point to the outflow of the anticipated command area, River Kiruruma drops through a vertical height of around 100 m. Given the horizontal distance traversed, the river could be classified as gently sloping. Even then, however, R. Kiruruma is still steeper in the upper and middle reaches than the lower reaches as it flows out of the command area (Figure 0-7). Consequently, the river would flow faster in the upper and middle reaches than in the lower reaches. However, the river would have a wider riparian zone as it spreads more in the flatter lower reaches in the northeastern part of the command area.

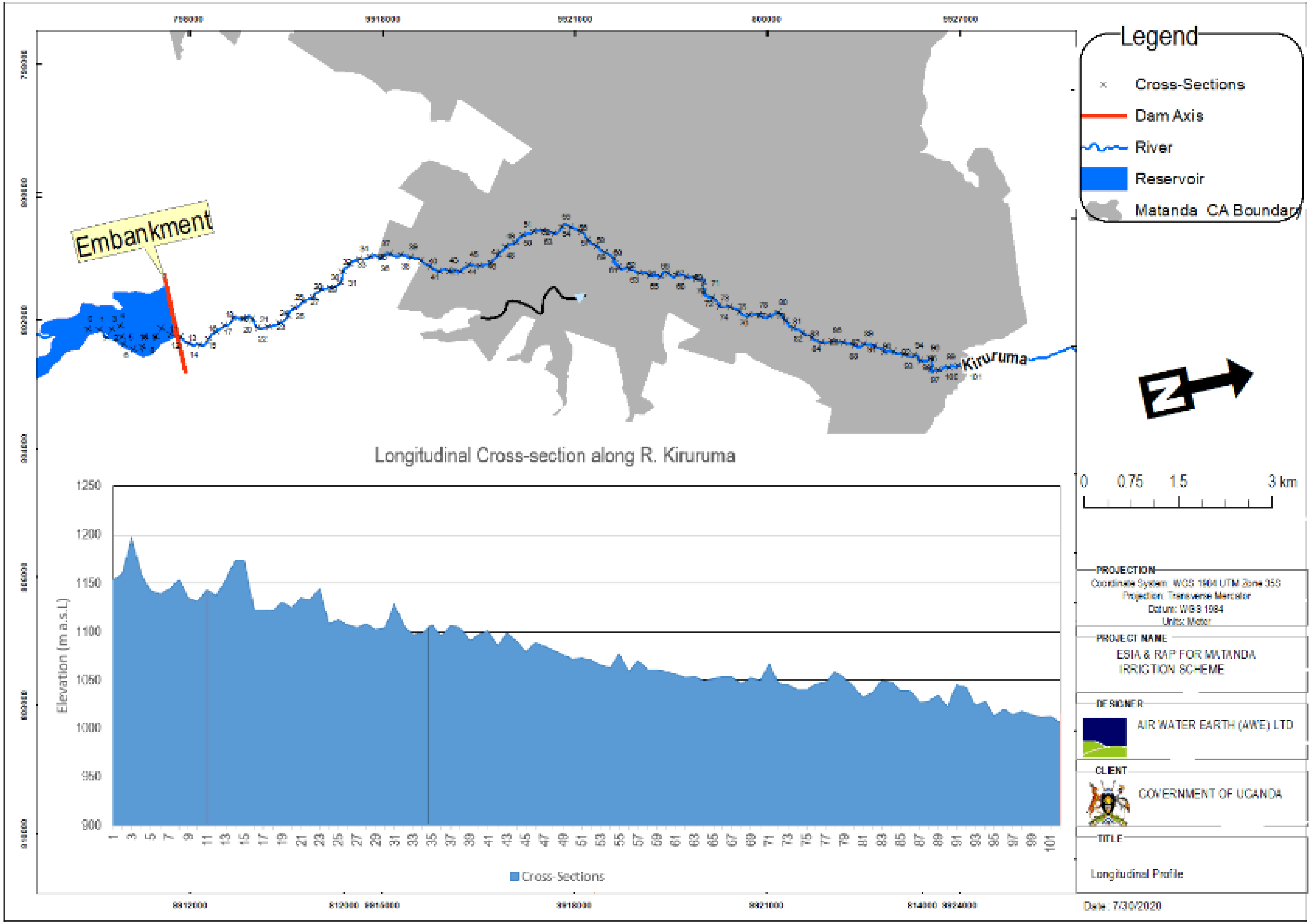


Figure 0-7: Longitudinal profile of R. Kiruruma from the proposed abstraction point through the anticipated command area

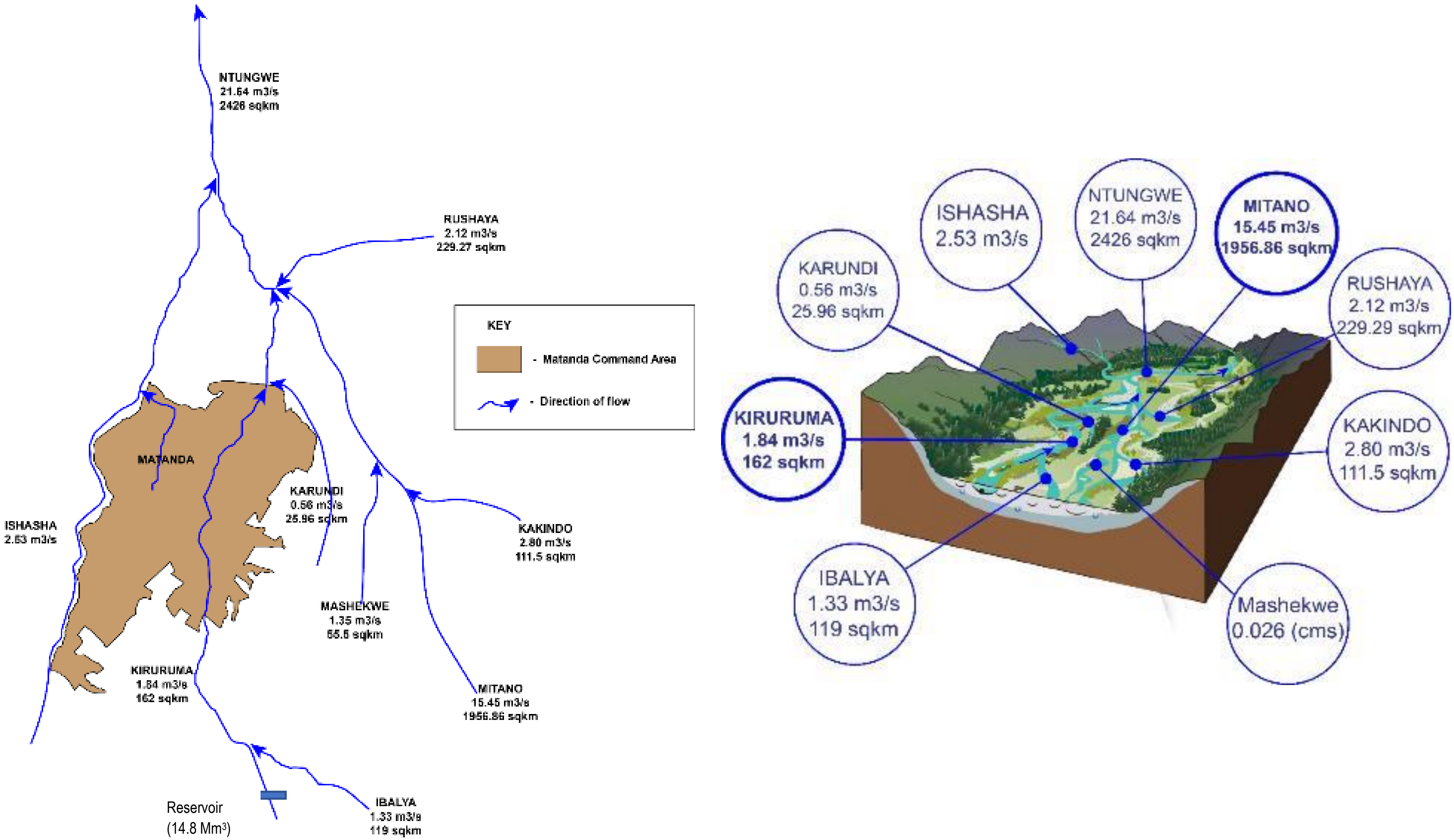


Figure 0-8: Conceptual representation of the drainage area around the proposed Matanda Irrigation Scheme. The proposed abstraction point is on R. Kiruruma downstream of the Kiruruma-Ibalya confluence.

