



THE REPUBLIC OF UGANDA

**Ministry of Water and Environment
Directorate of Water Resources Management
Victoria Water Management Zone**

RWIZI CATCHMENT MANAGEMENT PLAN



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PLAN**

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Directorate of Water Resources Management

Ministry of Water and Environment

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FOREWORD



Water resources support key sectors of the economy namely hydropower generation, agriculture, fisheries, domestic water supply, industry, navigation, etc. However, efficiency and sustainability of intervention under these sectors has recently been a concern in Uganda mainly due to inadequate sectoral collaboration in planning and implementation, increasing frequency of floods and droughts, environmental degradation and pollution of water resources. This situation therefore calls for development of mechanisms for promoting integrated planning, development and management of water resources so as to create synergy among various sectors, promote efficiency in utilization of available resources, reduce water and environment degradation and ensure more efficient utilization of water resources to meet various social and economic demand.

In 2011, my Ministry embarked on preparation of Catchment Management Plans (CMPs) as tools for ensuring equitable access to, and use of water resources, and safeguard of key natural resources for sustainable socio-economic development of the country.

A CMP provides a long-term strategy for sustainable development and utilization of water and related water resources. Catchment based water resources planning and management is in line with the integrated Water Resources Management (IWRM) paradigm, which ensures that land, water and related resources are developed and managed in a coordinated manner without compromising sustainability of vital ecosystems. As a lead agency for implementing Catchment based Water Resources Management (CbWRM) in Uganda, my Ministry through the Directorate of Water Resources Management is operationalizing the CbWRM framework through the four Water Management Zones of Albert, Kyoga, Upper Nile and Victoria WMZ.

In order to develop this CMP, a number of studies were undertaken which included an assessment of the existing catchment knowledge base, the current and projected water resources situation, the catchment's social and environmental assessment, and stakeholder engagement. The CMP identifies critical issues, challenges, opportunities, and threats within the catchment which need to be addressed to ensure the economic development of the people.

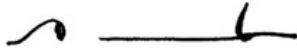
Guided by the key issues, challenges, threats, opportunities, key water resources planning principles and national strategies, the stakeholders developed a vision for the catchment. To achieve the vision, stakeholders came up with a number of strategic objectives, options and actions that need to be perused in the short, medium and long-term up to the year 2040.

Preparation of Rwizi CMP was initiated in 2013 following the Uganda Catchment Planning Guidelines. Over the years, stakeholders of Rwizi Catchment have made valuable contributions during meetings, fieldwork campaigns, piloting ideas, and stakeholder engagement workshops within the catchment that have contributed to the improvement and finalization of the plan. In 2020, the Rwizi CMP has been updated to include aspects of climate change.

My Ministry is therefore pleased to formally make this CMP available for use by various stakeholders. It will enormously help and guide all developers and users of water and related resources at the national and local levels. I therefore wish to call upon all the relevant government ministries and agencies at both national and local levels, the civil society, private sector, academia and research institutions, cultural institutions, religious institutions and the local communities to utilize this plan in order to optimally plan for the development and management of water and related resources for prosperity.

In line with the provisions of Section 5 of the Water Act Cap 152, I formally approve this Catchment Management Plan for use by various stakeholders.

For God and My Country.



Hon. Sam Cheptoris

MINISTER OF WATER AND ENVIRONMENT

THE REPUBLIC OF UGANDA

ACKNOWLEDGEMENTS



I would like to thank the Directorate of Water Resources Management for spearheading the preparing of Catchment Management Plans in Uganda. This is a stakeholder driven process that is key in ensuring that water resources are effectively planned for and sustainably developed and managed so as to support the achievement of the country's vision 2040.

Special thanks go to all the stakeholders at the national, regional and local levels for their active participation and involvement in preparation of this plan. Special appreciation goes to Victoria Water Management Zone for coordinating the plan preparation process and the Rwizi Catchment Management Organization through the Rwizi Catchment Management Committee for ensuring that the plan is stakeholders' driven and addresses

the needs of the people in the catchment.

Finally, I wish to thank the Danish and Austrian Governments for providing funds that enabled preparation of the initial draft of the Rwizi CMP in 2013. I also wish to thank Advocates Coalition for Development and Environment (ACODE) and Green Economy Coalition (GEC) for providing funds that facilitated the review, finalization of the CMP in 2020. All the support that led to the preparation and production of this plan is therefore appreciated.



Alfred Okot Okidi
PERMANENT SECRETARY

EXECUTIVE SUMMARY

Rwizi catchment is one of the four catchments in Victoria Water Management Zone (VWMZ) located in the South-Western Uganda. The other catchments are Maziba, Katonga and Northern Shores. Rwizi catchment has a total area of 8,554.7 km² (as provided by the State of Water Resources Basin Report for Victoria Water Management Zone, MWE, 2017) spanning over twelve districts of Buhweju, Bushenyi, Sheema, Ntungamo, Mbarara, Rwampara, Isingiro, Kiruhura, Lyantonde, Lwengo, Rakai and Kyotera with its waters draining into Lake Victoria. Within the catchment, there are over 1.4 million people that depend on the water resources therein.

Rwizi is the main river, originating from the hills in Buhweju. It has a series of tributaries joining it, flowing in a southerly direction, finally discharging its waters into Lake Victoria. Rwizi catchment has been subdivided into six sub-catchments of (i) Upper Rwizi covering the districts of Buhweju, Bushenyi, Sheema, part of Mbarara and part of Isingiro; (ii) Middle Rwizi covering part of Isingiro, Ntungamo, Rwampara, and part of Kiruhura districts; (iii) Kashara river covering part of Kiruhura and a small fraction of Mbarara district; (iv) Lake Kacheera covering part of Kiruhura, part of Lyantonde, part of Lwengo and part of Rakai district; (v) Bukora river covering part of Lwengo and part of Rakai district; and (vi) Kisoma river covering majorly Rakai and Kyotera districts.

Rwizi catchment is partly flat and sloppy with an average elevation of 1,517m.a.s.l, standing at 1,262m.a.s.l. at the outlet (Lake Victoria) and 2,168m.a.s.l. at the very northern part of the catchment (within Buhweju District).

It is characterized by two wet seasons between March to May (with maximum rainfall in April) and between October to December (with maximum rainfall in November), rainfall distribution ranges between 700mm/year in Kashara River and Lake Kachera sub-catchments (with the lowest) to 1,300 mm/year in the Upper Rwizi sub-catchment (with the highest). Dry months are those of July to August and January to February each year.

Rainfall received in the catchment is sufficient to provide the water requirements in the catchment since total annual surface water flow is estimated at 1,386 million cubic meters against an estimated total annual demand (Year 2020) of 55 million cubic meters.

The land use/cover within the catchment is predominantly subsistence farmland (including animal raring). The grazing lands and the banana plantations cover 53% and 21% respectively of the total land area. Major land use changes are associated with croplands, banana plantations and grazing lands.

Rwizi catchment has protected areas including a number of National Parks, Wildlife Reserves, Ramsar Sites and Forest Reserves harboring a diversity of fauna and flora. The upper catchment has Mbarara and Kyahi Central Forest Reserves found in the districts of Mbarara and Isingiro respectively. In the mid catchment, specifically in the districts of Kiruhura and Isingiro we have L. Mburo National Park and L. Mburo-Nakivali Ramsar Site, the mid catchment Kijanebarola and Kyamazzi Central Forest Reserves in Rakai district among others.

The Water Resources Assessment Report for the Victoria Water Management Zone (2017) describes the Rwizi catchment as being degraded by runoff, deforestation and forest degradation, encroachment on wetlands, sand mining, brick making, overgrazing and poor agricultural practices. The report further indicates that there is increasing pressure on available water resources due to population increase, industrial growth, urbanization and increasing growth in irrigated agriculture, factors which require substantial quantities of water to be sustained. Sustaining water resources requires comprehensive planning and requisite investment.

As such, in 2017, the Directorate of Water Resources Management (DWRM) embarked on a process to develop the Rwizi Catchment Management Plan (CMP) in a bid to operationalize both Catchment-

based Water Resources Management (CbWRM) as well as Integrated Water Resources Management (IWRM) in Rwizi Catchment. The process has been participatory in nature and guided by the Catchment Management Planning Guidelines developed by the Ministry of Water and Environment.

The CMP contributes to the vision for the catchment as agreed by the stakeholders in line with the Uganda Vision 2040: “A sustainable, beautiful Rwizi Catchment environment for better livelihoods”. In order to achieve this common vision, the CMP addresses the following strategic objectives which were formulated by the stakeholders:

1. To ensure sustainable access to water of adequate quality and quantity for domestic use and production.
2. To ensure that farming, animal husbandry systems and industrial establishments are productive, drought and climate resilient, and improve household incomes.
3. To restore degraded natural resources.
4. To strengthen natural resources management systems and structures.

Rwizi Catchment Management Plan aims at implementing interventions that will showcase benefits of Integrated Water Resources Management (IWRM) and development at catchment level. These include (i) Strengthening the Catchment Management Organization, (ii) investing in ecosystem restoration, (iii) investing in water and sanitation (and related infrastructure), (iv) investing in economic development including investments in income generating activities for livelihood improvement, infrastructure development and green economy investments aimed at achieving sustainable development whilst combating poverty.

Investments in institutional strengthening of the catchment management organization will require UGX 3.98 Billion, ecosystem protection and restoration will require UGX 35.5 Billion, investments in water and sanitation will require UGX 73.1 Billion while investments in agriculture, livelihoods improvement and economic development will require approximately UGX 3.1 Billion. The overall investment to deliver this plan is approximately UGX 115.7 Billion requiring an additional UGX 6.4 Billion per year for operation and maintenance over a period of 10 years.

Implementation of interventions in the CMP will assist in laying the foundation for the sustainability of future investments at catchment level through coordinated multi-sectoral water resources management and development. Successful implementation of the CMP will deliver four key water uses to stakeholders in the catchment. These are:

- a. Water for people - through water supply and wastewater treatment and disposal;
- b. Water for food - through development of irrigation infrastructure, livestock watering, and post-harvest handling and processing, among others;
- c. Water for nature - through demonstrated increase in quality, quantity and distribution of water for healthy ecosystems in the catchment; and,
- d. Water for other uses - including energy through hydropower production, navigation, tourism, fisheries, drainage and flood management, industry and the entire blue economy thinking.

It is hoped that this will address concerns by catchment stakeholders over high drought conditions; increased water demand for different uses; water pollution; impacts of climate change and variability; critical dependency on natural resources and wetlands encroachment for increased agricultural production. In addition, it will resolve threats, pressure and impacts associated with loss of vegetation cover, soil erosion and siltation of lakes and rivers, reduction in water levels impacting on water availability; nutrient enrichment and eutrophication; disease risks through poor waste disposal; loss of current livelihoods due to water stress and increased conflicts from limited water access. It is for

this reason that the Catchment Management Plan recommends:

1. Prioritizing water resources management and developing plans to address the identified threats, pressures, and impacts associated with developments in the catchment.
2. Improving law enforcement and surveillance and developing zero tolerance management approaches to non-compliance, insisting on adherence to environmental and social impact management plans by developers.
3. Developing restoration plans for the bare hills, wetlands, riverbanks and agricultural landscapes in the catchment, in collaboration with the landowners, emphasizing the business perspective of ecosystem restoration.
4. Inviting different categories of stakeholders to provide technical and financial support through integration of water resource management concerns into their program activities and taking part in joint implementation.
5. Identifying and engaging potential partners to collaborate with to advance the catchment management plan for the Rwizi Catchment.
6. Exploring innovative funding sources, options, and mechanisms to support implementation of the catchment-based approaches.
7. Prioritizing implementation actions at identified hotspot areas especially those related to controlling soil erosion, restoration of bare hills and restoration of wetlands.

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ACRONYMS AND ABBREVIATIONS

ACODE	Advocates Coalition for Development and Environment
ACORD	Agency for Cooperation and Research in Development
Asl	Above Sea Level
ASM	Artisanal and small-scale mining
BOD	Biochemical Oxygen Demand
CAO	Chief Administrative Officer
CBO	Community Based Organization
CbWRM	Catchment Based Water Resources Management
CCU	Climate Change Unit
CFM	Collaborative Forest Management
Cm	Centimetre
CMO	Catchment Management Organization
CMP	Catchment Management Plan
CMS	Catchment Management Secretariat
CSF	Catchment Stakeholder Forum
CSO	Civil Society Organisation
CTC	Catchment Technical Committee
DDP	District Development Plans
DEA	Directorate of Environmental Affairs
DfID	Department for International Development
DPO	District Production Officer
DRAW	District Rapid Appraisal of Wetlands
DWD	Directorate of Water Development
DWO	District Water Officer
DWRM	Directorate of Water Resources Management
DWSSC	District Water and Sanitation Coordination Committee
FAO	Food and Agricultural Organisation
FEWS	Flood Early Warning System
FSSD	Forestry Sector Support Department
GFS	Gravity Flow Scheme

GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoU	Government of Uganda
GW	Ground Water
ha	Hectare
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
km ²	Square Kilometre
l	Litre
LC	Local Council
LLG	Lower Local Government
LVEMP	Lake Victoria Environmental Management Project
M&E	Monitoring and Evaluation
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
masl	Metres Above Sea Level
MCM	Million Cubic Metre
MEMD	Ministry of Energy and Mineral Development
MLG	Ministry of Local Government
Mm	Millimetre
MM ³	Million cubic meters
MOFED	Ministry of Finance, Planning and Economic Development
MOH	Ministry of Health
MoU	Memorandum of Understanding
Mt	Metric ton
MTTI	Ministry of Tourism, Trade and Industry
MWE	Ministry of Water and Environment
MWLE	Ministry of Water and Environment
MWT	Ministry of Works and Transport
NAADS	National Agricultural Advisory Services
NaFORRI	National Forestry Resources Research Institute
NEMA	National Environmental Management Authority
NFA	National Forest Authority

NGO	Non-Governmental Organization
NWRA	National Water Resources Assessment
NWSC	National Water and Sewerage Corporation
O&M	Operation & Maintenance
OPM	Office of the Prime Minister
PPP	Public Private Partnership
PRA	Participatory Rural Appraisals
RDC	Resident District Commissioner
RUG	Resource User Groups
SME	Small and Medium Enterprises
SSEA	Strategic Social and Environmental Assessment
SW	Surface Water
SWOT	Strength, Weaknesses, Opportunities and Threats
TLU	Tropical Livestock Unit
TOR	Terms of Reference
TSU	Technical Support Unit
UBOS	Uganda Bureau of Statistics
UGX	Ugandan Shilling
UNMA	Uganda National Meteorological Authority
UNRA	Uganda National Roads Authority
UOs	Umbrella Organisation
UWA	Ugandan Wildlife Authority
UWASNET	Uganda Water and Sanitation NGO Network
VSLA	Village Saving and Loan Association
VWMZ	Victoria Water Management Zone
WAP	Water Action Plan
WASH	Water, Sanitation and Hygiene
WfP	Water for Production
WMD	Wetlands Management Department
WMZ	Water Management Zone
WRA	Water Resources Assessment
WRSA	Water Risk and Sustainability Assessment

WSDF	Water Sector Development Facility
WSS	Water Supply Scheme
WSSBs	Water Supply and Sanitation Boards
WUC	Water Users Committee
WWF	World Wide Fund for Nature
yr	Year