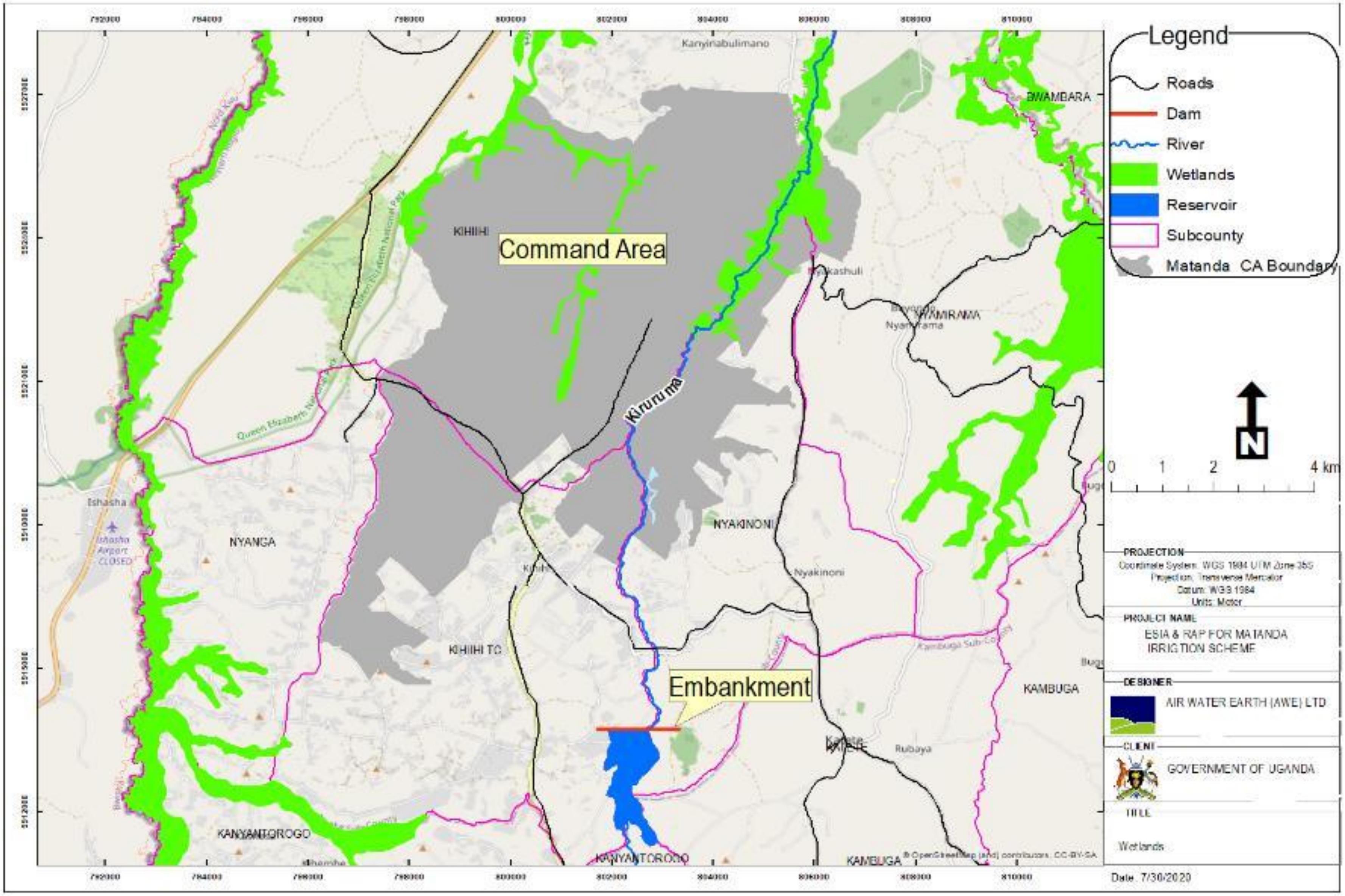


Figure 0-9: Wetlands in the proposed Matanda Irrigation Scheme command area

The HECRAS hydraulic model gives the Froude's number whose value greater than 1 indicates supercritical flow while a value of <1 indicates subcritical flow at cross section drawn within a 1.3 km stretch considered downstream of intake point.

Table 5: Hydraulic habitat types and their definitions

Habitat type	Depth (m)	Velocity (m s^{-1})
Fast deep (FD)	>0.3	>0.3
Fast intermediate (FI)	>0.2; ≤0.3	>0.3
Fast shallow (FS)	>0.1; ≤0.2	>0.3
Fast very shallow (FVS)	≤0.1	>0.3
Slow deep (SD)	>0.5	≤0.3
Slow shallow (SS)	≤0.5	≤0.3
Slow very shallow (SVS)	≤0.1	≤0.3

Inappropriate habitat management could exacerbate biodiversity declines. The nature of habitat relates to the hydraulic flow characteristics within a river stretch. (Table 5) indicates the classification of habitat type to depth and velocity. HECRAS model generated water surface profiles and Froude number graph reveals at various stations downstream of the proposed intake, the flows tend to be subcritical for about 1323 km. That would be a potential breeding area for aquatic life which can be proved during detailed biodiversity study downstream. The velocities along the profile ranged between 0 m/s to 3.43 m/s for extreme low flows as revealed. The maximum velocities increased accordingly for the other corresponding Environmental Flow Components (EFC).

Table 6: Flow Velocities for different EFC for river upstream of reservoir

EFC	Min (m/s)	Mean (m/s)	Max (m/s)	Standard Deviation
Extreme Low Flow	0.43	0.70	1.00	0.19
High Flow Peak	0.59	0.93	1.24	0.21
Large Flood	0.59	0.89	1.93	0.61
Small Flood	0.10	1.09	1.24	0.19
100yr	0.18	1.36	2.26	0.72
1000yr	0.69	2.60	3.48	1.01
PMF	0.76	2.70	3.65	1.03

Table 7: Flow Velocities for different EFC for river stretch downstream of proposed Dam

EFC	Min (m/s)	Mean (m/s)	Max (m/s)	Standard Deviation
Extreme Low Flow	0.38	0.75	1.27	0.39
High Flow Peak	0.52	1.09	1.59	0.53
Large Flood	0.53	0.98	2.17	0.55
Small Flood	0.90	1.48	1.59	0.45
100yr	1.16	1.82	2.54	0.61
1000yr	2.27	3.18	3.92	0.83
PMF	2.35	3.31	4.05	0.86

Sn	RS	Channel Distance	Extreme Low Flow-	High Flow	Small Flood	High Flood	100yr	1000yr-	PMF	
1	3563	3,527	1	1.21	1.61	)	2.09	3.43	3.44	Upstream of Reservoir
2	3455	3,419	0.58	0.82	1.45	0.82	1.81	3.24	3.39	
3	3328	3,292	0.73	0.93	1.22	0.93	1.52	3.48	3.65	
4	3223	3,187	0.43	0.59	1.05	0.59	1.27	2.61	2.79	
5	3120	3,084	0.64	0.84	0.95	0.84	1.25	3.01	3.12	
6	2957	2,921	0.72	0.94	1.93	0.94	2.26	2.89	2.97	
7	2880	2,844	0.6	0.88	0.38	0.88	0.53	1.42	1.51	
8	2806	2,770	0.93	1.24	0.1	1.24	0.18	0.69	0.76	
9	2693	2,657	0.08	0.1	0.03	0.1	0.06	0.3	0.33	Reservoir
10	2594	2,558	0.03	0.07	0.05	0.07	0.1	0.41	0.45	
11	2500	2,464	0.01	0.02	0.02	0.02	0.03	0.18	0.2	
12	2261	2,225	0	0	0.01	0	0.01	0.07	0.08	
13	2115	2,079	0	0	0	0	0	0.03	0.03	
14	1954	1,918	0	0	0	0	0	0.02	0.02	
15	1806	1,770	0	0	0	0	0	0.01	0.02	
16	1662	1,626	0	0	0	0	0	0.01	0.01	
17	1425	1,388	0	0	0	0	0	0.01	0.02	
18	1277	1,240	0	0	0	0	0	0.01	0.01	
19	1075	1,039	0	0	0	0	0	0.01	0.01	
20	891	854	0	0	0	0	0	0.01	0.01	
21	782	746	0	0	0	0	0	0.01	0.01	
22	685	648	0	0.01	0.01	0.01	0.02	0.12	0.13	
23	641	605	0	0.01	0.02	0.01	0.03	0.19	0.21	
24	517	480	0.38	0.53	0.9	0.53	1.16	2.28	2.39	Downstream of the Dam
25	367	331	1.03	1.27	1.9	1.27	2.31	3.72	3.82	
26	240	204	0.41	0.52	0.99	0.6	1.26	2.27	2.35	
27	162	125	0.66	1.52	1.43	0.91	1.83	3.72	3.92	
28	36	-	1.27	1.59	2.17	1.59	2.54	3.92	4.05	

The Froude's number at the subcritical flow section ranged between 0 to 4.39 for extreme low flow and to 0.00 to 5.18 for large flood flow conditions within the modelled river section. This implies there are sections of both subcritical and supercritical flows. Froude number has been recognized as a criterion to distinguish between pools and riffle. The average Froude's number is tending to 1 for the studied river section implying balance between sections of subcritical and supercritical flow conditions though more biased to supercritical flow. This can further be justified by the profile slope of 2% and average flow velocity >0.3 m/s for all the considered Environmental Flow Components.

Table 8: Froude's Number for different EFC for river stretch 1.4 km downstream of proposed Matanda Irrigation Scheme

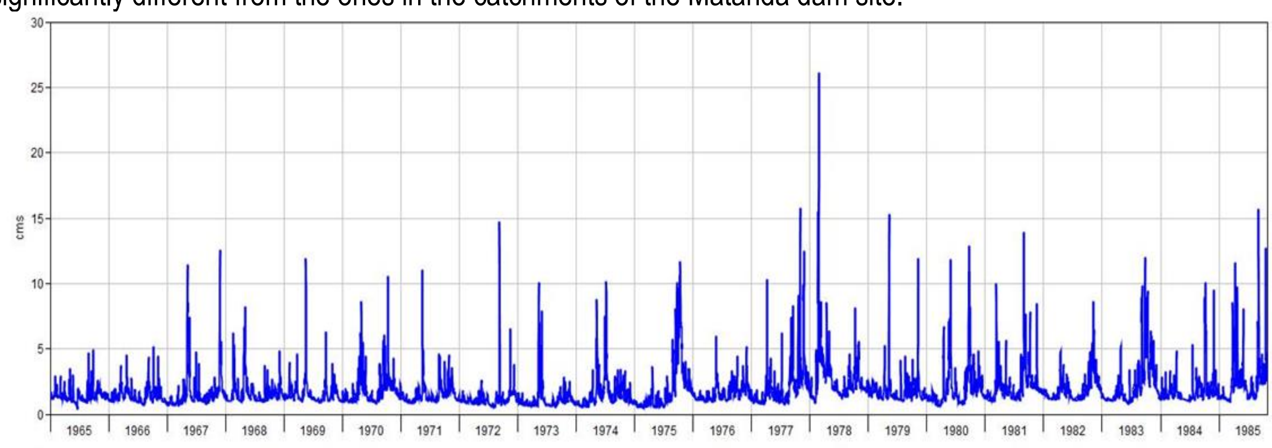
EFC	Min (m/s)	Mean (m/s)	Max (m/s)	Standard Deviation
Extreme Low Flow	0	0.75	4.39	1.1
High Flow Peak	0	0.80	4.85	1.2
Large Flood	0	0.88	5.12	1.3
Small Flood	0	0.87	5.18	1.3

Table 9: The average depth and velocity

EFC	Average Depth (m)	Average Velocity (m/s)	Mean Froude's Number
Extreme Low Flow	1.18	0.68	0.75
High Flow Peak	1.28	0.87	0.80
Large Flood	1.70	1.44	0.88
Small Flood	1.59	1.31	0.87

River Kiruruma has one gauging station (Gauge No 84270) located along Katete-Kihihi Road quite close to the locations of the proposed dam locations. The station is located at coordinates 0o45'46" S and 29o43'14" E and drains an area of about 162 km^2. Therefore, flows at the gauging stations are expected to be representative for the conditions in the dam catchment. R. Kiruruma flow gauge has a catchment area of 162 km^2 while that of at the proposed dam site is 137.9 km^2 giving an area ratio of 0.85. The gauging station has records from 1964 to 1997 after which it became non-operational. Therefore, it has 35 years of records though with some data gaps.