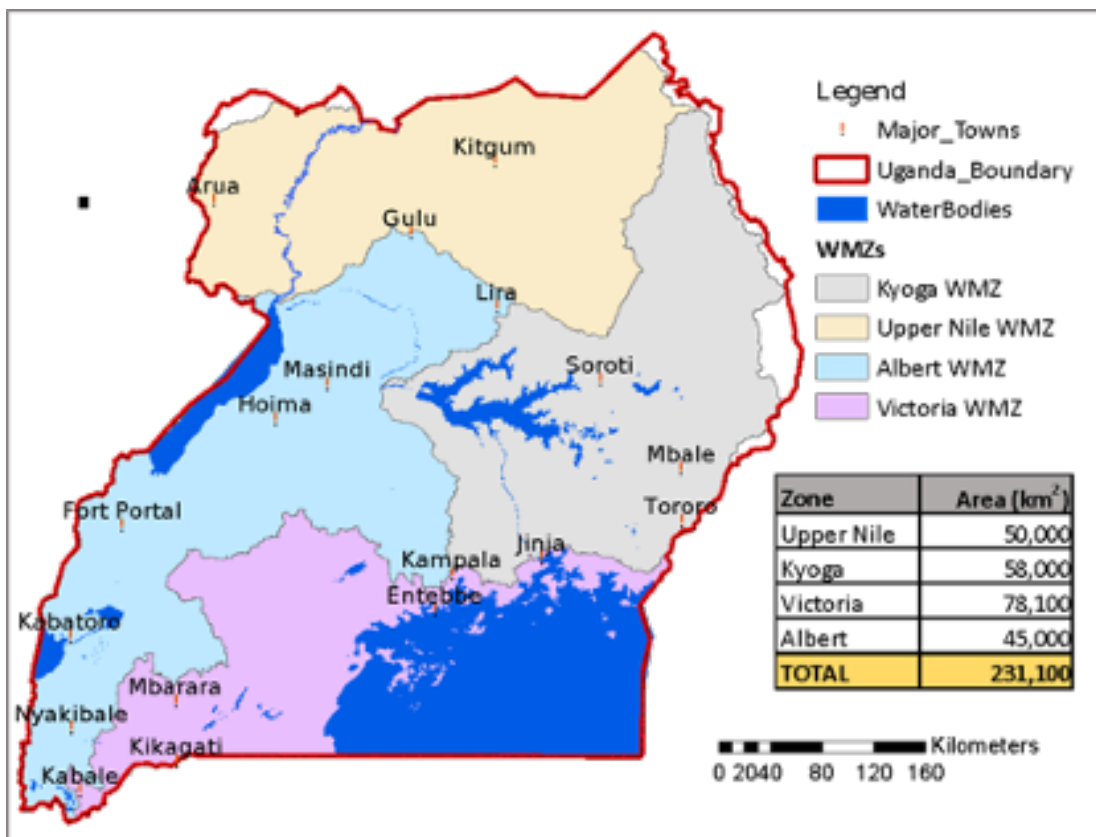
1. INTRODUCTION

1.1 BACKGROUND TO CATCHMENT MANAGEMENT PLANNING

The Ministry of Water and Environment (MWE) through its Directorate of Water Resource Management (DWRM) is implementing Catchment-based Water Resources Management (CbWRM) as part of its water resources management reforms completed in 2005. CbWRM places stakeholders at the center of developing and managing water and related resources in their area; it allows stakeholders to plan towards managing water and related resources (e.g., land, ecosystems, and socio-economic systems) in an integrated way, considering the different needs and interests, to achieve long-term sustainable development¹. CbWRM is based on the principle of Integrated Water Resources Management (IWRM)², which embraces a holistic approach to water resources.

The country has been divided into four Water Management Zones (WMZs), namely: Upper Nile, Albert, Victoria and Kyoga (Figure 1). Within each WMZ, are smaller hydrological units called catchments, which are further delineated into sub and micro catchments.

Figure 1: Water Management Zones



(Source: MWE, 2019)³

Rwizi catchment is one of 3 catchments in Victoria Water Management Zone (VWMZ); the other catchments being Kagera (part of which is in Rwanda, Katonga, the North shores and Sio (Figure 2). Rwizi catchment covers the districts of Mbarara, Sheema, Bushenyi, Buhweju, Kiruhura, Isingiro,

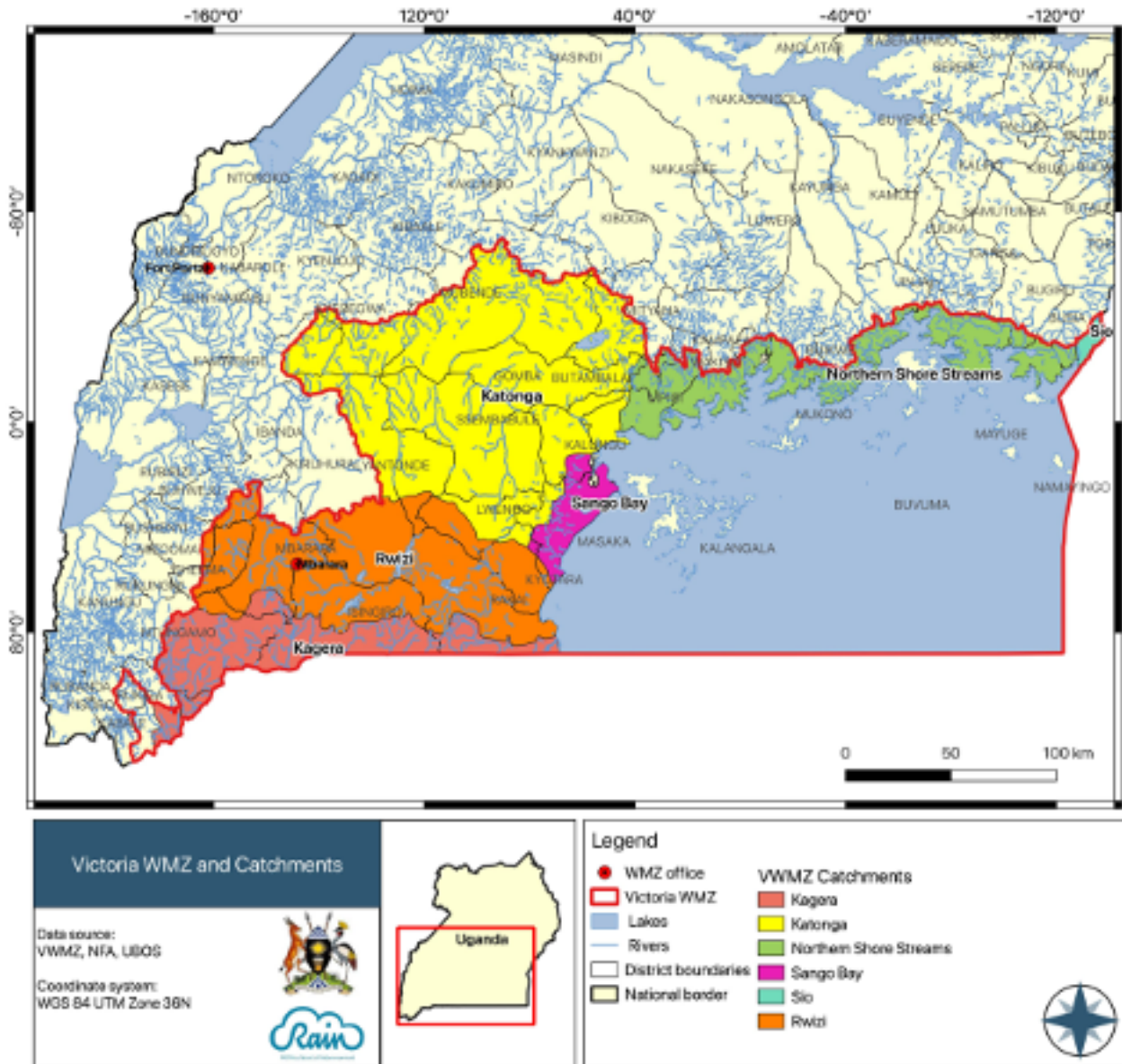
1 Catchment Management Organisations (CMO) procedures Manual 2019

2 IWRM is defined by Global Water Partnership as a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment.

3 Uganda Catchment Management Planning Guidelines 2019

Ntungamo, Kyotera, Lwengo, Lyantonde and Rakai. The catchment provides water resources for approximately 1.4 million people in South Western Uganda (MWE, 2019).

Figure 2: Catchments in Victoria WMZ

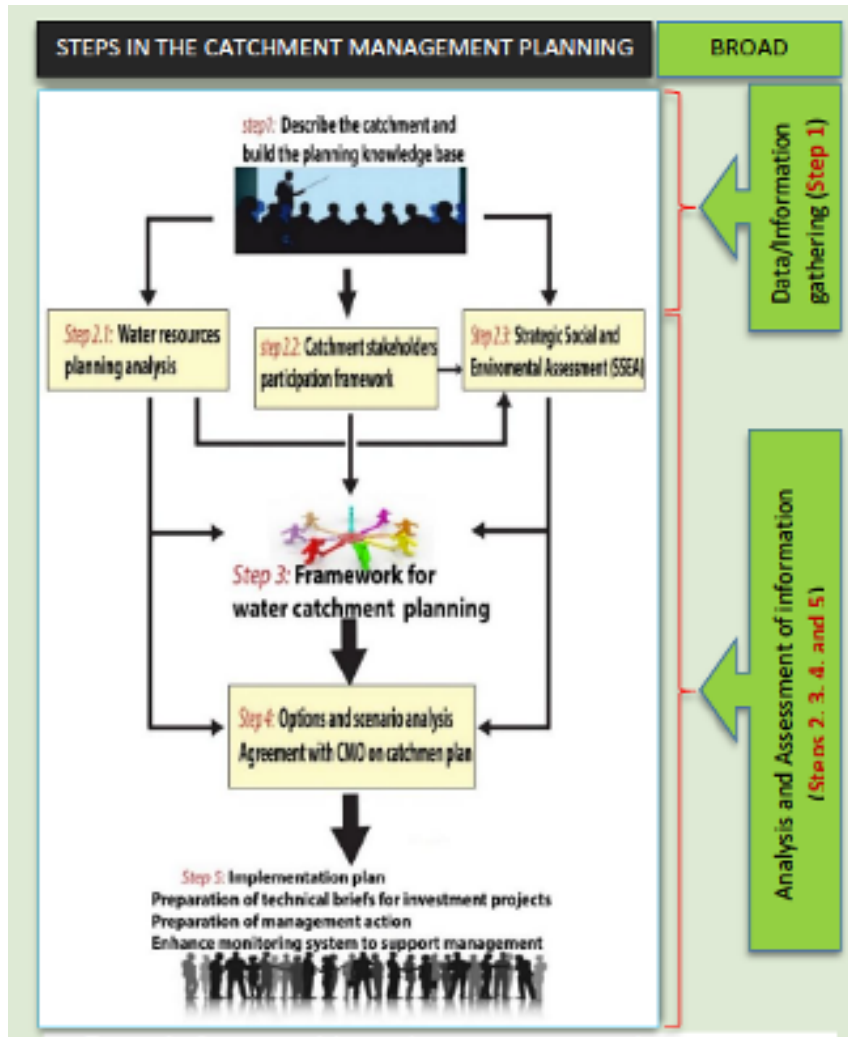


Within the catchment, there is increasing pressure on available water resources due to population increase, industrial growth, urbanization and increasing growth in irrigated agriculture, factors which require substantial quantities of water to be sustained. Sustaining water resources requires comprehensive planning and requisite investment.

1.2 DEVELOPING THE RWIZI CATCHMENT MANAGEMENT PLAN

In 2015, DWRM embarked on a process to develop the Rwizi Catchment Management Plan (CMP) through a participatory process guided by the Catchment Management Planning Guidelines (Figure 3). This CMP is intended to address the problems of protecting, conserving and managing the natural systems, taking into account the social and economic system by a) development of water for economic and social development; b) protection of the resource base that supports these economic and social benefits; and c) conservation of the catchment's resources.

Figure 3: Catchment management planning process according to the Guidelines (MWE, 2019)



1.3 PURPOSE OF THE CATCHMENT MANAGEMENT PLAN

Rwizi Catchment Management Plan aims at implementing interventions that will showcase benefits of integrated water resources management and development at catchment level. These include ecosystem restoration investments, up-front infrastructure investments (urban and rural water supply and sanitation, irrigation infrastructure services through expansion/development of gravity flow schemes and catchment/water sources restoration measures) and green economy investments aimed at achieving sustainable development whilst combating poverty. Implementation of various water resources management and development interventions in the CMP will assist in laying the foundation for the sustainability of future investments at catchment level through coordinated multi-sectoral water resources management and development interventions.

Successful implementation of the CMP will deliver four key water uses to stakeholders in the catchment. These are:

- a. Water for people -addressing water supply and wastewater treatment and disposal;
- b. Water for food - through development of irrigation infrastructure, livestock watering, post-harvest processing, industrial processing among others;

- c. Water for nature - with demonstrated increased in quality, quantity and distribution for healthy ecosystems in the catchment supporting all forms of life; and,
- d. Water for other uses - including energy through hydropower production, navigation, tourism, fisheries, drainage and flood management, and the entire green/blue economy thinking.

2. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK FOR WATER RESOURCES MANAGEMENT

Uganda adheres to a number of international conventions and frameworks guiding water resources management that is relevant to the Catchment Management Planning process in the Rwizi Catchment.

2.1 INTERNATIONAL AND REGIONAL FRAMEWORK

Uganda has ratified several international agreements that have a bearing on water resources management and sustenance of a healthy ecosystem. Relevant international and regional conventions, agreements, treaties and protocols that Uganda is signatory to and are relevant to catchment management plan for Rwizi Catchment are listed below:

- The Convention on Wetlands of International Importance, 1971 – that provides guidance on wetland management in the catchments,
- Convention Concerning the Protection of World and Cultural Heritage of 1972 – that guides the preservation of artifacts of cultural importance in the catchment.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 – that guides the protection of endangered species within in the catchment; with particular reference to the conservation efforts around Lake Mburo National Park.
- Convention on the Conservation of Migratory Species of Wild Animals, 1979 – considering the proximity of catchment to Lake Victoria that is shared between neighboring countries and therefore the potential for a number of species to go across borders.
- The Vienna Convention for the protection of the Ozone Layer, 1985 – which is important in as far as the climate change debate is concerned; and that Mbarara is growing into an industrial base with potential to emit greenhouse gases.
- The Montreal Protocol on Substances that deplete the Ozone layer, 1987 – which, similarly guides local dialogue on impacts of climate change
- Convention on Biological Diversity (CBD), 1992 – to which Uganda is signatory and guides the management of biodiversity whilst protecting the catchment from which rivers draw water.
- United Nations Framework Convention on Climate Change (UNFCCC), 1992 – based on which Uganda is preparing the climate change policy, the related investment plan, the legal frameworks and all the other commitments related to reduction of emissions.
- Kyoto Protocol to the United Nations Framework Convention, 1997
- United Nations Convention to combat Desertification (UNCCD), 1994
- The Lusaka Agreement, 1994
- The UN Convention on the Law of the Sea (UNCLS), 1982
- Bamako Convention on Transboundary Movement of Hazardous Wastes in Africa, 1991
- Technical Cooperation Committees for the promotion of resources Development and Environmental Protection of the Nile Basin of 1992
- The EAC Protocol on Environment and Natural Resources Management, 2006

- The Environmental Assessment Guidelines for Shared Ecosystems in East Africa, 2007

At regional level, Uganda is part of the Africa Water Vision 2025 that advocates for an equitable and sustainable water resources management. This has been a basis for the rollout of water policy reforms within the IWRM framework and the Rwizi Catchment Management Plan is crafted along these lines.

Since 1994, there have been significant reforms in policy, legal and institutional frameworks all of which aim to support catchment management planning. They all seek to address policy challenges related to water availability/supply and demand, ecosystem health, environmental safety and sustainable water resources management. The context within which the catchment management plan is developed and implemented is provided by the Constitution of the Republic of Uganda, national policies, national legislation and international conventions some of which are highlighted here under.

2.2 LAWS AND LEGISLATIONS

2.2.1 The Constitution of the Republic of Uganda (1995)

Uganda's constitution requires the state to adopt an integrated and coordinated planning approach to ensure balanced development between different regions of Uganda and the rural and urban areas, to protect important natural resources including land, water, wetlands, minerals, oil, fauna and flora, and endeavor to fulfill the fundamental rights of social justice and economic development of all Ugandans. The state is also required to further sustainable development and public awareness of the need to manage land, air, water resources, and natural resources in a balanced and sustainable manner for both current and future generations. Through this, the constitution provides the legal basis for Integrated Water Resource Management in Uganda.

Decentralization and devolution were formally adopted following the promulgation of the 1995 Constitution, and, for the first time, a clear distinction between Central and Local Governments' roles was provided. The mandate of Central Government is to set policy standards, supervise, inspect, coordinate, and monitor the Local Governments, while that of Local Governments is to provide a broad range of services⁴.

Article 178 of The Constitution provides that two or more districts may cooperate to form a regional government which shall be a corporate body (with powers to sue or be sued) having political, legislative, executive, administrative and cultural functions in the region. In a similar spirit, Section 8 of the Local Government Act, 2015, embraces collaboration on cultural and development issues between local governments. Among others, such a government would:

- develop and manage regional infrastructure for instance roads and hospitals but not those managed by national institutions;
- coordinate, monitor and supervise activities related to agriculture, forests (but not in national parks and wildlife reserves managed by government), cultural and traditional lands;
- promote water and sanitation; and
- perform functions and services surrendered voluntarily by district councils, however, such a government can impose tax only with approval of the central government.

2.2.2 The Water Act Cap 152 (1997)

Uganda's Water Act Cap 152 provides for the use, protection and management of water resources and supply; and facilitates the devolution of water supply and sewerage undertakings. Its objectives

⁴ Ministry of Local Government (2014). Decentralization and local development in Uganda. Accessed on 12/03/2020 at <https://www.ug.undp.org/content/dam/uganda/docs/UNDPUg2014%20-LOCAL%20GOVERNMENT%20HANDBOOK%202014.pdf>

are to:

- promote the rational management and use of the water resources of Uganda;
- promote the provision of a clean, safe and sufficient supply of water for domestic purposes;
- ensure appropriate development and use of water resources other than for domestic use, e.g. watering of stock, irrigation and agriculture, industrial, commercial and mining uses, generation of energy, navigation, fishing, preservation of flora and fauna and recreation in ways which minimize damage to the environment; and
- control pollution and promote the safe storage, treatment, discharge and disposal of waste, which may pollute water or otherwise harm the environment and human health.

The Act promotes the principles of IWRM and advocates for the involvement of all stakeholders in planning for the utilization, development and management of water resources. It addresses cross-sectoral interests in water resources and the (financial and technical) roles to be shared among stakeholders.

2.2.3 The National Water Policy (1999)

The National Water Policy gives the overarching policy framework which defines the government's policy objective as managing and developing the water resources of Uganda in an integrated and sustainable manner, in order to secure and provide water of adequate quantity and quality for all social and economic needs, with the full participation of all stakeholders. This policy, currently under review, is based on an IWRM framework.

The role of the central government's agencies is to guide and support local government as required, while the responsibility to provide water services and maintain facilities lies with local councils in districts and urban centres. Thus, the act emphasizes the shared responsibility among stakeholders, including the private sector and Non-Governmental Organisations (NGOs), in the development and management of water resources, and the regulation of human activities that pose potential risks to land and water resources.

2.2.4 The National Environment Management Policy (1994)

The National Environment Management Policy provides for environmental management in the country, in addition to provisions for regulating developments assumed to have impact on the environment (including impacts on water resources).

2.2.5 The National Environment Act (2019)

Section 3, subsection 2, places on every person the duty to create, maintain and enhance the environment, as well as to prevent pollution. Section 5 provides principles of environmental management:

- i. encouraging the participation by the people of Uganda, in the development of policies, plans and programmes for the management of the environment
- ii. providing for equitable, gender responsive and sustainable use of the environment and natural resources, including cultural and natural heritage, for the benefit of both present and future generations
- iii. maintaining stable functioning relations between the living and non-living parts of the environment through conserving biological diversity and by use of prudent environment management measures
- iv. ensuring optimum sustainable yield in the use of renewable natural resources
- v. ensuring that activities relating to extractive processes of renewable and non-renewable

natural resources are carried out in a sustainable manner

- vi. restoring lost or damaged ecosystems where possible and reversing the degradation of the environment and natural resources,
- vii. ensuring that adequate environmental protection standards are established and that effective monitoring of change in environmental quality is undertaken.

In addition, this law is supported by Environmental Regulations such as:

- The National Environment (Standards for Discharge of Effluents into Water or on Land) Regulations, SI 153-3
- The National Environment (Waste Management) Regulations, S 153-2
- The National Environment (Wetlands, Riverbanks and Lake Shores Management) Regulations, SI 153-5
- The National Environment (Hilly and Mountainous Areas Management) Regulations, SI 153-6

2.2.6 The Local Government Act 1997 [revised 2015]

The act gives local authorities the mandate to plan and implement development interventions according to local needs in water and sanitation. Section 8 of the Local Government Act provides that two or more district councils may cooperate (in accordance with article 178 of The Constitution) in areas of culture and development. The cooperating districts can establish joint institutions (e.g. councils, secretariats), trust funds, and appoint joint committees on matters of mutual interest.

2.2.7 Other relevant legal instruments

2.2.7.1 Laws

There are other legislations and sectors that cross-cut water management issues, that are taken into in Catchment Management Planning and harmonization of IWRM include:

- The Land Act Cap 227
- The Mining Act, 2003
- The Physical Planning Act, 2010
- The National Forestry and Tree Planting Act, 2003
- The Roads Act, Cap 358
- The Fish Act, Cap 197
- The Rivers Act Cap 357
- The Uganda Wildlife Act, Cap 200
- The Public Health Act, Cap 281
- The Occupational Safety and Health Act, 2006
- The Inland Water Transport (Control) Act Cap 356
- The Investment Code Act, Cap 92
- The Civil Aviation (Aerodromes) Regulations, 2007

2.2.7.2 Policies

The Uganda Gender Policy (2007) establishes a framework for the identification, implementation and coordination of interventions aiming at gender equality and the empowerment of women in Uganda. The policy tasks ministries to translate gender policy objectives into sector-specific strategies and activities.

The Uganda National Climate Change Policy (2015) calls for harmonization and coordination of all current and future efforts to address the impacts of climate change is a cross-sectoral approach. Due to climate change vulnerabilities and impacts in Rwizi, there is a strong need climate change concerns in the Rwizi CMP, focusing on all sectors of development.

The National Policy for the Conservation and Management of Wetland Resources (1995) guides the protection and conservation of wetlands as important catchment for water. The Rwizi catchment is richly endowed with wetlands requiring attention in this management plan.

The National Energy Policy (2002) guides the non-consumptive use of water for hydro-power production as well as biomass energy delivered from fuel wood. Within the catchment, there is potential for hydro-power production, but also high dependency on charcoal and firewood for energy is a challenge to water resources management.

The Uganda Wildlife Policy (2014) has provisions requiring the sustainable management of water resources for life in the wild, such as those in Lake Mburo National Park and the gazetted Ramsar sites.

The Uganda National Land Policy (2013) provides for sustainable land management approaches that do not compromise the ability of land to provide for environmental services including the regulation of water flows. Within the Rwizi Catchment, there are issues, concerns and challenges associated with landholding and these have to be addressed to have a sustainable River Rwizi catchment

The National Forestry Policy (2001) provides for the planting, growing and managing of forest and trees as part of a water secure catchment. The hilly areas of Upper, Middle and Lower Rwizi catchment are devoid of trees, forest reserves are heavily degraded and thus the need to address this concern.

Mining and Mineral Policy for Uganda (2018) guards against unsustainable use of heavy metals such as cyanide and mercury in the mining. In the Upper Rwizi Catchment, there are mineral deposits, with traces of artisanal mining in Buhweju District, leaving behind unrestored mining grounds. The same applies to sand mining that is common in all the 11 districts of the catchment.

The National Fisheries Policy (2004) observes the fact that the fisheries industry depends on quality water resources. Management of fisheries on Lake Kacheera, Lake Mburo, Lake Kijanebarola are subject to the provisions of the law.

The National Irrigation Policy (2017) regulates abstraction and use of water for commercial irrigation activities. There are traces of micro-irrigation in areas surrounding Lake Kacheera and various wetland ecosystems that need to be regulated according to this policy.

Policy Framework for Industry Sector (2008) provides for sustainable abstraction and use of water resources without compromising future requirements. Industries such as Nile Breweries Limited, Coca Cola in Mbarara (among others) are guided by this policy, to abstract water from the river whilst contributing to its sustainability.

2.3 RELEVANT STRATEGIES AND PLANS

2.3.1 Uganda's vision 2040

This is a development plan that aims to “transform society from a peasant to a modern and prosperous country within 30 years” and it is based on the adoption of a Comprehensive National Development

Planning Framework (CNDPF). The CMP aims to contribute towards its achievement by contributing to the following Vision 2040 indicators:

- Per capita water consumption increased from 26 to 100 litres/day.
- Percentage of the population with access to safe piped water increased from 15 to 100%.
- Population growth rate decreased from 3.2 to 2.4% (61 million people by 2040).
- Forest Cover (% land area) increased from 15 to 24%.
- Wetland Cover (% of total area) increased from 8 to 13%.

2.3.2 The National Development Plan III (NDP 3) 2020/21 - 2024/25

With a theme: “sustainable industrialization for inclusive growth, employment and sustainable wealth creation,” the development objectives of the NDP 3 are:

- Enhance value addition in key growth opportunities
- Strengthen the private sector to create jobs
- Consolidate and increase the stock and quality of productive infrastructure
- Enhance the productivity and social wellbeing of the population
- Strengthen the role of the state in guiding and facilitating development

NDP3 lists core projects related to water resources management planning and these include:

- Irrigation schemes and overall improvement of agriculture.
- Elevation of municipality into city status (e.g Mbarara City),
- Hydro-power production on Rwizi River,
- Modernize the public transport system, including the internal water transport sector and water tourism (such as on Lake Kacheera and Lake Mbuoro).
- Establishment of industrial hubs (such as industrial establishments in Mbarara)
- Sustainable tourism (with Mbarara city providing a chain of hotels and hospitality services that require water).
- Human capital development through inclusive green growth for poverty reduction pathways.

2.3.3 The National Irrigation master plan (2010 - 2035)

The aim of the master plan is to achieve economic growth and poverty alleviation through improving the country’s irrigation potential in a sustainable way thereby mitigating the potential impacts of climate change. The Irrigation Master Plan also promotes improvement of existing schemes and of crop yields and through livelihood differentiation.

2.3.4 The Uganda Country Refugee Response plan (Jan 2019-December 2020)

The recently approved Uganda Country Refugee Response plan (Jan 2019-December 2020) emphasizes that a catchment-based approach will be used to plan and implement environment and natural resource protection and restoration while promoting green livelihoods. It further explains that “In partnership with District Local Governments (DLGs) and Water Management Zones, environmental impact assessments, action plans and forest resource management plans will be developed for each refugee-hosting sub or micro-catchment. And as a matter of fact, the lowest and most effective

level of water resources management and planning is at micro-catchment level since it enables participation in planning and decision making of all the relevant stakeholders and most especially the custodians of the resources.

2.3.5 Other plans and strategies

Among other strategies and plans that are relevant to Rwizi Catchment Management Plan are the following:

- Climate Change Adaptation Strategy for the Water Sector, 2011
- Water for Production Strategy and Investment Plan, 2009
- National Irrigation Master Plan for Uganda (2010 – 2035)
- National Water Quality Management Strategy, 2006
- Uganda Wetland Sector Strategic Plan (2001/10)
- The National Forest Plan (2011/12-2021/22)
- The National Biodiversity Strategy and Action Plan, 2002
- Uganda Wildlife Authority Strategic Plan (2013-2018)
- The National Forest Plan (2011/12-2021/22)
- Uganda Wetland Sector Strategic Plan (2001/10)
- Water and Environment Sector Development Plan 2015/16-2019/20
- The Environmental Monitoring Plan for the Albertine Graben, 2012-2017

2.4 INSTITUTIONS AND COORDINATION STRUCTURES

2.4.1 National level

The Ministry of Water and Environment (MWE) is the lead agency for the formulation of national water and sanitation policies, as well as the coordination and regulation of the sector. It holds the national mandate to formulate policies for all aspects of water resources management and development. In Figure 4 the structure of the MWE is presented.