There is a second gauging station within the vicinity of the site along River Mitano on Kanungu - Rwensama Road - Gauge Number 84267. However, this station drains a much larger area of 1746 km^2 including dry and flatter belts in Rukungiri and Ntungamo districts. Therefore, the hydrological conditions in the catchment of the Gauge 84627 are significantly different from the ones in the catchments of the Matanda dam site.



Therefore, the analysis of flow was exclusively based on records at Gauge No. 84270 along River Kiruruma which is located close to the proposed dam.

The dependable flows at the study sites for various thresholds are shown in Table 10 while the monthly and annual flow duration curves for the upstream site are shown in Figure 0-10 and Figure 0-11, respectively.

Table 10: Dependable flows

Site	Dependability	80%	90%	95%
Lower site	Mean flow (m3/s)	1.3	1	0.8
	Annual flow (MCM/year)	61.19	56.73	53.14
Middle site	Mean flow (m3/s)	1.2	0.9	0.8
	Annual flow (MCM/year)	55.35	51.31	48.06
Upper site	Mean flow (m3/s)	1.05	0.8	0.67
	Annual flow (MCM/year)	49.4	45.8	42.9

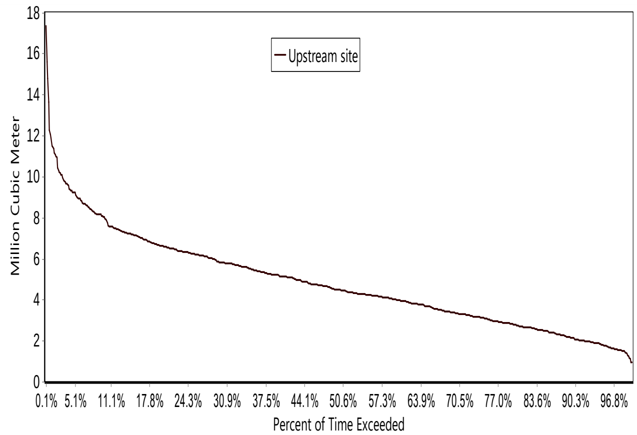


Figure 0-10: Monthly flow duration curve for upstream site

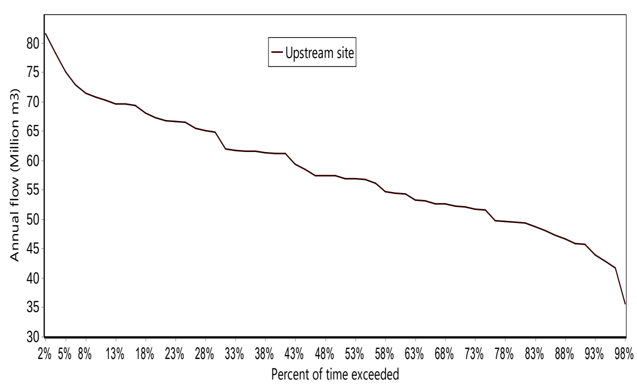


Figure 0-11:Annual flow duration curve for upstream site

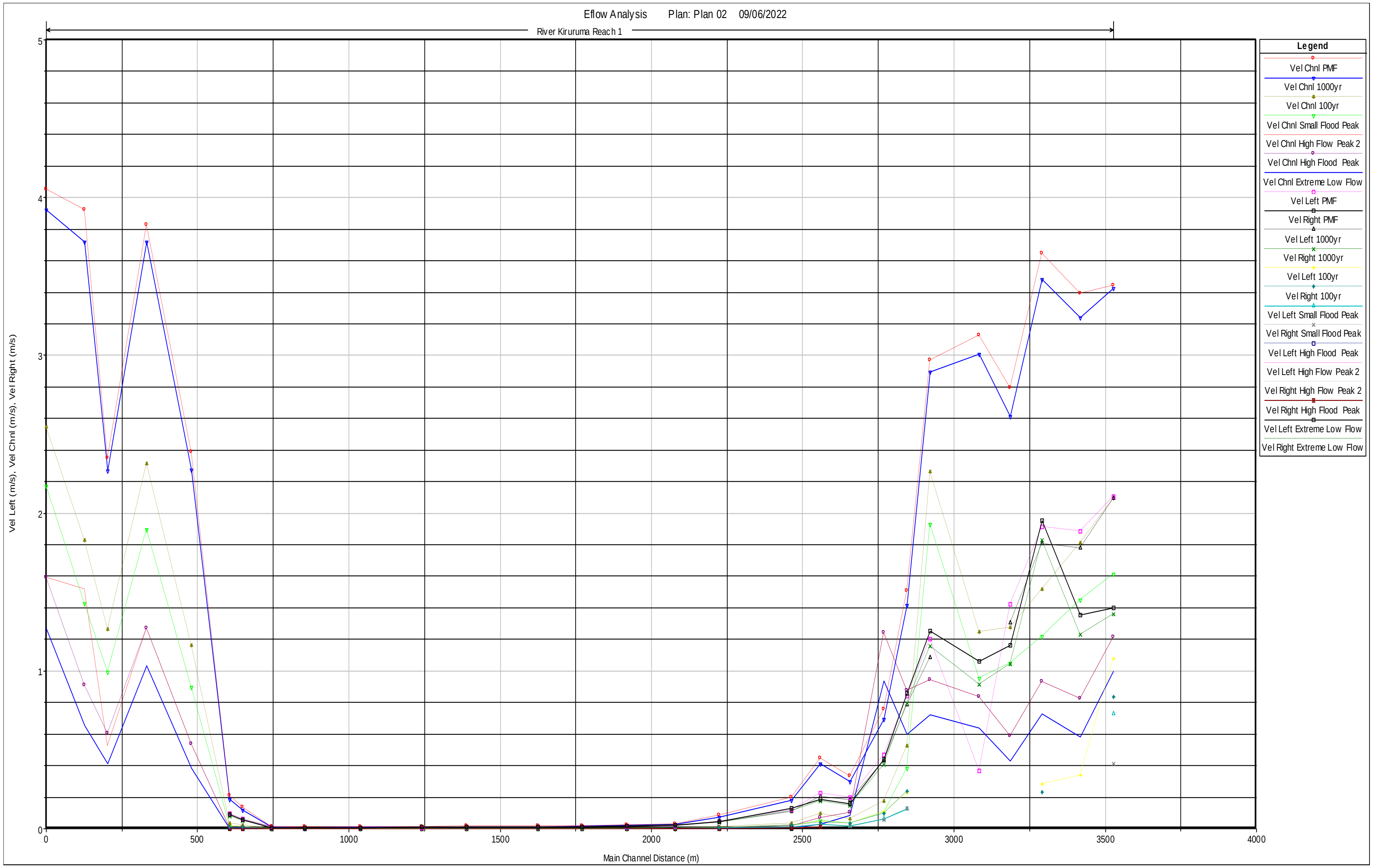


Figure 0-12: Flow velocity profiles for a 1.4 km reach downstream of the proposed Matanda Intake point

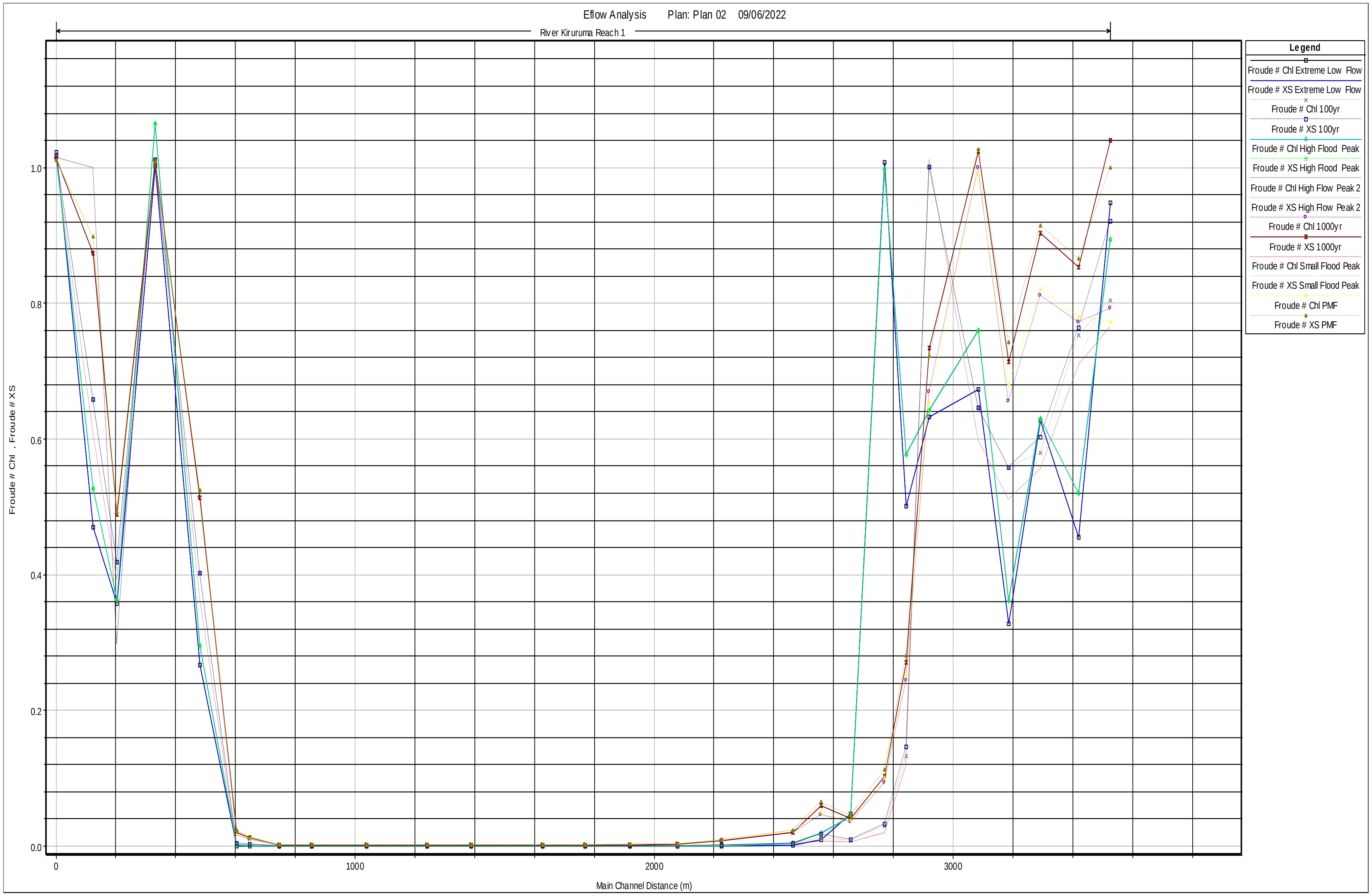


Figure 0-13: Froude's number profiles for a 1.4 km reach downstream of the proposed Matanda Intake point

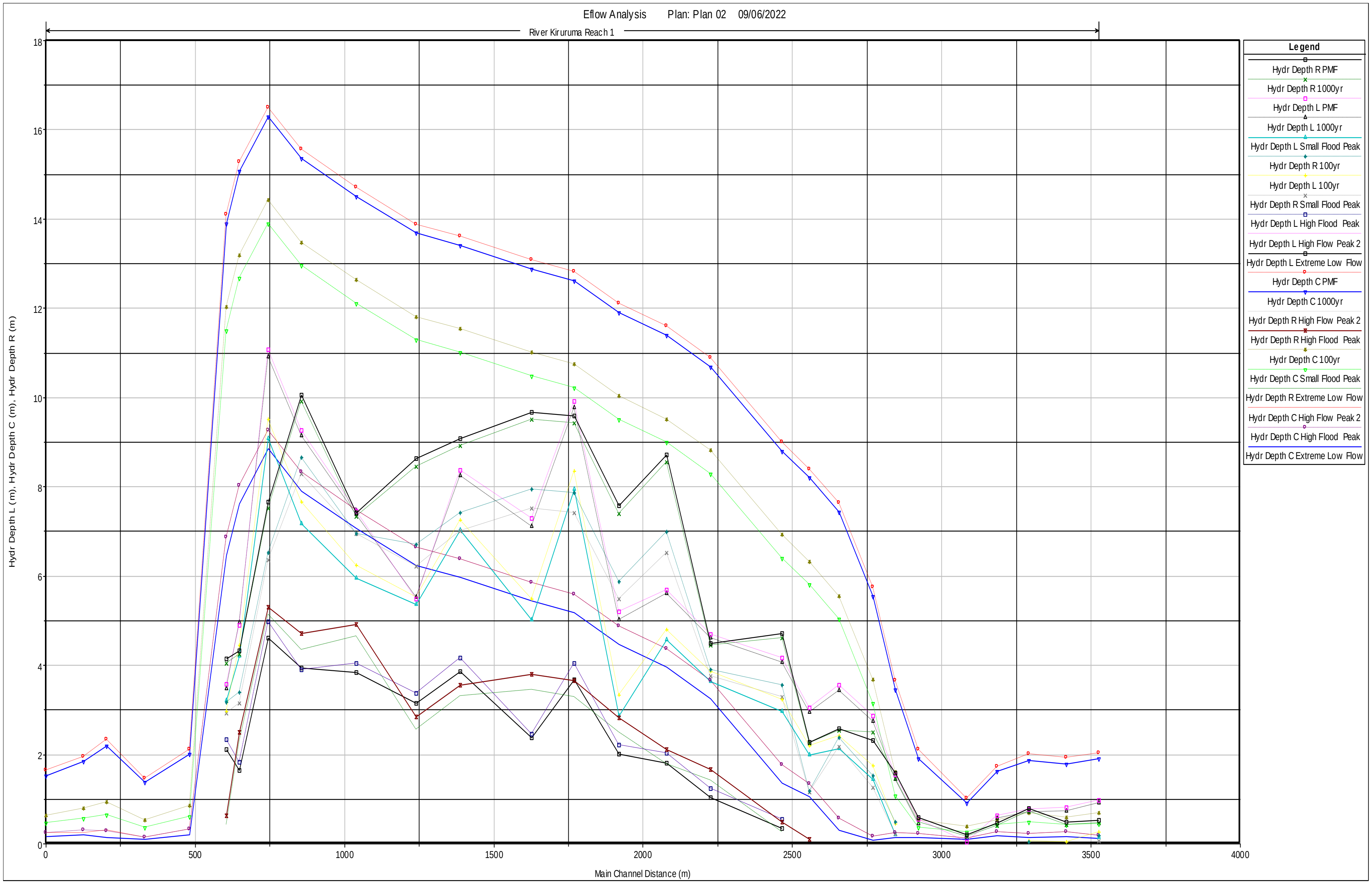


Figure 0-14: Hydraulic depth profiles of R. Kiruruma downstream of the proposed Matanda Irrigation Irrigation Scheme abstraction point

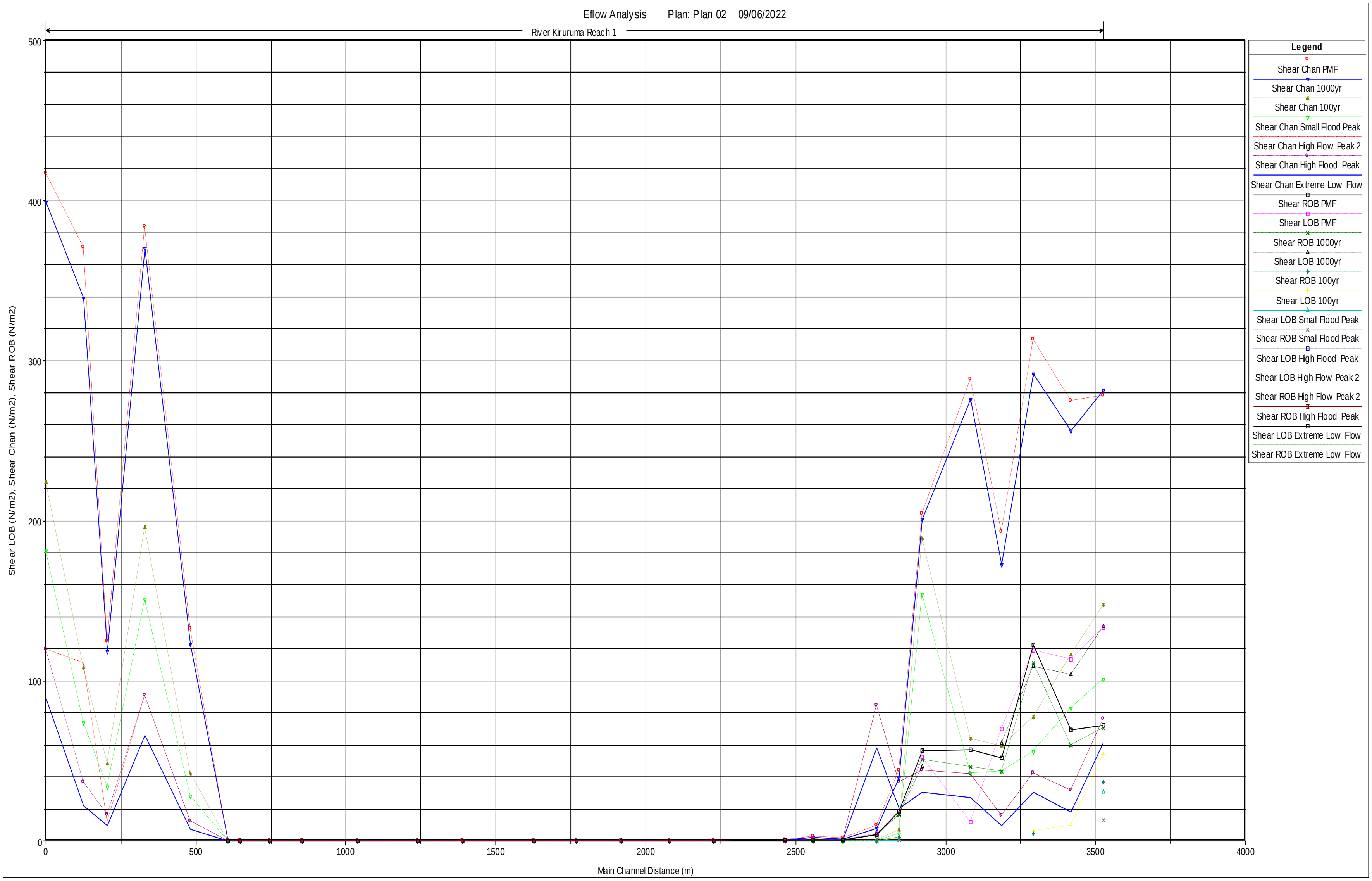


Figure 0-15: Elevation profiles of R. Kiruruma downstream of the proposed Matanda Irrigation Irrigation Scheme abstraction point

B. <u>Water Access</u>

Main source of water during dry season

The major water sources during the dry season were piped water to households (31.4%) and surface water from the rivers/streams (31.4%), presented in Table 11.There is also use of shared unprotected wells (7.4%) and shared protected wells (7.2%). This implies that people in Kanungu were still using unclean water.

Table 11: Main sources of water during dry seasons

Main source of water during dry season	Frequency	Percentage (%)
Piped water to household	161	31.4
Private protected well	5	1.0
Private un-protected well	4	0.8
Shared protected well	37	7.2
Shared unprotected well	38	7.4
Neighbors protected well	10	2.0
Stand post	28	5.5
Borehole	15	2.9
Surface water –River/stream	161	31.4
Other	53	5.5
Total	**512**	**100.0**

Main sources of water during rainy season

Respondents were asked to estimate the distance they move to get water during rainy season. Findings indicate that majority of the households (48%) indicated that they travelled less than 50 meters to get water, followed by 26.4% who moved a distance between 100 - 500 meters, and those who move over 1 km were 5.5%.

<u>Distance travelled to water source</u>

Overall, a substantial number of households (33.8%) travelled less than 50 meters. This implies that majority of the respondents in the area had a water point within their yards or immediate neighborhood. Communal water points were also close by in the distance of 100 – 500 meters (32.0%) and then those who had to walk a distance of over 1 km to their water sources including the rivers were the least (8.4%).

C. Ecological water demand

Basing on the Biodiversity Studies Approach: identifed major components of ecosystem including plants, birds, mammals, fish and herpetiles in terms of species, conservation status and habitats; assessed the status and evaluated the impacts of water uptake from the river, findings were;

Plants - transpiration and evapotranspiration processes keep the water cycle between plants and the river system in balance.