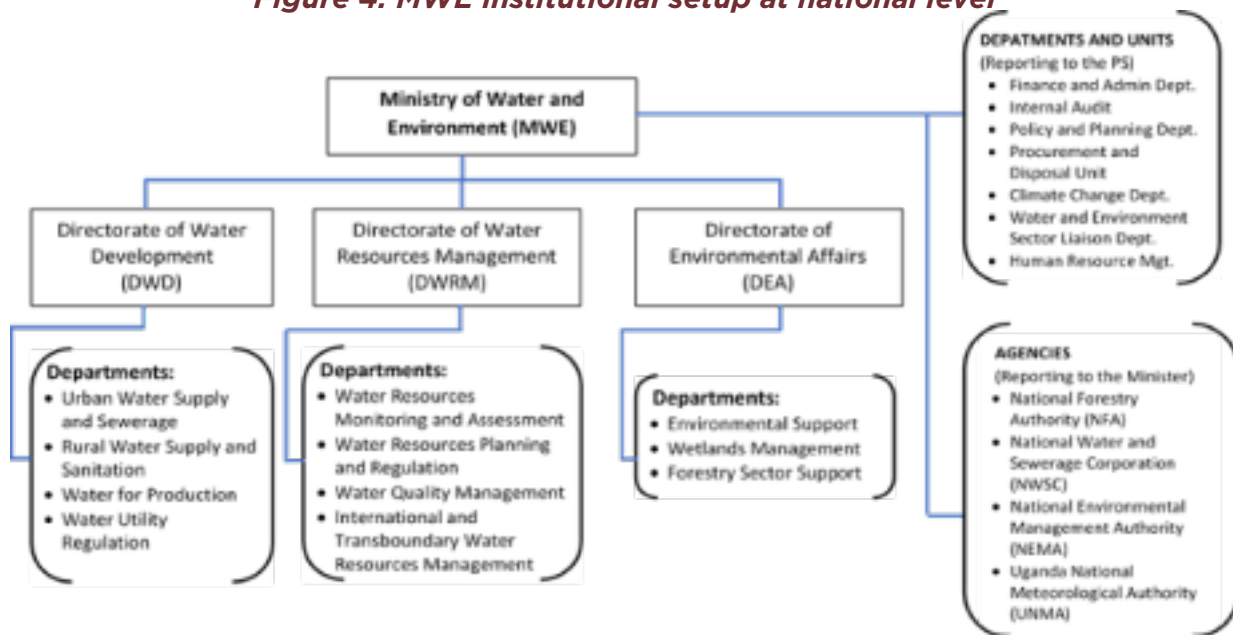
MWE is responsible for setting the standards to manage and regulate all water resource developments, to determine priorities for water development and management as well as for monitoring and evaluation of all sector development programmes. Below are the roles and functions of MWE:⁵

- Developing legislations, policies and standards for management of water and environment resources
- Providing sustainable safe water supply and sanitation facilities in rural areas
- Providing viable water supply and sewerage/sanitation systems for domestic, industrial and commercial use in urban areas
- Provision of water for production for use in agriculture, rural industries, tourism and other uses
- Coordinating the national development for Water for Production (agriculture, industry, aquaculture, tourism, trade)
- Promotion of integrated and sustainable water resource management

⁵ <https://www.mwe.go.ug/mwe/about-ministry>, accessed on February 19, 2020

- Providing effective planning, coordination and management mechanisms for water and sanitation sector
- Providing sound and sustainable management of environment for optimum and social and economic benefits for the present and future generations
- Promotion of effective management of forests and trees to yield increases in economic, social and environment benefits for the current and future generation, especially the poor and vulnerable
- Receiving, transmitting and processing all weather data from stations nationwide and to international centres

Figure 4: MWE institutional setup at national level



(Source: Uganda Catchment Management Planning Guidelines 2019)

MWE operates through three directorates (see Figure 4):

- *The Directorate of Water Resource Management (DWRM)* is responsible for the development and management of water resources and supports the enforcement of national water legislation, policies and regulations. It also monitors, assesses and regulates the country's water resources through issuance of water abstraction and wastewater discharge permits. DWRM is the lead in agenda development for CbWRM and has the responsibility to coordinate the Water Management Zones, as well as to mobilize resources and build the capacity of CbWRM stakeholders. DWRM will directly oversees and monitors the implementation of the Rwizi CMP.
- *The Directorate of Water Development (DWD)* has the responsibility for the development of large-scale water infrastructure. Its mandate is to promote and ensure the rational and sustainable utilisation, development and safeguard of water resources, and provide overall technical oversight for the planning, implementation and supervision of urban and rural water and sanitation services. DWD will provide guidance on the implementation of water infrastructure as well as water for development programs in the catchment.
- *The Directorate of Environmental Affairs (DEA)* is the lead agency for environmental policy, regulation, coordination, inspection, supervision and monitoring of the environment and

natural resources, and the restoration of degraded ecosystems as well as mitigation of and adaptation to climate change. Technical oversight for ecosystem restoration (wetlands, forestry) and concerns surrounding the non-green environment (pollution, water management, illegal artisanal mining) within the Rwizi Catchment, will be provided by the Directorate of Environment Affairs, its constituent departments (forestry, climate change, wetlands) and associated agencies (NEMA, NFA, UNMA). The MWE collaborates with affiliated semi-autonomous bodies such as:

- *The National Forestry Authority (NFA)* is charged with the management of central forest reserves “on a sustainable basis and to supply high quality forestry-related products and services to government, local communities and the private sector”. The restoration of degraded central forest reserves in the Rwizi Catchment is largely the responsibility of the NFA.
- *The National Environment Management Authority (NEMA)* is mandated to coordinate, monitor, regulate, and supervise environmental management in Uganda. It is the lead in the development of environmental policies, laws, regulations, standards and guidelines. NEMA will therefore guide the implementation of the Rwizi CMP particularly on sound environmental management, funding through the National Environment Fund aimed to support, among other activities: management of sensitive and fragile ecosystems; critical environmental restoration activities; research intended to further the requirements of environmental management, capacity building, environmental publications and scholarships; and innovations for environmental conservation and management by the public and private sector.
- *The Uganda National Meteorological Authority (UNMA)* is mandated to offer weather and climate services, and to analyze scientific research findings and provide guidance on climate change. Part of the Rwizi catchment experiences adverse climate conditions where UNMA will have to play a role.
- *The National Water and Sewerage Corporation (NWSC)* is responsible for the operation of sewerage services and the provision of water in urban centres. The responsibility of NWSC will be to provide piped water solution and sewerage collection facility for urban and peri-urban establishments within the catchment, invest in infrastructure improvements, new investments, and water source protection.
- *The Climate Change Department (CCD)* is responsible for strengthening the country's implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (KP). In collaboration with stakeholder institutions, CCD will guide the implementation of climate change interventions intended to reduce on existing vulnerabilities in the catchment.

Other ministries that have direct relevance for water resources management due to their mandates and operations are:

- *The Ministry of Agriculture, Animal Industry and Fisheries (MAAIF)*; mandated to lead on water use and management of on-farm agricultural water facilities, while MWE is responsible for off-farm activities
- *Ministry of Works and Transport*; is relevant to water resource management because they use water for transport (ferry, boats etc), road and bridge construction (across water bodies and catchments). They also responsible for management and control of rainfall runoff from the roads, that can be harvested to support irrigation and other related uses like ground water recharge.
- *The Ministry of Tourism, Trade and Industry (MTTI)*; covers the water use and management of industries, commerce, wildlife and tourism

- *The Ministry of Energy and Mineral Development (MEMD)*; oversees the water use and management for hydropower generation
- *The Ministry of Health (MOH)*; has the role of ensuring that everyone in Uganda has access to quality health services through primary health care, a process in which water plays a key role.
- *The Ministry of Works and Transport (MWT)*; relevant to water resource management due to the potential use of roads and bridges as water harvesting structures
- *The Ministry of Local Government (MLG)*; responsible for the establishment of structures and frameworks for governance of districts.

The *Water Policy Committee (WPC)* advises MWE on water resources and development issues. Among other functions, its role is to promote inter-ministerial and inter-sectoral coordination over a wide range of water resources management and development. It enables high-level and strategic dialogue specifically in the water sector.

2.4.2 Regional level

The *Water Management Zones (WMZs)* have been established in order to de-concentrate the implementation of IWRM functions and to move closer to stakeholders and physical realities on the ground. The country is divided into four WMZs based on major hydrological basins. The four WMZs are: Victoria WMZ (based in Mbarara), Albert WMZ (based in Fort Portal), Upper Nile WMZ (based in Lira) and Kyoga WMZ (based in Mbale). The WMZs are responsible for planning, water quality and quantity monitoring and assessment, water allocation and regulation. Victoria Water Management Zone will have oversight responsibility for this management plan.

Water and Sanitation Development Facilities (WSDFs) design and construct water supply and sanitation facilities, carry out related community mobilization activities and set up operation and maintenance structures. Investment for water and sanitation in small towns, town boards and rural growth centres is funded through WSDF. They currently operate through 4 branch offices currently established in Mbarara (southwest), Lira (north), Mbale (east) and Wakiso (centre). The Mbarara WSDF has the mandate within the Rwizi Catchment Management area.

Technical Support Units (TSUs), which exist in nine locations across Uganda, are tasked with capacity building of district local governments, as part of the decentralization of rural water supply and sanitation and the channeling of government grants to the sub-sector through the District Water and Sanitation Conditional Grant (DWSCG). Among other functions, TSUs cover quality assurance, monitoring of observance of guidelines, standards, financial management and reporting, sanitation and hygiene promotion, promotion of effective private sector use, and support to local governments and NGOs in service provision.

Umbrella Organizations (UOs) provide support to local water authorities, water boards and scheme operators in the provision of sustainable piped water supply services. The six regional UOs support operation and maintenance on demand, as well as provide training, technical advice and managerial support, planning and supervision of rehabilitation and extension works, and regular water quality monitoring. According to the SPR 2019, these structures will become Authorities, although that is not yet operationalised.

Water for Production Regional Centres that promote the development of water for production by constructing valley tanks and dams, as well as irrigation schemes. The four branch offices are located in Mbarara (west and centre), Lira (North), Mbale (East), and Moroto (Karamoja). The Mbarara Water for Production Centre services the Rwizi Catchment Management area among other catchments in the region.

2.4.3 Catchment level and Sub Catchment level

At catchment level the MWE through the WMZ establish Catchment Management Organisations (CMO) responsible for the coordination and supervision of the activities of stakeholders involved in the use and management of water and related resources in the catchment. The CMO comprises the following structures.

- a *Catchment Stakeholders Forum (CSF)* comprising all stakeholders in the catchment with an interest in or whose activities affect or are affected by the status of water and related natural resources. It plays a key role in identifying issues and hotspots in the catchment. The input of the CSF members is very crucial in the development of a CMP and proper catchment management.
- a *Catchment Management Committee (CMC)* made up of representation of all relevant stakeholder categories in the catchment. These categories include NGOs, Religious leaders, Opinion leaders, Cultural leaders, private sector, water users, community-based organisations (CBOs), government, politicians and administrators at district local government level, media and research and academic institutions. The CMC is the executive arm of the CMO, elected by the CSF. The CMC works closely with the WMZ in the formation of the catchment management plan (CMP), endorses the CMP and also plays a crucial role in its implementation.
- a *Catchment Technical Committee (CTC)* comprising technical experts from relevant stakeholder groups or organisations or institutions in the catchment is the technical arm of the CMO. Among other roles, it offers technical advice to the CMC and other stakeholders during the planning and implementation of interventions for water resources management, and
- a *Catchment Management Secretariat (CMS)* comprising professionals who have the technical and managerial capacity to perform the administrative functions is the administrative arm of the CMO.

At sub catchment level, a Sub Catchment Management Committee (SCMC) is established comprising political leaders, administrators and other stakeholders at sub county level. At micro catchment level, a Micro Catchment Management Committee (MCMC) is established which is a mirror image of the SCMC at parish or village level. These committees are responsible for coordination and supervision of implementation at their respective levels of operation.

The composition of the CMO structures, the roles of its different structures, the establishment process of the structures as well as their linkages with stakeholders at different level are elaborated in the CMO Procedures Manual⁶.

2.4.4 District local government level

In consultation with MWE, District Local Governments (DLGs) appoint and manage private operators for urban piped water schemes outside of NWSC jurisdiction. The District Water Offices manage water and sanitation development and oversee the operation and maintenance of existing water supplies in the District. As described under the legislative framework, DLGs may cooperate to form and support joint institutions for managing, among others, water and related resources, which is very important for the formation and functioning of CMOs.

At DLG level, several offices and departments are relevant to water resources management:

- The District Environment Office, the District Forestry Office and District Wetlands Office under the District Natural Resources Department are responsible for natural resources management, capacity building, sensitization, enforcement of the law and compliance.
- The District Water Office supplies reliable and safe water and water for production
- The District Production Department including Agriculture, Livestock and Fisheries Offices.

⁶ DWRM (2019) Catchment Management Organisation Procedures Manual

- The Department of Community Based Services coordinates all activities related to community development. They also coordinate all activities of CSOs, NGOs and other Community Based Structures. The department is in direct contact with communities and mobilizes and sensitizes them for poverty eradication, gender, probation and social welfare and community development.
- The Department of Planning is mandated to provide planning services within the district by working with other district departments, as well as the lower local governments to ensure timely production of up-to-date and high-quality medium-term operational plans
- The District Communication Office is the official government communication platform at district level. It has free airtime in both private and government media, as well as budgets for community mobilization and sensitization.
- The District Health Office has the responsibility to ensure that the district population has access to quality health services through primary health care.

District Environment and Natural Resources Committees responsible for, among other functions: coordinating the activities of the urban or district council relating to the management of the environment and natural resources; ensuring that environmental concerns are integrated in all plans and projects approved by the urban or district council; assisting in the formulation and enforcement of ordinances monitoring all activities within the district to ensure that such activities do not have any significant impact on the environment.

District Water and Sanitation Coordination Committees (DWSCCs) are present in all districts and provide a coordinating platform which oversees the activities of the DLG'S water and sanitation sector. DWSCCs are to strengthen cross-sector collaboration, and are composed of political leaders, relevant district departments, NGOs and development partners at the DLG level.

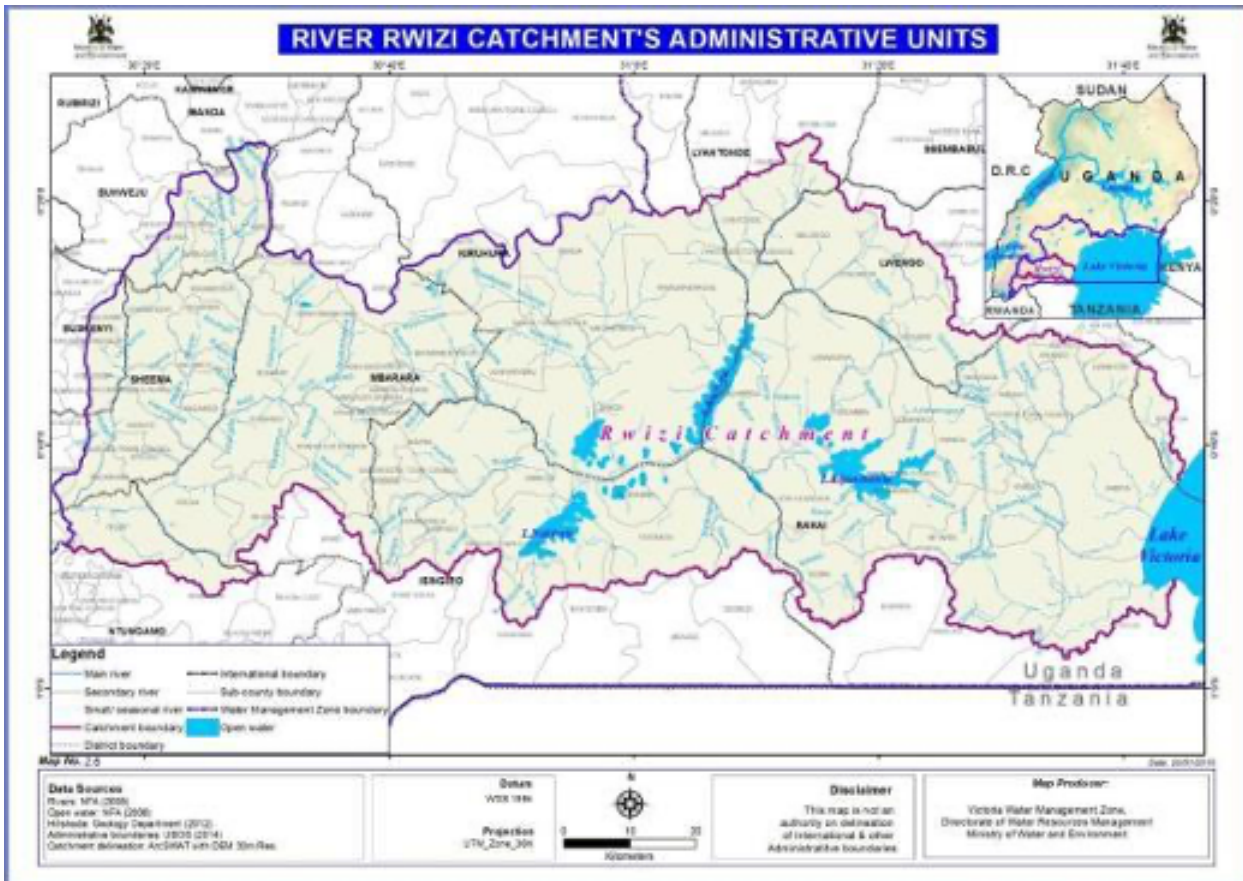
3. STATUS OF RWIZI CATCHMENT

3.1 BIOPHYSICAL CONTEXT

3.1.1 Location

Rwizi catchment is located in the South-Western Uganda and has a total area of 8,554 km² spanning over eleven districts of Buhweju, Bushenyi, Sheema, Ntungamo, Mbarara, Isingiro, Kiruhura, Lyantonde, Lwengo Rakai and Kyotera (Figure 5). The Catchment is mainly drained by river Rwizi, which forms a complex system of wetlands and streams originating from the hills in Buhweju. It has a series of tributaries joining it, flowing in a southerly direction, later turning eastwards for about 57 kilometers until the gauge at Mbarara water works. The river later joins River Kagera and finally discharges into Lake Victoria.