Mammals - on average, experimental animals in captivity, daily water intake of primates is approximately 60.2 ± 22.5 mL/kg while mice drink 3-5 ml a day (1.5 ml/10 g body weight/day) lying within the calculated flow.
Birds – the average daily water consumption of a 724.9g captive common buzzard has been experimentally estimated at 31.4cc or 4.3% of its live body weight which is within the calculated flow. With the relative abundances of birds ranging between 0.00-5.20 for all sites investigated, the total volume of water requirements for birds may be insignificant given their mobility and availability of other water sources. The water volume is more than tenable within the dam area of the proposed scheme.
Fish - any slight changes in water quality and quantity have differing impacts on the fish population within the river system. Breeding, spawning, though not demarcated, feeding, and the entire fish life require the presence of substantial volumes of water.

i). Domestic Water Needs

Baseline social survey in the project catchment identified a small proportion of the community downstream of the proposed take off point relying on the R. Kiruruma for their domestic water needs. The average household size is 5 and about 53 percent of the populations are children below 18 years and 2.1% of households were child-headed (UBOS, 2014 Census). The villages do not necessarily rely on River Kiruruma for domestic water needs, their main source of water was piped water supply scheme. Moreover, the river is also largely in a gouge that makes it inaccessible to the communities. Though currently the river is not the main source for communities, future scenarios are considered here with the view that the river may act as an alternative source of water in future. The scenarios considered include: Prolonged dry periods resulting into unsustainable supply by Piped Water Systems drawing water from other sources and; Population explosion within the communities living near the river with delayed initiatives to expand piped water to such communities.

The population within the project area is projected up to 2040 using annual growth rate of 3% in accordance with UBOS 2014 census. Based on field observations, it was obvious that there were no people living within 50 meters of the river banks. The immediate river surrounding areas were occupied by gardens and patches of disturbed and natural vegetation to a lower extent. Based on findings of socio-economic survey as preliminary project inception, a buffer zone of not more than 500 m considered for river stretch of 1.5 km downstream of proposed take off point. Area ratios of portion within buffer zone to total area of village within which the river passes were used to ascertain population within the selected buffer zone assuming the population distribution is homogeneous.

As indicated by findings of social survey 31.4% of population in the river buffer zone was assumed to abstract water from the river of which only 32% walked a distance of not more 500 km (Table 12). A buffer zone of 500 m was created around 1.5 km stretch of river Kiruruma downstream of the proposed take off point. The populations for the areas are estimated on the assumption that the population is uniformly distributed throughout the villages; this assumption is expected to give a realistic estimate of the population settlement patterns. The population projections were then made for initial year - 2024 after 5 years, Future Year - 2034 after 15 years and ultimate year - 2044 after 20 years. The per capita water demand was taken as 25 l/c/d and maximum day demand estimated with a factor of 1.1. No water uses for industrial or irrigation purposes was identified. The small social dependence on such a rural setting water resource is largely because of good piped water coverage in a number of the parishes which R. Kiruruma traverses.

Table 12: Population projections for the communities likely to depend on R. Kiruruma for their domestic water needs

Village	Parish	Projected Population				
		2010	2019	Initial Year 2024	Future Year 2034	Ultimate Year 2040
Ibumbwe	Katete	0	0	0	0	1
Buhumuliro	Karubeizi	8	11	13	18	20
Muruhura	Karubeizi	4	6	7	9	10
Nkumbagara	Nyakatunguru	13	18	21	28	32
Mukishunju	Nyakatunguru	8	10	12	16	19
Karama	Nyakatunguru	1	2	2	3	3

Total domestic water needs for households that rely on the river

Based on the national average per capital water consumption prescribed by the Directorate of Water Development (DWD Water Supply Design Manual, 2013), total domestic water D_W is:

Dw = 25 (l/person/day) x Total No. of Household members (1)

Projected water demand for communities depending on R. Kiruruma for their domestic water needs

Table 13: Projected water demand for communities depending on R. Kiruruma for their domestic water needs

Maximum Day Demand (m^3/day)						
Village	Parish	2010	2019	Initial year 2024	Future Year 2034	Ultimate Year 2044
Ibumbwe	Katete	0.0	0.0	0.0	0.0	0.0
Buhumuliro	Karubeizi	0.2	0.3	0.4	0.5	0.6
Muruhura	Karubeizi	0.1	0.2	0.2	0.2	0.3
Nkumbagara	Nyakatunguru	0.4	0.5	0.6	0.8	0.9
Mukishunju	Nyakatunguru	0.2	0.3	0.3	0.4	0.5
Karama	Nyakatunguru	0.0	0.0	0.1	0.1	0.1
Total Water Demand (m^3/day)		**1.0**	**1.3**	**1.5**	**2.0**	**2.3**

It is assumed that there will be no settlements in Katete Parish over the time. These estimates were further considered for the entire considered river reach.

ii). Livestock Water Demand

Livestock water demands were estimated by taking in consideration the socio-economic findings by relating the average number of livestock per household and percentage of households keeping livestock. The total number of households was estimated using the average household size of 4.7 in Rukungiri and Kanungu divided by the total population within the buffer zone. The Livestock numbers were converted to Tropical Livestock Units (TLUs) using the approach of the Water Supply Design Manual Second Edition as detailed below. According to the Water Act of Uganda in part 1 interpretations "Livestock Unit" means a mature animal with live weight of ~250 kg live weight. Conversion factors of 0.7, 0.1 and 0.1 for Cattle, Goats and Sheep, respectively were used to convert the livestock population to size in TLUs (Source: FAO, 1987a - FAO, 1986b). Each TLUs consumes not more than 50 l/day.

Table 14: Livestock water Demand

Animals	2019	Initial year 2024	Future Year 2034	Ultimate Year 2044
Goats and Sheep	212	247	328	377
Cattle	42	48	60	60
Pigs	52	56	68	72
Birds	180	204	258	300
Total	**486**	**555**	**714**	**809**
TLUs	91.0	103.3	131.3	142.4
Water Demand (m^3/day)	**4.6**	**5.2**	**6.6**	**7.2**

iii). **Aquatic Life Water Needs**

Aquatic species in rivers are accustomed to live in flowing river conditions, with their life cycle stages requiring the following factors: low silt content, well-oxygenated intra-boulder flows and minimum current, depth, velocity of water and dissolved oxygen. The significance of minimum flow is that it is needed to keep the streambed wet to an acceptable depth to support fish life. To maintain the fish population, all parameters related to flow are equally important for fish living in flowing river conditions. The river flow should be of appropriate velocity in relation to the different life stages (e.g., egg, fry, juvenile, and adult) of fish. Tennant proposed a 10% Median Annual Discharge (MAD) or monthly median flows as a lower tolerance limit for many aquatic organisms and a 30% MAD for good to optimal water depths and velocities. The environment within the 100 m buffer of the river is moderately to largely modify with no critical or endangered species. It is therefore concluded that the 30% MAD would be acceptable for R. Kiruruma.

Table 15: Environmental Flow Requirements (EFR) for Aquatic habitats based on Tennant method.

Median Annual Discharge (MAD) (m^3/s)	Aquatic Environmental Flow (m^3/s)	Remark
1.45	**0.435**	The river stretch downstream of Matanda Intake is moderately to largely disturbed

There is no available research data on water needs for fish species found in the Kiruruma River, but this water need level is comparable to water needs of other species as found from available literature (Vaidya S.D. et al., 2008):

Present Ecological Status

The biodiversity assessments of the river stretch found considerable modification of the catchment and riparian areas by cultivation. A vast part of the lower reaches of the river is used for rice farming. More details of this ecological modification are included in the main report. The FDC shift approach was used to determine flow exceeded at different times for example Q50 (0.90) for Kiruruma which is moderately to a largely modified state. By uniformly reducing (shifting) the natural (unregulated) flow duration curve by a fixed number of percentile places, and further disaggregating it into a complete time series of modified flows the impact on the downstream environment, habitats, and socio-indicators can be predicted and subsequently the Environmental Flow Requirement (EFR) determined. Q50 relates to extreme low flow threshold estimated with IHA Software Version 7.1. The worst-case scenario for R. Kiruruma shall be assumed for EFR when the river surroundings including the banks are cleared in preparation for the planting season. Since the R. Kiruruma stretch downstream of the proposed abstraction point is no longer in its pristine natural state, the FDC was shifted to the current state observed as modified and largely. The water requirement for ecological functions under low flow scenarios indicated by Q99 (1.3) and Q99 (0.8) for moderately and largely Modified status of river, respectively.

Table 16: FDC Shift to fit River Kiruruma current status

	8%	15%	23%	31%	38%	46%	54%	62%	69%	85%	92%	Min	Max	Mean	Median	SD	RMS
No Change	2.62	2.02	1.81	1.81	1.72	1.50	1.34	1.30	1.27	1.18	1.12	1.12	2.62	1.57	1.42	0.44	1.63
A: Natural	2.08	1.72	1.57	1.54	1.49	1.29	1.17	1.16	1.11	1.03	0.99	0.99	2.08	1.35	1.23	0.34	1.39
B: Slightly Modified	1.77	1.51	1.38	1.36	1.31	1.14	1.03	1.03	0.98	0.87	0.85	0.85	1.77	1.17	1.08	0.29	1.21
C: Moderately Modified	1.58	1.35	1.21	1.21	1.15	0.99	0.90	0.89	0.87	0.74	0.72	0.72	1.58	1.03	0.95	0.27	1.06
D: Largely Modified	1.40	1.20	1.08	1.07	1.00	0.88	0.81	0.78	0.75	0.66	0.63	0.63	1.40	0.91	0.84	0.24	0.94
E: Seriously Modified	1.22	1.06	0.96	0.90	0.89	0.80	0.72	0.71	0.65	0.62	0.58	0.58	1.22	0.81	0.76	0.20	0.83
F: Critically Modified	1.09	0.92	0.85	0.80	0.79	0.73	0.65	0.65	0.59	0.58	0.56	0.56	1.09	0.73	0.69	0.16	0.75
Min	1.09	0.92	0.85	0.80	0.79	0.73	0.65	0.65	0.59	0.58	0.56						
Max	2.62	2.02	1.81	1.81	1.72	1.50	1.34	1.30	1.27	1.18	1.12						
Mean	1.68	1.40	1.27	1.24	1.19	1.05	0.95	0.93	0.89	0.81	0.78						
Median	1.58	1.35	1.21	1.21	1.15	0.99	0.90	0.89	0.87	0.74	0.72						
SD	0.53	0.38	0.34	0.36	0.34	0.28	0.25	0.24	0.25	0.22	0.22						
RMS	1.75	1.44	1.31	1.28	1.23	1.08	0.97	0.96	0.92	0.84	0.80						

Table 17: Monthly averages and the different environmental management classes at intake

Month of Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Nov**	**Dec**	**Min**	**Max**	**Mean**	**Median**	**SD**	**RMS**
No Change	1.12	1.27	1.34	1.72	2.62	1.30	1.18	1.18	1.81	2.02	1.50	1.12	2.62	1.57	1.42	0.44	1.63
A: Natural	0.99	1.11	1.17	1.49	2.08	1.16	1.03	1.03	1.57	1.72	1.29	0.99	2.08	1.35	1.23	0.34	1.39
B: Slightly Modified	0.85	0.98	1.03	1.31	1.77	1.03	0.87	0.88	1.38	1.51	1.14	0.85	1.77	1.17	1.08	0.29	1.21
C: Moderately Modified	0.72	0.87	0.90	1.15	1.58	0.89	0.74	0.76	1.21	1.35	0.99	0.72	1.58	1.03	0.95	0.27	1.06
D: Largely Modified	0.63	0.78	0.81	1.00	1.40	0.75	0.66	0.68	1.08	1.20	0.88	0.63	1.40	0.91	0.84	0.24	0.94
E: Seriously Modified	0.58	0.71	0.72	0.89	1.22	0.65	0.62	0.62	0.96	1.06	0.80	0.58	1.22	0.81	0.76	0.20	0.83
F: Critically Modified	0.56	0.65	0.65	0.80	1.09	0.58	0.59	0.59	0.85	0.92	0.73	0.56	1.09	0.73	0.69	0.16	0.75
Min	0.56	0.65	0.65	0.80	1.09	0.58	0.59	0.59	0.85	0.92	0.73						
Max	1.12	1.27	1.34	1.72	2.62	1.30	1.18	1.18	1.81	2.02	1.50						
Mean	0.78	0.91	0.95	1.19	1.68	0.91	0.81	0.82	1.27	1.40	1.05						
Median	0.72	0.87	0.90	1.15	1.58	0.89	0.74	0.76	1.21	1.35	0.99						
SD	0.22	0.22	0.25	0.34	0.53	0.27	0.22	0.22	0.34	0.38	0.28						
RMS	0.80	0.93	0.97	1.23	1.75	0.94	0.84	0.85	1.30	1.44	1.08						

Minimum Environmental Flow Recommended

From values of Domestic Water Needs, Livestock Water Demand, Ecologicaland Aquatic Life Water Needs determined above, environmental flow recommended is, in principle, the amount of water left in a river upon abstraction for any project should be able to satisfy the downstream water demands as well as the instream water demands that would include the ecological and aquatic water demand as well as the extreme low flow thresholds. The ecologiocal and aquatic water demand is not necessarily consumptive but it is that amount of water that has to be in the stream to maintain a certain stream level that would support the aquatic life within the system.

Table 18: Estimated environmental Flow downstream of Matanda scheme intake

Aquatic Environmental Flow (m3/s)*	**Domestic and Livestock Water Demand (m3/s)**	**Extreme Low Flow Threshold****	**Total Environmental Flow (m3/s)*****	**Remark**
0.435	**0.00066**	**0.54**	**0.58**	Downstream is moderately to largely modified

*determined using the Tennant method, **determined using the hydraulic rating method ***determined using the FDC shift approach

The domestic and livestock water demand was very small (0.00066 m^3/s) indicating a low social dependence on the river. This is likely because of existence of a piped water system covering a large part of the proposed command area. The mean annual flow of River Kiruruma as estimated from the historical river flow data for the period 1964 - 1986 is 1.85 m^3/s with low flows of about 0.95 m^3/s. However, during the last decades the land cover/use has drastically changed from what was mainly forested, grasslands and bush lands to mainly subsistence farmlands. The land use cover assessment for the area gave a composite curve number of 78 indicates reduced infiltration capacities. There is, therefore, more contribution from surface runoff than base flow, which is storage in underground layers that would slowly be released for continued stream flow even during the dry season.

This study recommends design environmental flow of 0.58 m^3/s for low flow regimes of River Kiruruma. Flood flow regimes are essential for sediment transfer into flood plains, recharge of groundwater, and sustainability of permanent and seasonal floods. As an EFR, the weir structure across the river should allow passing of the small and large flood magnitudes as indicated by the Environmental Flow Components.

EFR also considered the waste assimilative capacity of the river to ensure that sufficient dilution is achieved. Areas that suffer decreases in 7Q10 flows will have decreased estimated waste assimilative capacity as well as flows for off-stream uses. 7Q10 was estimated as 0.6 m^3/s.

The minimum Environmental Flow has been derived on the basis of domestic and institutional water needs, industrial, and aquatic environment water requirements as to maintain the current status-quo of the environmental ecological functioning as per the mean hydrological year. The Flow Duration Curve (FDC) derived from daily discharges was shifted taking into consideration the Ecological Class of River Kiruruma. The shift of the FDC for largely modified river condition results into mean flow of 0.91 m^3/s and 0.81 m^3/s for the seriously modified river conditions. From the Hydraulic Rating approach, the Habitat type was determined to be Fast and Deep since the average flow depth was >0.5 m and Average flow velocities >0.3 m/s. The stream section below the Intake is moderately to largely modified during the cultivation stage and seriously modified during the garden preparation stage as indicated by the biodiversity studies. EFR for such conditions would correspond to a flow of 0.58 m^3/s. This assessment of environmental flow considered environmental conservation and satisfaction of the anticipated future water demands. This assessment adopted the use of hydrological methodologies combined with considerations of domestic water use, livestock water use and biodiversity information including in-stream aquatic water requirements.

This study found the e-flow value of 0.58 m^3/s sufficient given the current field observations. Further considerations were, however, made of all possible uncertainties related to the river dependence that could result in future partly as a result of the proposed irrigation scheme development in the area and built in a factor of 0.10 to cover such uneasily foreseeable extremes. With that uncertainty consideration taken care of, therefore, the final revised e-flow requirement for R. Kiruruma would be **0.638 m^3/s**. This was exposed to Building Block Method after revison of the design (adoption of 31.14m height of dam, Design, 2022), and still found to be sufficient (0.638 ~ 0.64 m^3/s), with recommendations (*Table 19*).

Table 19: Recommended reservoir releases in cubic meters per second for environmental flow.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flow [m^3/s]	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**	**0.64**
FDC %	94	91	92	94	96	93	92	94	97	95	96	96
Small Flood peak [cumecs]					13							
Small Flood duration [days]					5							
Small Flood timing [Julian days]					289							
Small Flood freq. [No per yr]					Once every two years							
Small Flood rise rate [Δdisch/day]					5.7cumecs/day							
Small Flood fall rate [Δdisch/day]					-4.7/cumecs/day							

APPENDIX S

ENVIRONMENTAL AND SOCIAL INCIDENT REPORTING TOOL (ESIRT)

1.1 Appendix L1: Reportable Incidents

Reportable Incidents

(extracted from Annex 1 of ESIRT March 2023)

The following incident types are to be reported using the environmental and social incident response process.

Fatality: Death of a person(s) that occurs within one year of an accident/incident, including from occupational disease/illness (e.g., from exposure to chemicals/toxins).

Lost Time Injury: Injury or occupational disease/illness (e.g., from exposure to chemicals/toxins) that results in a worker requiring 3 or more days off work, or an injury or release of substance (e.g., chemicals/toxins) that results in a member of the community needing medical treatment.

Acts of Violence/Protest: Any intentional use of physical force, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, deprivation to workers or project beneficiaries, or negatively affects the safe operation of a project worksite.

Disease Outbreaks: The occurrence of a disease in excess of normal expectancy of number of cases. Disease may be communicable or may be the result of unknown etiology.

Disease Outbreak Example: Reporting COVID-19

The purpose of reporting incidents on a project through ESIRT is to inform management so they can help determine if the Bank needs to adapt to, manage or correct the situation. COVID19 is a global pandemic, and there is not yet an internationally agreed determination whether, or in what circumstances, it is considered an occupational disease (as discussed in the following resources: WHO and ISSA). This makes it difficult to use occupational disease as a criterion for determining whether to report COVID-19-related incidents through ESIRT. Therefore, the Bank is requiring teams to apply ESIRT for reporting COVID-19-related incidents on projects only under certain circumstances, as follows.

Teams should request their PIUs to keep the Bank informed of any outbreaks on project offices or worksites, and in particular, when either:

i. The infection rate in the workforce increases to the point that the client or contractor's ability to implement the project is compromised.
ii. The client or contractor is unable to ensure that infected workers are receiving proper care.
iii. The client or contractor is failing to deliver preventative measures adequately.

An investigation into an outbreak of COVID-19 does not need to be undertaken by the Borrower. But the PIU should keep teams informed of any concerns or problems associated with providing care to infected workers on project sites. For example, if there are shortages of PPE, equipment, medicines, or if health care workers become ill and incapacitated etc.; the information should enable teams to discuss and identify any assistance that they may be able to bring to bear to resolve any problems. In addition, should works need temporarily to be halted (for example due to widespread worker illness) teams should seek reassurance that the worksite has been left in a safe condition, from the supervision agency. These actions would be part of regular implementation support.

If a fatality occurs, and the information available suggests that the fatality may be a result of the client or contractor failing to deliver preventative measures adequately (i.e., scenario (iii) above), the ESIRT process should be followed, including any appropriate investigation, so that the appropriate follow-up actions of the Bank can be brought to bear on the project, to help correct the situation. The Bank will track only fatalities reported as part of the ESIRT process.

Displacement Without Due Process: The permanent or temporary displacement against the will of individuals, families, and/or communities from the homes and/or land which they occupy without the provision of, and access to, appropriate forms of legal and other protection and/or in a manner that does not comply with an approved resettlement action plan.

Child Labor: An incident of child labor occurs: (i) when a child under the age of 14 (or a higher age for employment specified by national law) is employed or engaged in connection with a project, and/or (ii) when a child over the minimum age specified in (i) and under the age of 18 is employed or engaged in connection with a project in a manner that is likely to be hazardous or interfere with the child's education or be harmful to the child's health or physical, mental, spiritual, moral or social development.

Forced Labor: An incident of forced labor occurs when any work or service not voluntarily performed is exacted from an individual under threat of force or penalty in connection with a project, including any kind of involuntary or compulsory labor, such as indentured labor, bonded labor, or similar labor-contracting arrangements. This also includes incidents when trafficked persons are employed in connection with a project.

Unexpected impacts on heritage resources: An impact that occurs to a legally protected and/or internationally recognized area of cultural heritage or archaeological value, including world heritage sites or nationally protected areas that was not foreseen or predicted as part of the project design or the environmental or social assessment.

Unexpected impacts on biodiversity resources: An impact that occurs to a legally protected and/or internationally recognized area of high biodiversity value, to a Critical Habitat, or to a Critically Endangered or Endangered species (as listed in IUCN Red List of threatened species or equivalent national approaches) that was not foreseen or predicted as part of the project design or the environmental and social assessment. This includes poaching or trafficking of Critically Endangered or Endangered species.