Figure 5: Rwizi Catchment Administrative Units



Source: MWE, 2017

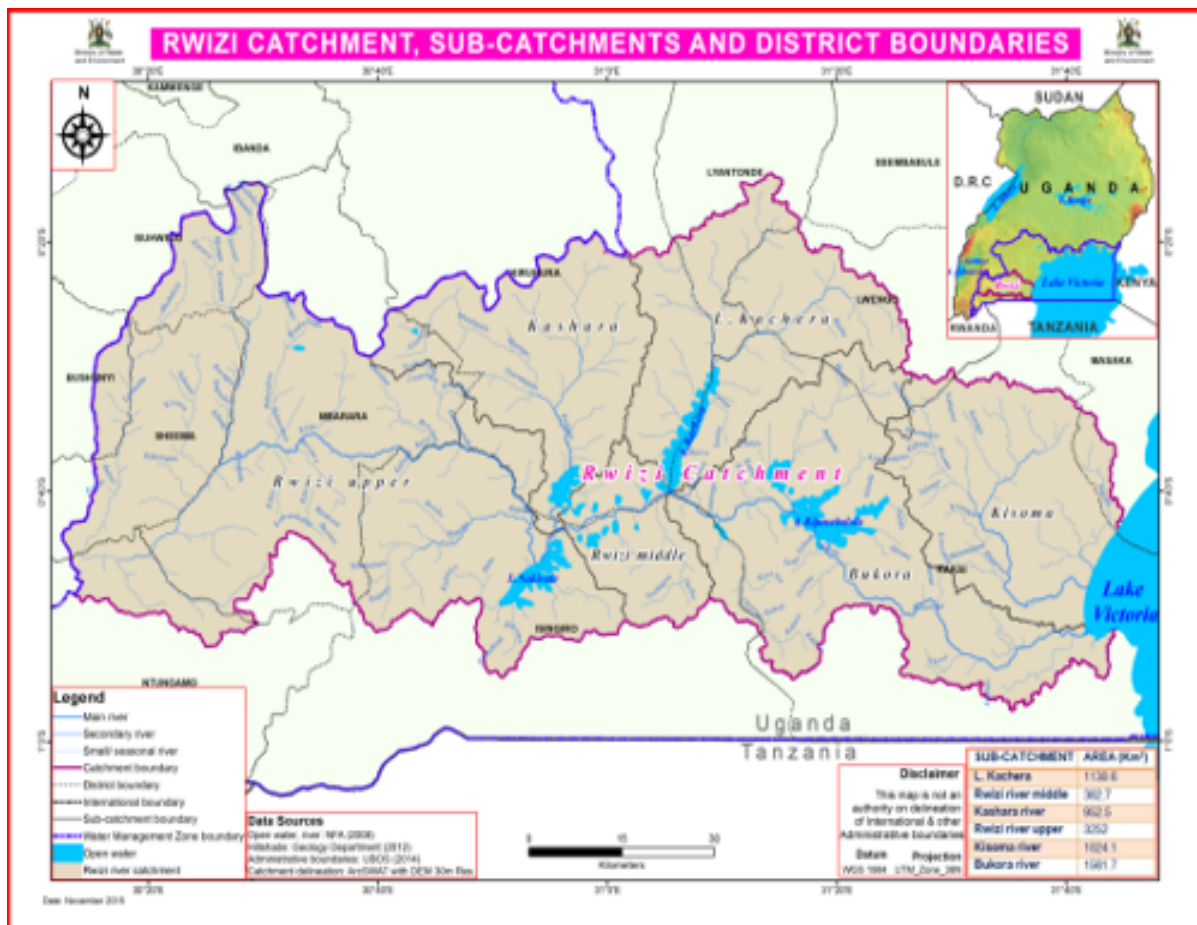
3.1.2 Sub catchments

The catchment is subdivided into six sub-catchments and named based on the major surface water bodies in the area. These sub-catchments together with the areas they cover are shown in Table 1 and Figure 6. In annex 1, the sub catchments are described.

Table 1: Sub Catchments of Rwizi Catchment

Sub-Catchment	Description	General comment
Rwizi Upper	Covers the districts of Buhweju, Bushenyi, Sheema, part of Mbarara and part of Isingiro	There is need to undertake a spatial analysis and delineate the sub-basins and ascertain the area of each of the sub-catchments.
Rwizi Middle	Part of Isingiro, Ntungamo, Rwampara, and part of Kiruhura districts	
Kashara river	Part of Kiruhura and a small fraction of Mbarara district	
Lake Kacheera	Part of Kiruhura, part of Lyantonde, part of Lwengo and part of Rakai district	
Bukora river	Part of Lwengo and part of Rakai district	
Kisoma river	Majorly Rakai and Kyotera district	

Figure 6: Rwizi catchment, sub catchments and district boundaries



The Upper Rwizi sub catchment corresponds to the upper hilly areas and the wetlands below the hills up to the Mbarara town gauging station. It also includes streams draining into Lake Nakivale. The middle catchment is made up of the major marshlands and lakes in the catchment. Other river systems making sub catchments are the Kashara from Kiruhura and Kacheera emanating from parts

of Lyantonde district. The lower reaches of the catchment are the Bukora and Kisoma catchments.

Each sub-catchment has its own unique characteristics. The upper catchment is predominantly in the hilly areas with major agricultural activities being related to tilling the land. These are the main sources of sediment carried into the river channel. The middle catchment (Kacheera, Nakivale and Kashara) is generally flat and lies within the cattle (dry land) corridor. The river system here is fed by ephemeral/ seasonal streams. The Kisoma and Bukora sub catchments represent the marshlands of Rakai and Kyotera towards Lake Victoria.

3.1.3 Weather and Climate

3.1.3.1 Rainfall

The catchment receives rainfall within the range of 700mm/year (for the dry cattle corridor realms of Isingiro, Mbarara (Kashari), Kiruhura and Lyantonde) to 1,300mm/year (mainly for Upper Rwizi in the hill ranges of Buhweju, Sheema and Bushenyi as well as around the Lake Victoria shores in Rakai/ Kyotera).

Rwizi Catchment is characterized by two wet seasons; between March to May (with maximum rainfall in April) and between October to December (with maximum rainfall in November). Dry months are those of July-August and January-February. Rainfall distribution in the catchment exhibits spatial and temporal variability. The average annual rainfall received (987mm) is influenced by topography and the presence of wetlands and open water. The catchment experiences two rainy seasons (March to May, September to November and sometimes up to December) and two dry seasons (December to February, June to August). November and April are the wettest months, receiving on average a maximum of 135 mm and 131 mm of rain, respectively, whereas July is the driest month, receiving just 35 mm of rainfall on average. This is about 100 mm of rainfall less than is received in the wettest months (ARUP, 2014).

Figure 7 shows the mean monthly rainfall as measured at different stations within the Rwizi catchment. This variation corresponds to the cattle corridor areas stretching from Isingiro through Mbarara, Lyantonde and Kiruhura. The spatial variation exhibits a trough or 'U' shape i.e. minimum values in the middle of the catchment and higher values at the headwaters and near the outlet into Lake Victoria. The highest rainfall received ranges between 1,200 and 1,300 mm a year and is mainly influenced by topography and wetland systems in the west, and by lakes and wetland systems in the east.

Figure 8 shows the biannual pattern of rainfall. The main rainfall seasons are March - May and September to December. The highest precipitation is received in this latter period.

Figure 7: Map of Rainfall Distribution in Rwizi Catchment

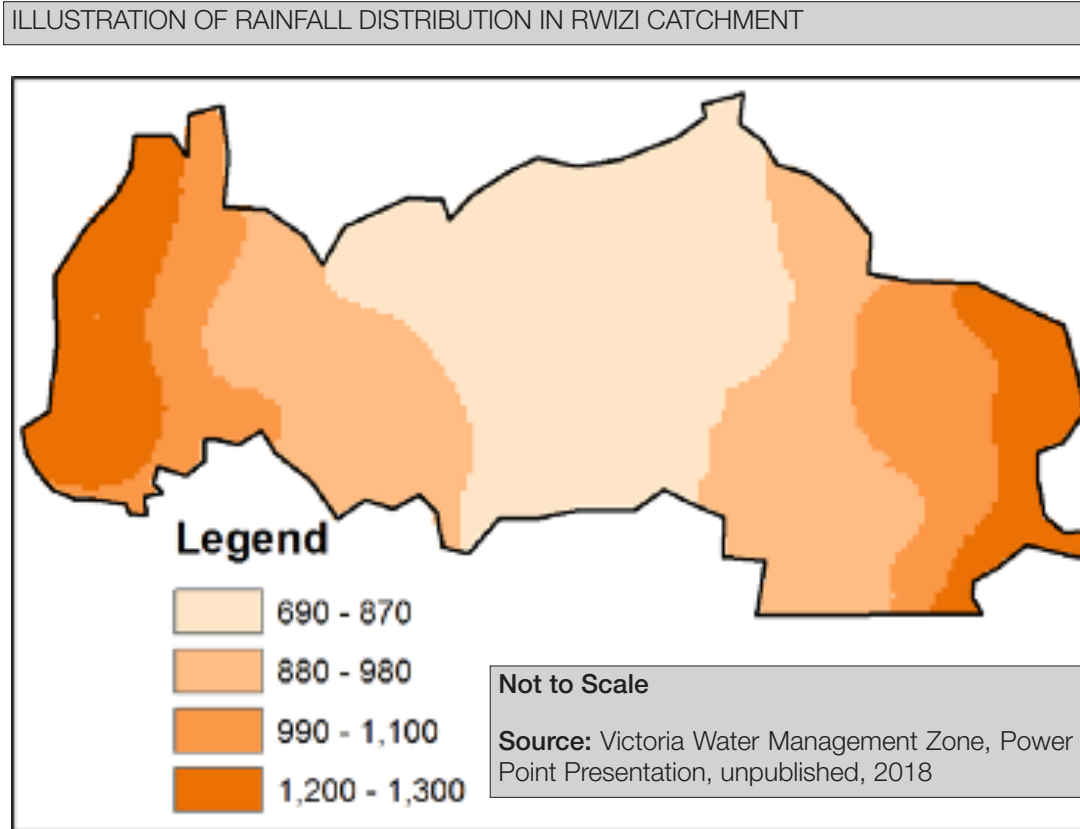
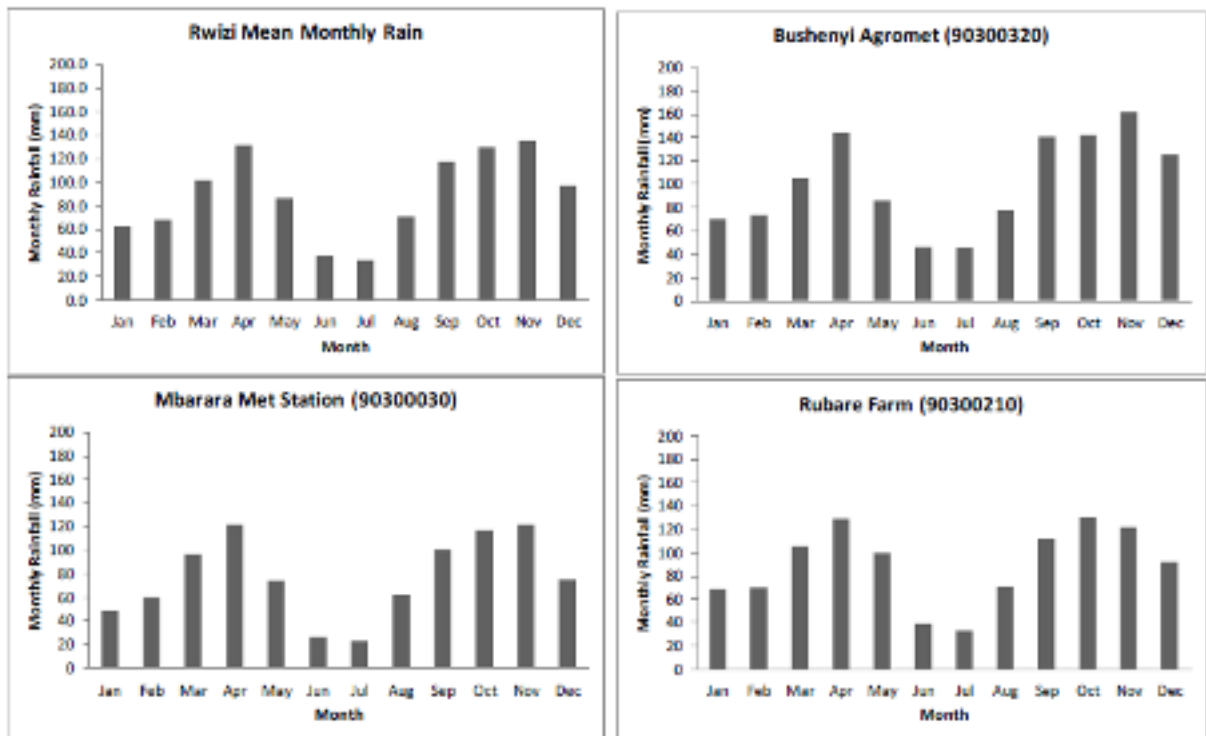


Figure 8: Biannual Pattern of Precipitation in Rwizi Catchment



Data availability over the long term and spatial resolution is not reliable. This affects the quality and content of analyses that could be done. As shown in the trend line in the Figure 9 and Figure 10, the rainfall in the catchment is generally stable with a slight decrease over the last 60 years. This slight decrease cannot be significant to the water availability in the catchment. Maximum rainfall is recorded during April and November, while the driest months are observed during July-August and January-February. Going forward, there is an opportunity to collect data from rain gauges that have been established in almost all the districts within the catchment districts.