Environmental pollution incident: Exceedances of emission standards to land, water, or air (e.g., from chemicals/toxins) that have persisted for more than 24hrs or have resulted in harm to the environment.

Dam failure: A sudden, rapid, and uncontrolled release of impounded water or material through overtopping or breakthrough of dam structures.

Violence on the basis of SOGI: The threat or use of physical force that injures or abuses a person, or damages or destroys property, and that is motivated in whole or in part by the victim's real or perceived sexual orientation, gender identity, gender expression, or sex characteristics.

Discrimination on the basis of SOGI: Discrimination means creating a distinction, exclusion, or restriction which has the purpose or effect of impairing or excluding a person based on their real or perceived sexual orientation, gender identity, gender expression, or sex characteristics from being on an equal basis with others.

Sexual Exploitation: Any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another. In Bank financed operations/projects, sexual exploitation occurs when access to or benefit from a Bank financed Goods, Works, Non-consulting Services or Consulting Services is used to extract sexual gain.

Sexual Abuse: Actual or threatened physical intrusion of a sexual nature, whether by force or under unequal or coercive conditions. In Bank financed operations/projects, sexual abuse occurs when a project related worker (contractor staff, subcontractor staff, supervising engineer) uses force or unequal power vis a vis a community member or colleague to perpetrate or threat to perpetrate an unwanted sexual act.

Sexual Harassment: Any unwelcome sexual advance, request for sexual favor, verbal or physical conduct or gesture of a sexual nature, or any other behavior of a sexual nature that might reasonably be expected or be perceived to cause offence or humiliation to another, when such conduct interferes with work, is made a condition of employment, or creates an intimidating, hostile or offensive work environment. In Bank financed operations/projects, sexual harassment occurs within the context of a subcontractor or contractor and relates to employees of the company experiencing unwelcome sexual advances or requests for sexual favor or acts of a sexual nature that are offensive and humiliating among the same company's employees.

Task teams also have the discretion to elevate incidents to management, irrespective of whether the type is listed in this annex: task teams should apply the ESIRT process to inform about such incidents they deem worthy of management attention using the 'Other incident type' defined below.

Other: Any other incident or accident that may have a significant adverse effect on the environment, the affected communities, the public, or the workers, irrespective of whether harm had occurred on that occasion. Any repeated non-compliance or recurrent minor incidents which suggest systematic failures that the task team deems needing the attention of Bank management.

1.2 **Appendix L2: Incident Investigation Reporting Guide**

C1: Investigation Findings
Please replace text in italics with findings, noting for example: I. where and when the incident took place, II. who was involved, and how many people/households were affected, III. what happened and what conditions and actions influenced the incident, IV. what were the expected working procedures and were they followed? V. did the organization or arrangement of the work influence the incident, VI. were there adequate training/competent persons for the job, and was necessary and suitable equipment available, what were the underlying causes; where there any absent risk control measures or any system failures.

C2: Corrective Actions from the investigation to be implemented (To be fully described in Corrective Action Plan)		
Action	**Responsible Party**	**Expected Date**

C3a: Fatality/Lost time Injury information
Immediate cause of fatality/injury for worker or member of the public (please check all that apply)[2]:
1. Caught in or between objects ☐ 2. Struck by falling objects ☐ 3. Stepping on, striking against, or struck by objects ☐ 4. Drowning ☐ 5. Chemical, biochemical, material exposure ☐ 6. Falls, trips, slips ☐ 7. Fire & explosion ☐ 8. Electrocution ☐ 9. Homicide ☐ 10. Medical Issue ☐ 11. Suicide ☐ 12. Others ☐

Vehicle Traffic: **13. Project Vehicle Work Travel ☐ 14. Non-project Vehicle Work Travel ☐ 15. Project Vehicle Commuting ☐ 16. Non-project Vehicle Commuting ☐ 17.Vehicle Traffic Accident (Members of Public Only) ☐**						
Name	**Age/DOB**	**Date of Death/Injury**	**Gender**	**Nationality**	**Cause of Fatality/Injury**	**Worker (Employer)/Public**

C3b: Financial Support/Compensation Types (To be fully described in Corrective Action Plan template) **1. Contractor Direct ☐ 2. Contractor Insurance ☐ 3. Workman's Compensation/National Insurance ☐** **4. Court Determined Judicial Process ☐ 5. Other ☐ 6. No Compensation Required ☐**			
Name	**Compensation Type**	**Amount (US$)**	**Responsible Party**

C4: Supplementary Narrative

Definition of fatality/injury immediate causes

1. **Caught in or between objects:** caught in an object; caught between a stationary object and moving object; caught between moving objects (except flying or falling objects).
2. **Struck by falling objects:** slides and cave-ins (earth, rocks, stones, snow, etc.); collapse (buildings, walls, scaffolds, ladders, etc.); struck by falling objects during handling; struck by falling objects.
3. **Stepping on, striking against, or struck by objects:** stepping on objects; striking against stationary objects (except impacts due to a previous fall); Striking against moving objects; Struck by moving objects (including flying fragments and particles) excluding falling objects.
4. **Drowning:** respiratory impartment from submersion/emersion in liquid.

5. **Chemical, biochemical, material exposure:** exposure to or contact with harmful substances or radiations.
6. **Falls, trips, slips:** falls of persons from heights (e.g., trees, buildings, scaffolds, ladders, etc.) and into depths (e.g., wells, ditches, excavations, holes, etc.) or falls of persons on the same level.
7. **Fire & explosion:** exposure to or contact with fires or explosions.
8. **Electrocution:** exposure to or contact with electric current.
9. **Homicide:** a killing of one human being by another.
10. **Medical Issue:** a bodily disorder or chronic disease.
11. **Suicide:** the act or an instance of taking, or attempting to take, one's own life voluntarily and intentionally.
12. **Others:** any other cause that resulted in a fatality or injury to workers or members of the public.

Vehicle Traffic

13. **Project Vehicle Work Travel:** traffic accidents in which project workers, using project vehicles, are involved during working hours and which occur in the course of paid work.
14. **Non-project Vehicle Work Travel:** traffic accidents in which project workers, using non-project vehicles, are involved during working hours and which occur in the course of paid work.
15. **Project Vehicle Commuting:** traffic accidents in which project workers, using project vehicles, are involved while travelling to (i) the worker's principal or secondary residence; (ii) the place where the worker usually takes his or her meals; or (iii) the place where he or she usually receives his or her remuneration.
16. **Non-project Vehicle Commuting:** traffic accidents in which project workers, using non-project vehicles, are involved while travelling to (i) the worker's principal or secondary residence; (ii) the place where the worker usually takes his or her meals; or (iii) the place where he or she usually receives his or her remuneration.
17. **Vehicle Traffic Accident (Members of Public Only):** traffic accidents in which non-project workers/members of the public are involved in an accident while travelling for any purpose.

1.3 Appendix L3: Incident Investigation

Investigating Incidents

This paper advises on the approach for investigating health and safety incidents (for example, incidents that do not involve allegations of SEA/SH or discrimination based on SOGI[1]) on a construction site.

It summarizes the main steps for securing a site immediately following an incident, and sets out the an approach for investigating the incident to ensure the causes are identified and relevant remedial actions identified to minimize the chances of recurrence.

Securing the site following an incident

Immediately following an incident, the emergency or incident response plan (often part of the Contractor's Environmental and Social Management Plan) should be followed, and the site secured to ensure no further harm is caused. As necessary a regulatory authority such as the Police, Occupational Safety and Health Authority (OSHA), or Environmental Protection Agency (EPA) should be informed and any instructions they provide followed.

While securing the site, it is important that information that may assist in understanding the cause of the incident is not removed, damaged, or lost (unless necessary to prevent further harm from occurring). Securing the site is the first opportunity for understanding what has happened and for gathering information that will subsequently prove useful to the investigation, and therefore while securing the site, evidence should be preserved, and records should be collected to assist the subsequent investigation.

The records to be collected should include:

- incident description and details, including the nature and extent of any injury, damage or harm;
- a sketch or drawing and photographs of the incident site, showing any property, tools, equipment or machinery involved, and of the relative position of these to the incident;
- details (including serial numbers and maintenance tags) of the tools/machinery/equipment involved in the incident, and of that within the vicinity of the incident;
- details of the environmental conditions at the time of the incident and the site conditions, including weather conditions, site cleanliness and ground conditions;
- descriptions of the works being undertaken at the time of the incident, and of the works being undertaken in the general vicinity;
- method statements for the tasks being undertaken at the time of the incident;
- names and job titles of the personnel involved and of the personnel in the vicinity of the incident;
- details of the health and safety trainings and discussions (e.g., tool box talks) held with relevant work crews that day;
- names of witnesses, including those from community;
- details of the steps taken to safeguard conditions at the site.

[1] Incidents that involve allegations of SEA/SH or discrimination on the basis of SOGI should be managed in accordance with the advice within the relevant Good Practice Notes or other Bank guidance.

Approach to the Investigation

The investigation should be initiated as soon as possible following the incident to ensure information is fresh and available (i.e. people and teams concerned are still on site, memories are accurate, the site reflects the conditions prevalent at the time of the incident and has not been corrupted by subsequent actions or activity). The investigation should be independent of any official investigation undertaken into an incident by a regulatory authority[2], although it may be assisted by review of any regulatory authority report that is available.

Qualifications of Investigators

The investigation may be carried out by project staff (e.g., a member of the Contractor or Supervising Engineer teams) who have the appropriate qualifications and experience to undertake a suitable investigation, or by an independent consultant specifically commissioned, for example where the suitably qualified personnel are directly involved in the incident, or where specialist knowledge of equipment or safe working methods is required. Appropriate qualifications for an investigator include familiarity with the subject of the incident, familiarity with the nature of the works being undertaken, adequate experience (reflective of the severity of the incident) of investigating similar incidents, familiarity with the country/region, and availability to carry out the investigation quickly. Consideration should also be given to the scale, severity and complexity of the incident when considering who is needed to undertake an objective, unbiased and robust investigation.

Scope of the Investigation

The scope of the investigation should be proportionate to scale, severity and complexity of the incident.

The investigation should focus on the program (and not on behaviors), and on the causes (not on attributing blame or fault). Except in the unlikely event of malicious or deliberate violation or sabotage of the workplace, the root causes of an incident usually trace back to the failures of the systems used to identify and manage hazards. For example, it should not be assumed that carelessness or failure to follow a procedure alone was the reason why the incident occurred; in this case the investigation should be adequate to identify the changes that are needed to the system to minimize the chances of carelessness or failure to follow a procedure occurring in the future.

The investigation should identify the:

- **immediate causes**: the agent of the injury or adverse impact (e.g. collapsed trench, reversing vehicle, oil spill);
- **underlying causes**: unsafe acts and unsafe conditions that have allowed undetected unsafe practices to persist in the past (e.g. soil conditions not assessed/trench shoring not used, reversing alarms not working/no banksman in place, oil barrels stacked/stores not bunded); and
- **root causes**: the design, planning and organization of the work, and/or operational system failures from which all other failings grow (e.g. excavation method statement omitted regular ground condition inspection, absence of procedure for vehicle inspections prior to use, lack of training in management of hazardous materials/absence of equipment for storage of hazardous

[2] A regulatory authority's investigation will be focused on whether the regulatory framework has been applied appropriately, whereas the project investigation will be focused on the project systems and procedures.

materials, failure to identify training needs and assess competence, low priority given to risk assessment and management etc.).

A successful incident investigation will discover the root causes: an investigation focused on finding fault is likely to stop at the immediate or underlying cause, without discovering the root cause and what can be done to prevent the incident occurring again. The main goal of the investigation is to identify the risk control measures that were inadequate, unused or missing; why the management, design, planning, organizational and/or operational systems failed to prevent the incident from occurring.

Finding the root causes may require persistent questioning as to 'why' something occurred. For example:

- 'why' a worker did not follow procedures maybe because the worker:
  - ✓ was not aware of the procedure;
  - ✓ was in a hurry and under pressure to complete the task; or
  - ✓ did not have the correct equipment.
- 'why' the worker was not aware of the procedure maybe because:
  - ✓ they had not received training in this activity;
  - ✓ there had been no pre-works briefing; or
  - ✓ the incorrect method statement had been provided to the foreman.
- 'why' they had not received training maybe because:
  - ✓ they were not present on the day that the specific training had been given;
  - ✓ no checks of workers training records are taken prior to the start of shifts; or
  - ✓ the method statement for the works did not require the training to have been taken
- 'why' they were not present on the day the training was given maybe because:
  - ✓ the training had not been repeated;
  - ✓ the worker was a temporary employee; or
  - ✓ there was no requirement for workers to attend trainings.
- 'why' the training had not been repeated maybe because:
  - ✓ training records were not kept;
  - ✓ training program is not linked to the works program; or
  - ✓ the budget for training is inadequate for it to be repeated.

The questions listed below are examples of inquiries that an investigator may pursue to identify contributing factors that, in turn, can assist in identifying the root causes:

- If a procedure or process was not followed, why not? Was the procedure out of date or safety training inadequate? Was there anything encouraging deviation from job procedures such as incentives or speed of completion? Was the activity time sensitive and had it been planned properly? What was the prevailing work culture and why?
- Was the machinery or equipment damaged or missing parts (such as safety guards) or did it fail to operate properly? If so, why? Does the system require maintenance in accordance with manufacturers requirements, and workers to undertake checks immediately prior to using equipment?
- Was necessary emergency equipment present for the hazards encountered while undertaking a task? Was it accessible and in good condition? Had the need for emergency equipment been identified in method statement and was someone present who was trained in its use?

The causes of an incident are rarely the result of a single action, and more usually a result of a combination of job, organization, equipment or human factors and possibly human failings (e.g. lapse of memory, error of judgement, or violation of rules). Understanding the causes of the incident may therefore be assisted by understanding the contribution of these factors. The following table illustrates the different factors that may contribute to the cause of an incident.

Job Factors	Organisation Factors
- Insufficient attention given to the task - Divided attention or distractions - Inadequate procedures - Time availability to complete the task	- Work pressure, long working hours - Availability of resources - Quality of supervision - Safety culture
Equipment Factors	**Human Factors**
- Presence of necessary equipment in working condition - Clear and simple instructions and controls	- Physical ability for the task - Competence (knowledge, skills, experience) - Fatigue, stress, morale, alcohol, drugs

Corrective Actions

Based on the understanding of the immediate, underlying and root causes of the incident and the contributing factors, the investigation should recommend remedial actions to prevent recurrence of the incident. These should include any changes in management systems, knowledge or equipment needed to control the risks, and should be specific, measurable, actionable by the project, realistic and timebound.

Note that corrective actions may be of limited preventive value if they do not address the root causes of the incident and superficial conclusions such as 'the worker should have used common sense' with corresponding weak corrective actions such as 'workers must remember to use the provided equipment' are unlikely to prevent future incidents.

Further Advice on Conducting Investigations

Further advice on investigating incidents can be found in:

Investigating accidents and incidents – A Workbook for employers, unions, safety representatives and safety professionals. Health and Safety Executive 2004.

Incident [Accident] Investigations: A guide for Employers – A Systems Approach to Help Prevent Injuries and Illnesses. OSHA 2015.

Root Cause Analysis for Beginners. James J rooney and Lee N. Vanden Heuvel. 2004.

Investigation of Occupation Accidents and Diseases – A Practice Guide for Labour Inspectors. ILO. 2015.

Learning the Lessons – How to respond to deaths at work and other serious incidents. IOSH. 2015

Incident Investigation – Learning from the past to Change the Future. Phillip Byard, Intersafe. 2013

The Ultimate Accident Investigator's Guide. Steve Geigle, OSHAcademy. 2016

1.4 **Appendix L4: Incident Forms**

B1: Incident Details			
Date of Incident:	**Time:**	**Date Reported to PIU:**	**Date Reported to WB:**
Reported to PIU by:	**Reported to WB by**:	**Notification Type**: Email/'phone call/media notice/other	
Full Name of Main Contractor:		**Full Name of Subcontractor**:	

B2: Type of incident (please check all that apply)[1]
Fatality ☐ Lost Time Injury ☐ Displacement Without Due Process ☐ Child Labor ☐ Acts of Violence/Protest ☐ Disease Outbreaks ☐ Forced Labor ☐ Unexpected Impacts on heritage resources ☐ Unexpected impacts on biodiversity resources ☐ Environmental pollution incident ☐ Dam failure ☐ Other ☐

[1]See Annex 1 for definitions

B3: Description/Narrative of Incident
Please replace text in italics with brief description, noting for example: *I. What is the incident?* *II. What were the conditions or circumstances under which the incident occurred (if known)?* *III. Are the basic facts of the incident clear and uncontested, or are there conflicting versions? What are those versions?* *IV. Is the incident still ongoing or is it contained?* *V. Have any relevant authorities been informed?*

B4: Actions taken to contain the incident			
Short Description of Action	**Responsible Party**	**Expected Date**	**Status**
For incidents involving a contractor: Have the works been suspended (for example, under GCC8.9 of Works Contract)? Yes ☐; No ☐; Trading name of Contractor (if different from B1): Please attach a copy of the instruction suspending the works.			

B5: What support has been provided to affected people

Appendix T: Approved RAP Report for Matanda Dam Site

The Matanda Dam Rap report was prepared and cleared for disclose by the WorldBank via link
https://www.mwe.go.ug/library/matanda-dam-sectional-rap
The RAP will be shared as an independent appendix.

Appendix U: Vulnerable and Marginalized Groups Framework (VMGF)

Note: The VMGF is presented and will be disclosed separately.

Appendix U: Biodervisity Action Plan

Introduction

The Biodiversity Action Plan (BAP) has been prepared to achieve no net loss of biodiversity in known natural habitats and net gain for species that trigger Critical Habitat by following the mitigation hierarchy, ensuring that the biodiversity is protected, enhanced and where possible implementing offsets undertaken.

This BAP provides the objectives, justification, the roles and responsibilities of key stakeholders and the budget estimates for biodiversity management during construction of the Matanda Irrigation Scheme. The Contractors will prepare specific Biodiversity Management Plans prior to commencement of works.

Objectives

The **objectives** of the BAP are to:

● Review existing biodiversity baseline information and legislative/policy frameworks for the study area and identify gaps.
● Implement a consultation process with relevant stakeholders and biodiversity experts to inform priorities and actions for biodiversity conservation.
● Identify priorities and actions for biodiversity conservation, in consultation with stakeholders and biodiversity experts.
● Establish a monitoring and evaluation programme for biodiversity allowing for the success of the BAP interventions to be assessed.

Justification

The biodiversity assessment report showed that the project area of influence is rich in biodiversity. This BAP will be implemented to ensure that ICRP project activities avoid, mimimize and mitigate loss of biodiversity resources and habitats in the project area.

Scope
This BAP will cover the Matanda Irrigation Dam Site and Reservoir, the command area and the material borrow sites. It will be implemented during the construction and the defects liability phase of the project.

Roles and Responsibilities of key stakeholders under the BAP

S.N	Stakeholder	Role
1	Ministry of Water and Environment	Coordinate the implementation of the BAP during project implementation Fund some aspects of the BAP e.g. Catchment management and restoration
2	Uganda Wildlife Authority	Protect wildlife in Queen Elizabeth National Park and neighbouring communities Sensitization of workers and communities on wildlife conservation Implement benefit sharing projects with communities Resolve human-wildlife conflicts Establish and maintain the electric fence between QENP and the neighbouring communities Rescue for stray wild animals Enforce provisions of the Uganda Wildlife Act during the construction

3	Kanungu District Local Government	Sensitize communities and contractors workers on biodiversity conservation Implement benefit sharing projects with UWA Enforce the provisions of the Local Government Act and National Environment Act within Kanungu DLG
4	Contractor	Prepares the Contractors Environmental and Social Management Plan (C-ESMP) with a specific Biodiversity Management Plan Implements the Contractors Biodiversity Management Plan Compliance with policy, legal, regulatory framework and the World Bank policies related to biodiversity management Train personnel on biodiversity management Allocate resources for biodiversity management Monitor and report biodiversity management activities at construction sites and approved material sources.
5	Engineer	Enforce the C-ESMP Monitors and reports compliance of the contractor to biodiversity management requirements of the project.

Budget for the BAP

S.N	**Activity**	**Amount (USD)**	**Source of Funds**
1	Community sensitization	20,000	MWE, UWA, Kanungu DLG and Contractor
2	Biodiversity rescue (aquatic biodiversity resources at the dam site)	25,000	Contractor
3	Habitat restoration/regreening of construction and material borrow sites	100,000	Contractor
4	Training of site workers on biodiversity conservation	15,000	Contractor
5	Catchment management and restoration sub-projects	1,000,000	ICRP, MWE
6	**Total**	**1,160,000**	