Figure 9: Long term precipitation records for Mbarara Stock Farm

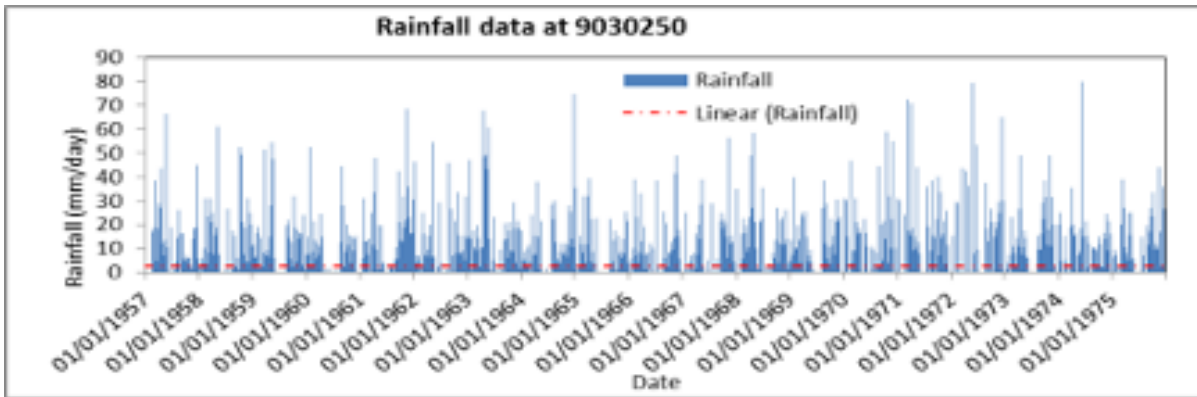
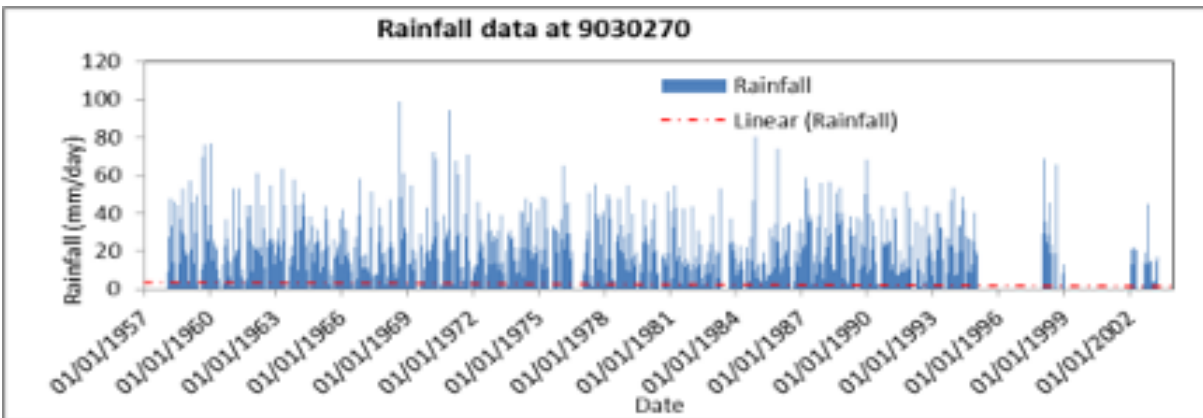
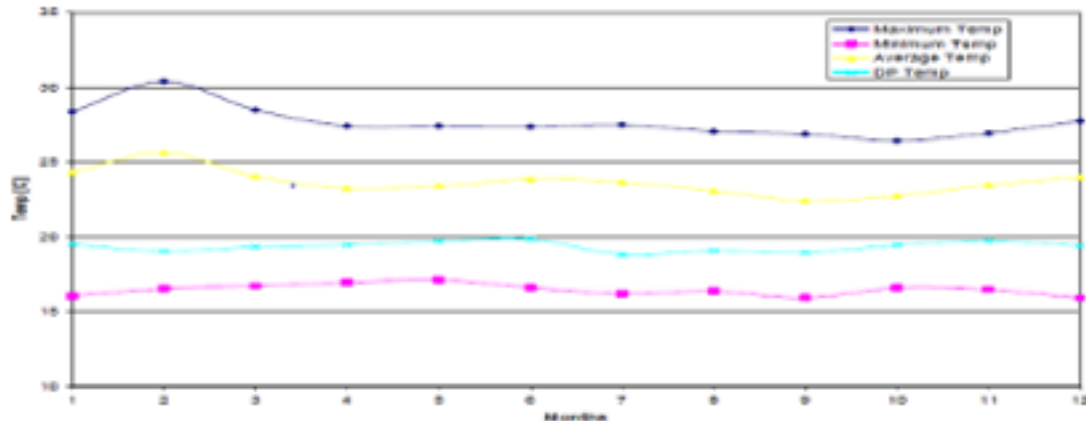


Figure 10: Long term precipitation records for Bugamba, Mbarara



3.1.3.2 Temperature

Average daily temperature for the catchment is reported here based on data from Mbarara Meteorological Station for the period 1960-1993. Over this period, the average minimum temperature was 13.7°C and the average maximum 26.6°C. Analysis of the trend shows an increase of about 2°C over this period. The average dew-point temperature for the area is 19°C, and the long-term average temperature is 24°C. January, February and March are the hottest months of the year (ARUP, 2014). Figure 11 is a general overview of the temperature variation throughout a normal year; the range is 17 – 30°C.

Figure 11: Average Monthly Temperatures, Mbarara

3.1.3.3 Impacts of climate change on rainfall and temperature

With respect to rainfall, the findings indicate that possible increase in the magnitude of the rainfall extremes is projected. According to an analysis of future climate scenarios⁷ over Central Uganda, rainfall extremes in the different parts of Lake Victoria basin are projected to change. For the western parts, of which Rwizi catchment is part, the mean of the rainfall extremes are projected to increase by about 10% to 12% in the 2050s and 16% to 19% in the 2090s. The results further showed that the south western part of the basin would experience a decrease in extremes by about 25% in the 2050's and 2090's.

The change in the monthly mean maximum and minimum temperature is projected to be more positive. The range of projected change in Tmax is -4°C to 8°C and that for Tmin is -4°C to 10°C. The tendency for the Tmin to decrease in the drier months was eminent while the Tmax is projected to increase more in the wetter months than in the dry months. The increase and decrease in Tmax and Tmin, respectively, would mean an increase in difference between the Tmax and Tmin and thus an increase in evaporation.

3.1.4 Soils

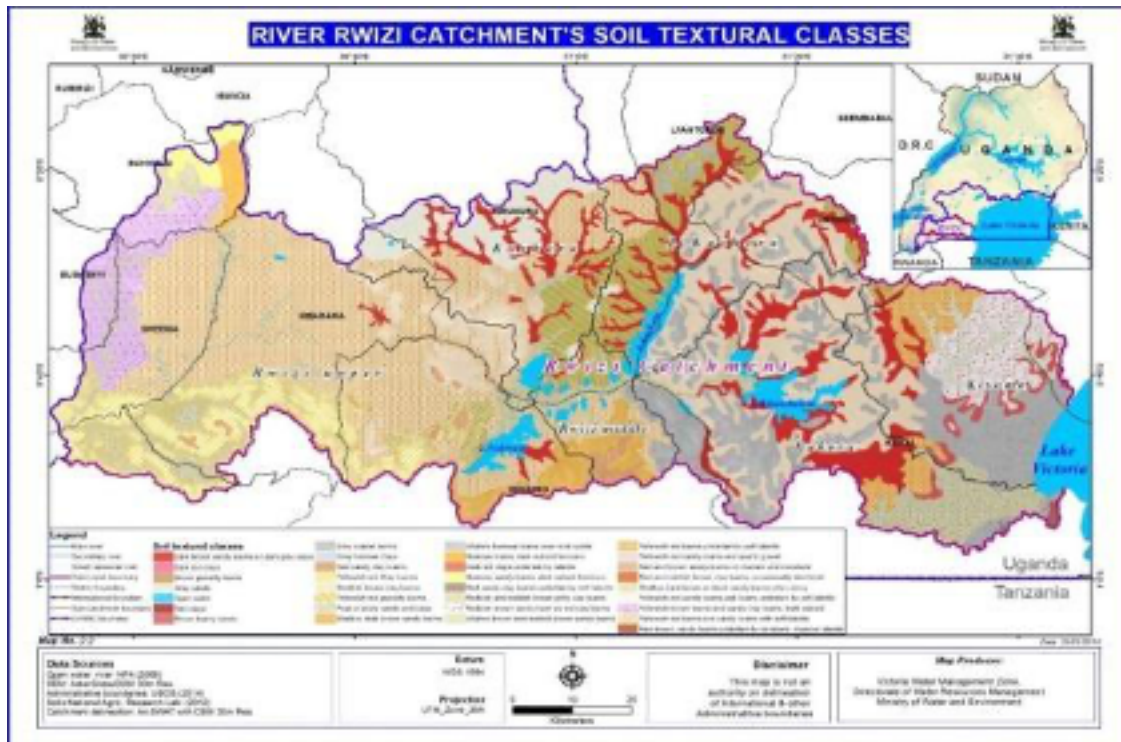
Soils in Rwizi catchment are dominantly clay loam, sand clay loam, sandy loam and peaty loam soils. The dominant soil types according to FAO classification are the alisol with extremely low base saturations. The high grazing practices in the catchment has compacted the soils, decreasing infiltration rates while cropland and eucalyptus species as well as skeletal soils enhance the intake rate, reducing the runoff.

Generally, the soils of the catchment area especially in the districts of Mbarara, greater Bushenyi and Kiruhura are sandy loams, clay loams and slightly lateritic loams. Sandy loam is found in the long and shallow valleys which favour aquatic flora and fauna as they are seasonally or permanently flooded. The soils in the wetlands contain peat derived from accumulated residual litter of the swamp flora mainly papyrus, sedges and typha. Soils are generally black clays with sandy soils along the river line of river Rwizi.

Figure 12 shows soil classification in the Rwizi catchment. Soil is classified into acric ferralsols which is mainly in Buhweju, Sheema and between Lake Kachera, Kijanebarola and Mburo; luvisols which cover areas of Mbarara, some part of Sheema, Isingiro, Kiruhura and Kisoma in Rakai. Others are leptosols, arenosols, gleysols, planasols etc; but acric ferralsols and luvisols dominate a bigger part of the catchment area.

⁷ Nimusiima et al., Analysis of Future Climate Scenarios over Central Uganda Cattle Corridor, Journal of Earth Science and Climate Change, 2014, 5:10:

Figure 12: Soil textural classes for Rwizi catchment



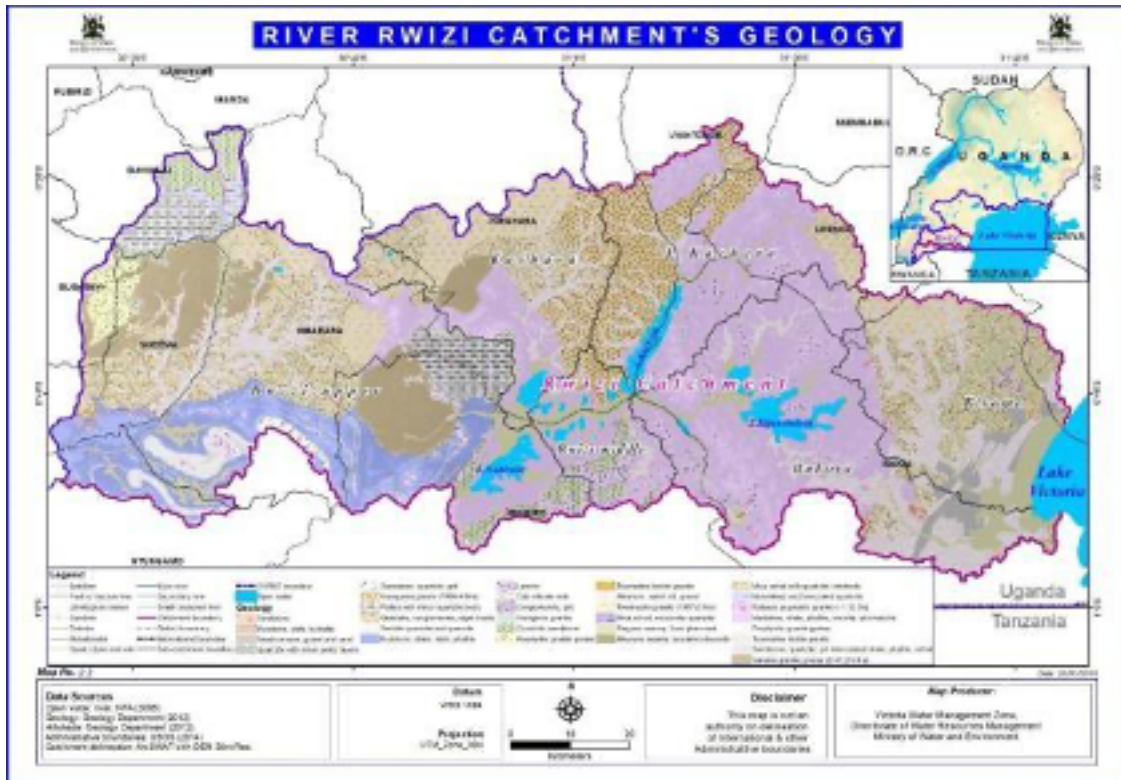
3.1.5 Geology

Figure 13 shows the geology of the catchment as described by Geological Surveys and Mines in 2012. The geology of the catchment is composed of metamorphic rocks overlain by alluvial deposits in some places. The eastern, north-western and south-western parts of the catchment are composed of Buganda-Toro system (Argillites, arenites with some basal metacalcareous rocks). The lower central part and north-eastern part of the catchment comprises the Karagwe series (phyllites and schists, basal quartzites and amphibolites). The upper central part and some parts in the eastern region consist of undifferentiated gneisses. Intrusive granites and highly granitized rocks are also present in the catchment as pockets. Highly mineralized rocks occur in some parts of the Buganda-Toro system. The phyllites in the catchment are associated with high iron content which makes the groundwater unpalatable.

Buhweju district has predominantly quartzitic sandstone and pelites with minor quartzite beds; districts of Mbarara, Bushenyi, Sheema, Ntungamo, Isingiro and some part of Kiruhura are composed of mudstone, shale, slate, phyllite; alluminium sand; mica schist with quartzite interbeds; sandstone, quartzite, grit intercalated shale; alluvium, swamp, lacustrine deposits; porphyritic granite gneiss; other districts like Kiruhura, Rakai and Lyantonde have Kasagama granite, beach terrace especially near lake Victoria, sericite quartzite, Rwamasha, respectively.

The significance of the geology relates to erosivity factor; that measures the rainfall's kinetic energy and intensity to describe the effect of rain on erosion. Within the Upper Rwizi, the rock system is complex and therefore not easily eroded. The middle Rwizi is an area characterized by rock systems that are easily erodible (highly susceptible to detachment and transport by runoff) while the downstream end of the catchment is characterized by rock systems arising from deposition and sedimentation. The rock system therefore point to erosivity (the capacity of rain to produce erosion) and erodibility (the susceptibility of the soil to be eroded)

Figure 13: Geology of Rwizi catchment



3.1.6 Topography

The average elevation is 1,517 m.a.s.l, standing at 1,262 m.a.s.l. at the outlet and 2,168 m.a.s.l. at the very northern part of the catchment. Rwizi catchment is partly flat and sloppy. The upper Rwizi catchment altitude varies from 1,600 m.a.s.l. to 2,168 m.a.s.l. Buhweju district has the highest altitude varying from 1800 m.a.s.l. to 2168 m.a.s.l. The mid Rwizi catchment areas surrounding L. Mburo and Kashara river and L. Kachera altitude varies from 1,200 m.a.s.l. to 1,300 m.a.s.l. in the southern parts of Kiruhura and Rakai districts. The areas surrounding the main Rwizi catchment outlet around the L. Victoria shore altitude varies from 1100 m.a.s.l. to 1150 m.a.s.l. Similar to the importance of understanding the geology of the landscape, analysis of the topography of the catchment is assess the erosivity and erodibility potential within the catchment. Figure 14 shows the topography of Rwizi Catchment.

Figure 15: Drainage of Rwizi catchment

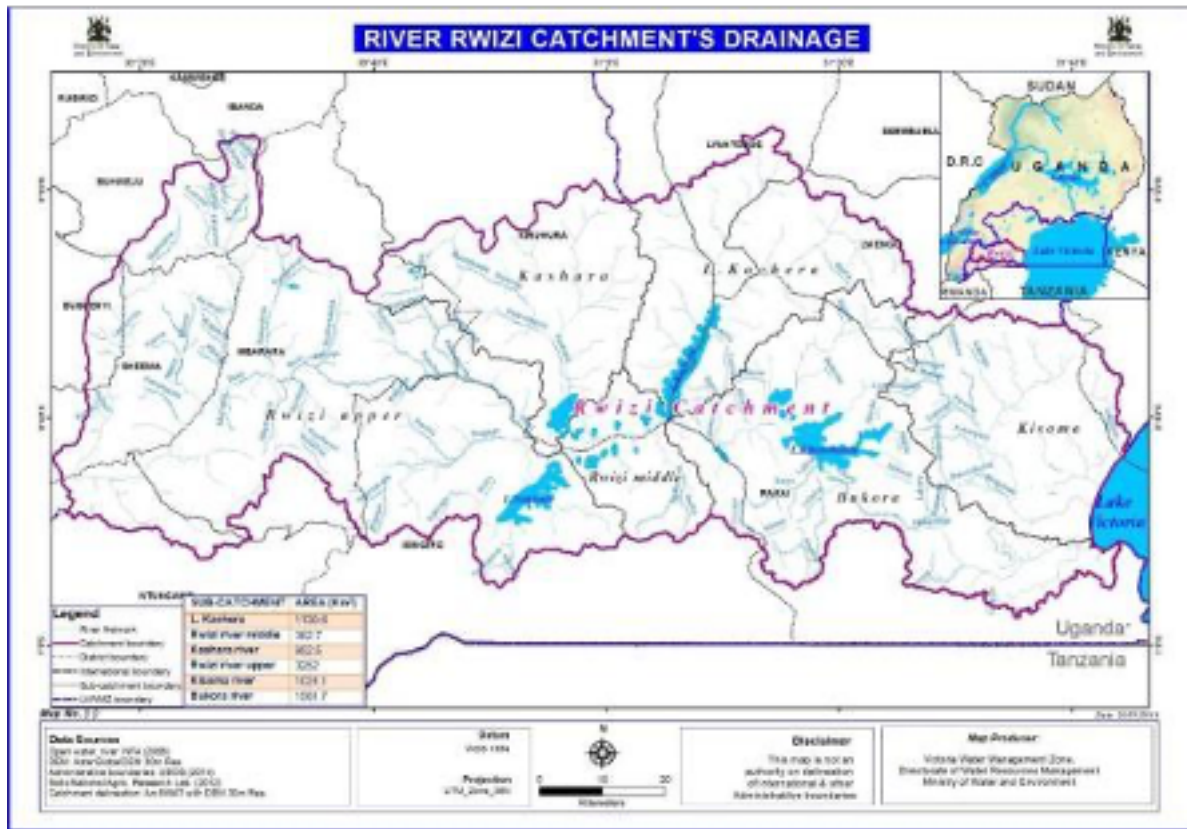
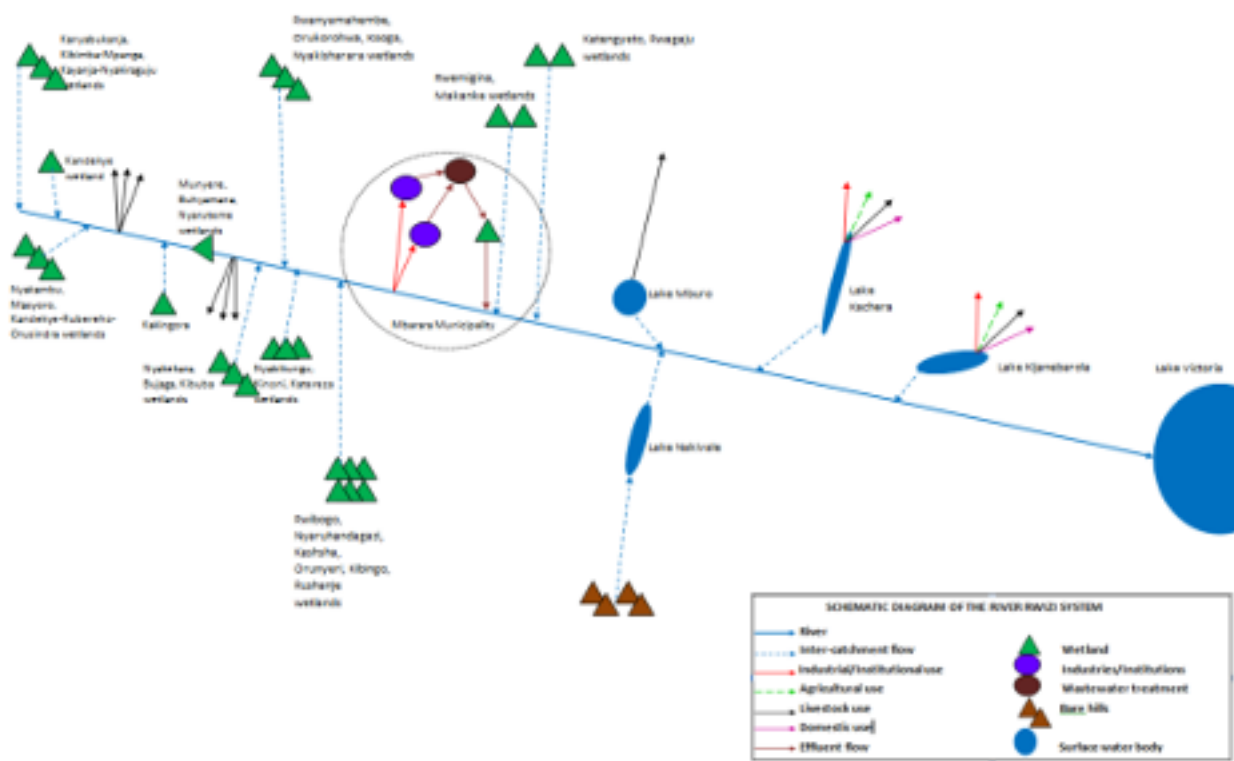


Figure 16: Schematic diagram of Rwizi Catchment



3.2.1.2 Flow analysis

The maximum monthly flows for the catchment range between 92.71m³/s to 8.84m³/s with overall average value of 51.76m³/s while the minimum monthly flows range between 3.24m³/s to 0.7m³/s with overall average of 1.74m³/s (Table 2). It can be concluded that the flow reduces considerably between June and September with lowest values in July/August, corresponding with the dry season in the year. The catchment experiences two rainy seasons (March to May, October to December) and two dry seasons (July to August and January to February). April and November are the wettest months, while July is the driest month. The average monthly specific discharge (discharge per unit area) clearly follows the monthly rainfall patterns and varies between 104.1 - 634.7 mm/month corresponding to the months with the lowest and highest mean flows.

Table 2: Upper Rwizi Monthly Discharge Statistics

Months	Min (m ³ /s)	Mean (m ³ /s)	Max (m ³ /s)	Standard Deviation	Mean Discharge/Area (mm/month)
January	2.66	8.11	65.38	7.3	319.9
February	1.8	5.77	36.09	4.69	187.8
March	1.73	6.15	41.33	4.95	243.2
April	1.9	10.17	58.68	8.54	376.7
May	2.69	12.52	84.12	12.1	495.1
June	1.27	5.4	26.08	3.19	200.1
July	0.92	3.13	8.84	1.09	123.6
August	0.7	2.72	12.98	1.17	104.1
September	0.76	5.44	47.93	6.23	207.7
October	1.19	9.07	65.45	9.24	346.9
November	2.03	15.36	92.71	11.86	587.6
December	3.24	16.62	81.49	12.56	634.7
AVERAGES	1.74	8.37	51.76	6.91	318.95

Flow varies significantly between the dry and wet seasons. The flow in the wet season is significantly from rainfall while most of the dry weather flow is base flow. Analysis using flow duration curve showing excess probability demonstrates the high variability as seen in Figure 17 and Table 3. The catchment yield ranges from 110 m³/s to as low as 2 m³/s. Reliable flow with 90% confidence is 3.3 m³/s. The low variability part of the curve 20-90% corresponds to the base flows from the catchment. The extreme low flow (Q-95) is 1.93 m³/s and as mentioned the extreme high flows are in excess of 96m³/s.

Figure 17: Flow duration curve for Rwizi Catchment

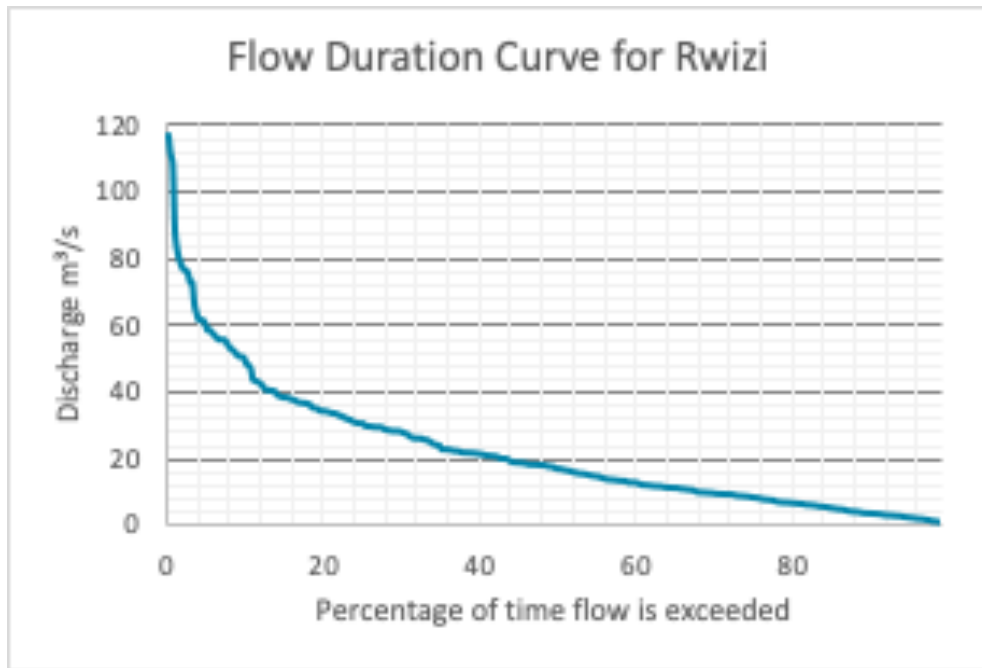
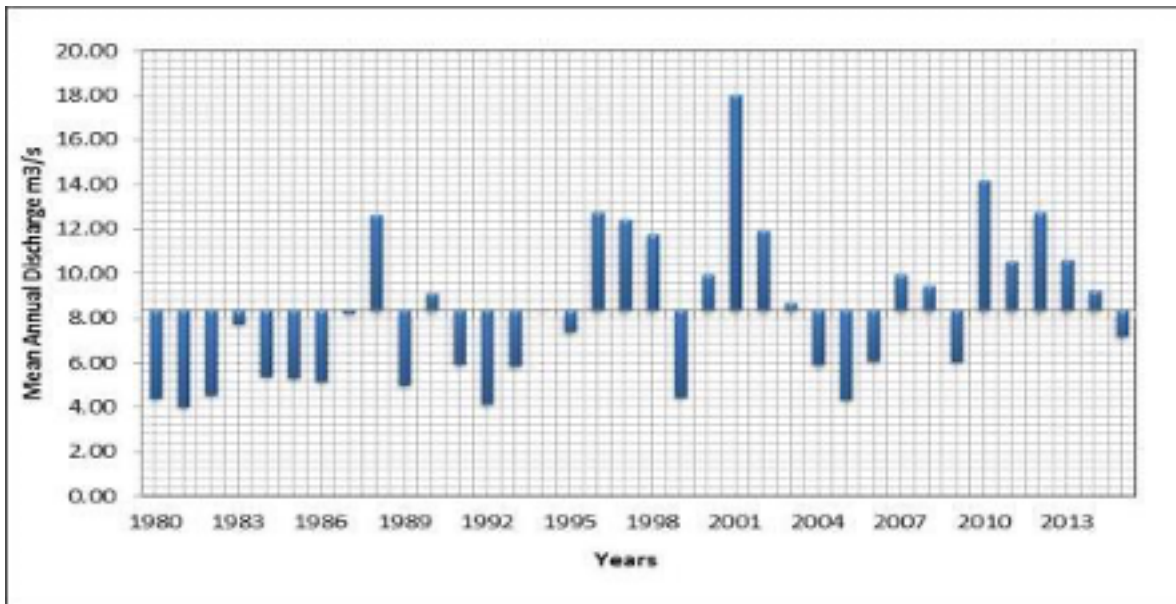


Table 3: Flow Attributes for Rwizi

Attribute	CUMECS (m3/s)	Daily Flow (m3)
Extreme high flow	110	9,504,000
Reliable flow 90% Confidence	3.3	285,120
Extreme low flow Q-95	1.93	166,752

The mean annual discharge for upper Rwizi catchment for the period of record between 1980 and 2014 was 8.35m³/s (RGS 81224 Rwizi at old NWSC works). There is a general decline of discharge values from 1990's series especially 1998 to 2000's series. The daily discharge for Rwizi catchment analyzed into mean annual flow; pattern analysis revealed the clustering of mean annual flows values about the long-term mean (Figure 18). The pattern indicated that for record under investigation the catchment was relatively drier since 54.3% of the mean annual flow were below average of 8.35 m³/s, the lowest flows were recorded during the 1990's series and earlier 2000 series.

Figure 18: Mean Annual discharges for Rwizi compared to the overall mean annual discharge



3.2.2 Ground water

Rwizi catchment has limited ground water availability, according to State of Water Resources Basin Report for Victoria Water Management Zone⁸. The availability of groundwater depends primarily on the geology in combination with the possibilities for recharge. The amount of recharge sets an upper limit for how much groundwater can be replenished, which defines the groundwater resource that is renewable, while the geology determines how water can be stored and can flow within the rock. Given the nature of the aquifers (Table 4) and overburden in these areas (Figure 19), groundwater is mostly recharged during heavy rainfall events and the percentage of rainfall that becomes recharged mainly depends on soil properties, vegetation cover and/or land use, topography and depths to water table. The estimation of groundwater recharge rates from different studies averagely range from 90 - 238 mm/yr accounting for 7 - 24% of the average annual rainfall (from different studies using various approaches).

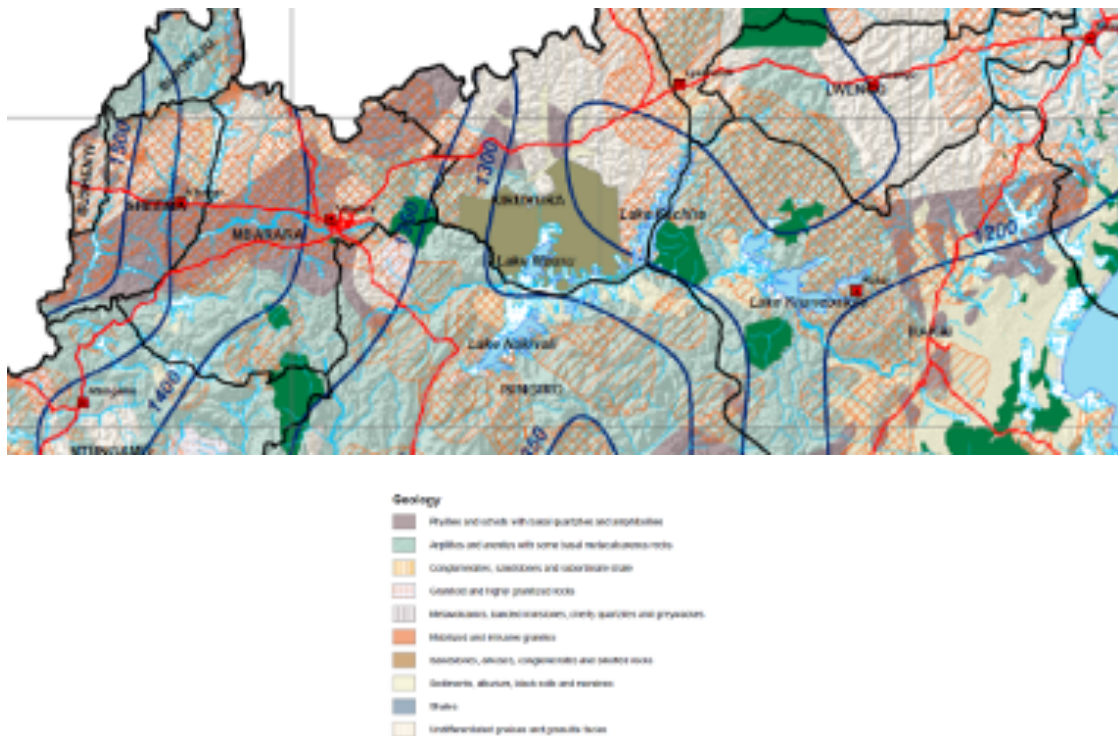
Table 4: Main aquifer types in the Rwizi Catchment

Aquifer Type	Characteristics
Fractured bedrock	These aquifers are from variably fractured fresh bedrock and the sap rock or weathered bedrock. The sap rock-fresh bedrock junction is generally transitional or even fluctuating in banded sequences. Fractured systems are related either to decompression or to tectonic forces. Fissures permeability is assumed to correlate to some degree with frequency of fractured occurrence, with a further assumption that both parameters will decrease with depth. The rocks are typically of low productivity and development is mainly from point sources utilizing hand pumps. The aquifers are generally phreatic in character but may respond to localized abstraction in semi-confined fashion if the rest water level occurs in a low permeability horizon such as clay regolith. Although the aquifers have a regional occurrence, they respond to abstraction in discontinuous fashion due to discontinuities or barrier boundaries within the fracture system being tapped or the constraints of the low permeability regolith. These features are reflected in a significant borehole failure rate and a wide range of yields, despite the apparent regional uniformity of the basic controls of climate, morphology and geology (Wright & Burgess 1992).

⁸ MWE, 2017: State of Water Resources Basin Report for Victoria Water Management Zone.

Aquifer Type	Characteristics
Regolith	The regolith consists of the collapsed zone and saprolite. Since weathering is most effective in the vadose zone and the zone of the water table fluctuations, there is a tendency to develop subdivisions into an upper and lower saprolite relative to current (or previous) water levels. Regolith thickness and lithology, along with corresponding aquifer hydraulic parameters depend on the complex combination of controls including bedrock characteristics, climate and relief.

Figure 19: Hydrogeological Map for Rwizi Catchment



Groundwater potential in the catchment is highly variable but is generally poor (Figure 20); groundwater quality is also poor especially because of high Iron, Calcium and Magnesium content in many areas. Groundwater levels are monitored at a few specific locations across the catchment, for example Rwonyo (Figure 21) and Rakai (Figure 22). Trends indicate declining trends possibly as a result of increased abstraction levels in the face of reduced recharge from rainfall. Groundwater depletion could be a possible risk where the low permeability basement aquifers are exploited by high yielding electric pumps, which is the case with areas abstracting water for industrial use in the urban centers.

Generally, interviews with stakeholders suggested that the yields of groundwater-based sources are reducing; and that it is not uncommon for groundwater-based sources (such as boreholes) to reduce in yield and subsequently be abandoned.

Figure 20: Groundwater potential for Rwizi catchment

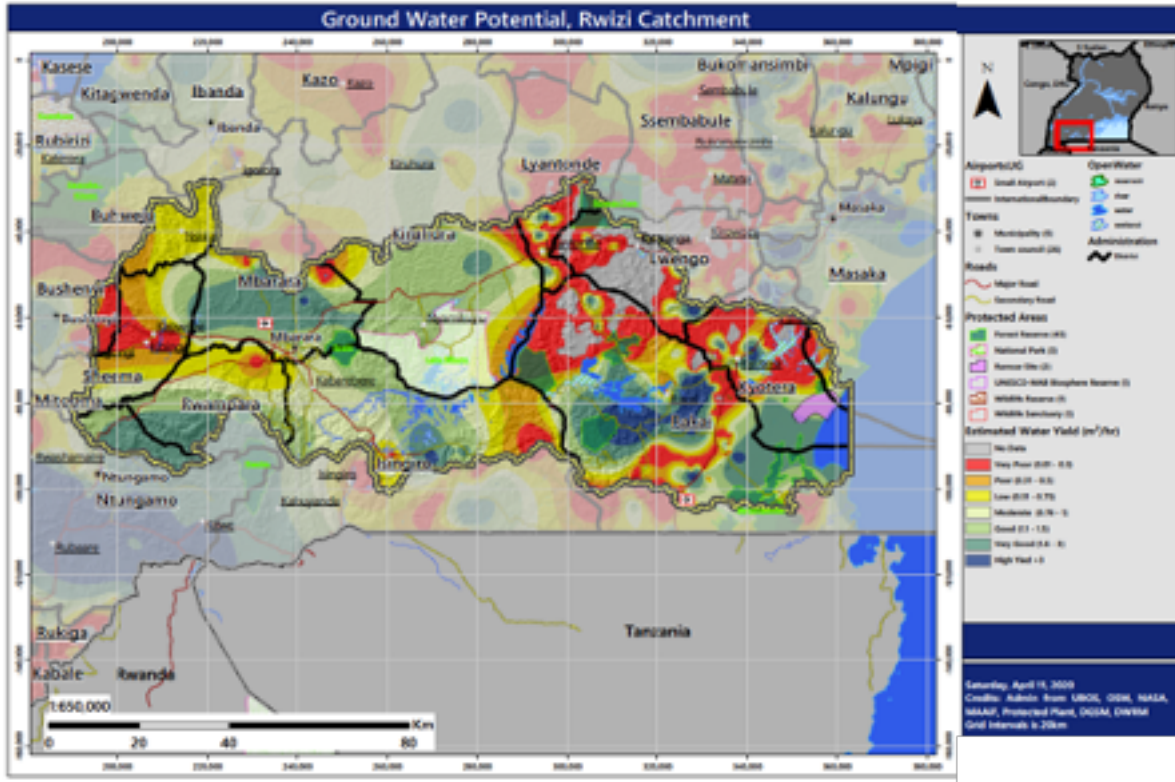


Figure 21: Groundwater levels at Rwonyo Monitoring well in Mbarara

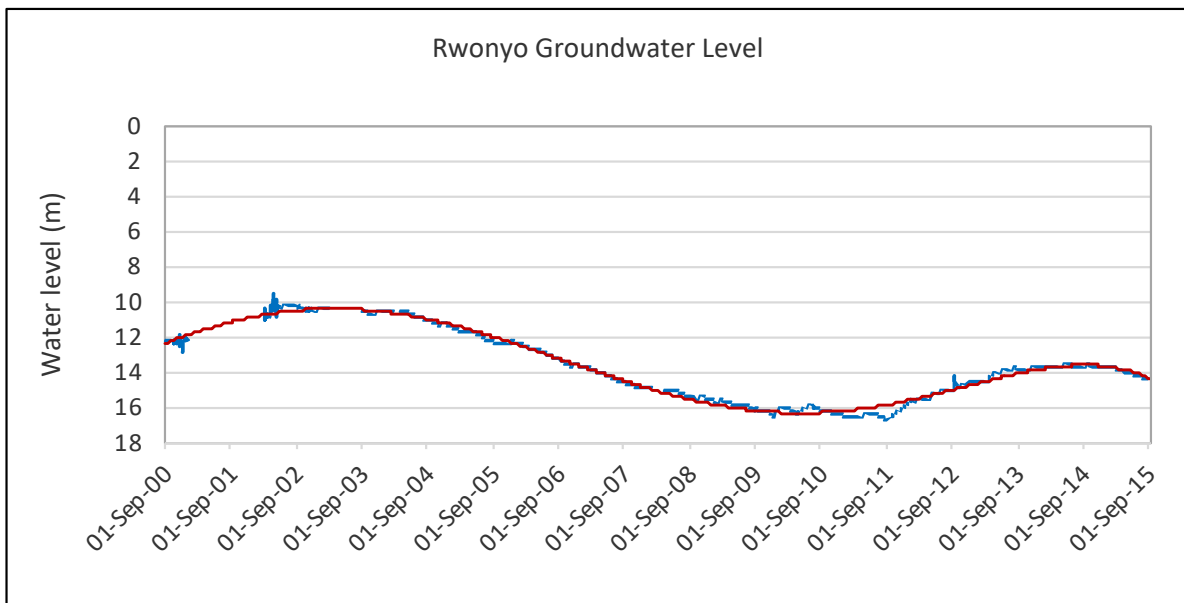
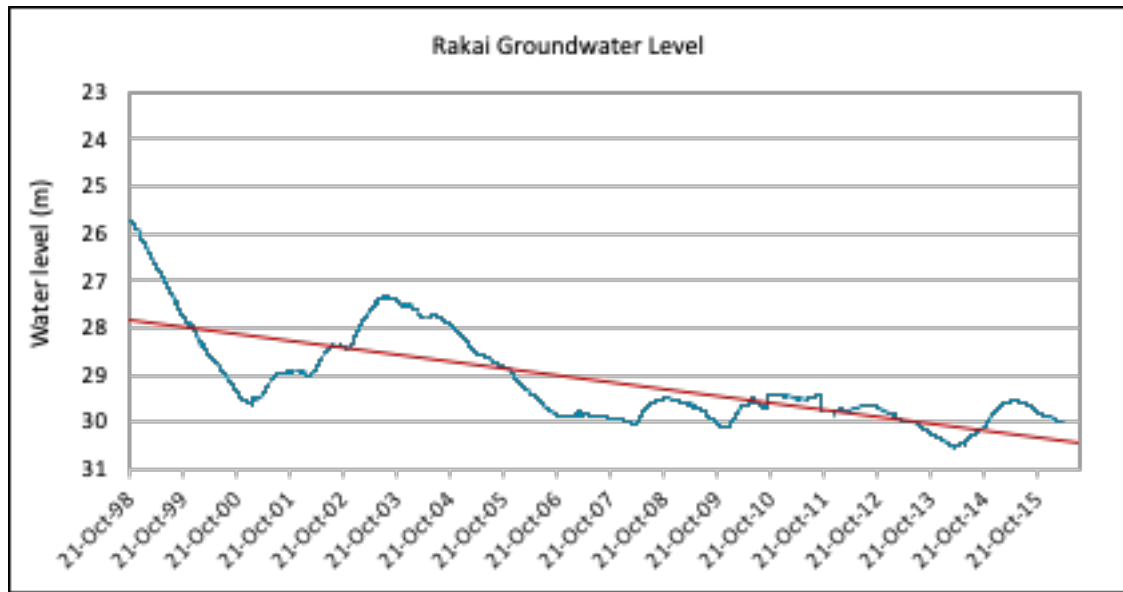


Figure 22: Groundwater monitoring well in Rakai

3.2.3 Water quality

3.2.3.1 Surface and groundwater Quality

The Directorate of Water Resources Management carries out water quality sampling and monitoring at various locations along Rwizi River as well as monitoring of both groundwater, surface water and effluents discharged to water bodies (Table 5).

Table 5: Water Quality of Rwizi Catchment

Site ID	EC (us/cm)	pH	T.Hard (mg/l)	COD (mg/l)	BOD (mg/l)	TSS (mg/l)	PO4 (mg/l)
L.Kijjanabarora (surface)	438	7.57	105	3	3	16	<0.08
L.Kachera	200	6.4	64	<22	<0.5	16	<0.08
L.Kachera (surface)	242	7.15	64	68	4.4	21	<0.08
L.Mburo	116	5.7	42	34	<0.5	15	<0.08
L.Mburo (surface)	156	6.93	48	3	1.8	62	<0.08
L.Nakivale	713	7.6	215	135	24	65	<0.08
L.Nakivale (shore)	547	8.24	175	135	3.1	34	<0.08
R. Bukora	189	7.4	99	45	0.8	19	<0.08
R. Kisoma	269	6.9	250	38	2.5	23	0.55
R. Rwizi	89	6.3	41	<22	<0.5	65	<0.08
Required standard	1500	5.5-8.5	600	100	50	500	10

Source: Draft Rwizi CMP 2015

Most of the ambient water sources present good quality water except Lake Nakivale which has high COD levels. The high COD in L. Nakivale is mainly due to human waste deposition in the lake due to the high population of refugees living at the shoreline of the lake. All the water sources have acceptable physical and chemical quality as shown in the table of results however some sources have microbial standards above the required standard which renders these particular sources unsuitable for human consumption.

Previous assessments (e.g. the WRSA 2014 and State of Basin Report for Victoria Water Management Zone 2016) revealed high values of color and turbidity in River Rwizi water, especially in areas with heavy settlement where wetlands have been encroached upon for various anthropogenic activities. Sediments may transport with them various contaminants from land, including nutrients, bacteria, and toxic chemicals from agricultural activities. Moreover, the sediments are deposited in the wetlands downstream in the lake/wetland system of Mburo, Kacheera, and Kijanebarola causing silting of lakes and wetlands, increased flooding due to reduced capacity of the river channel.

3.2.4 Water demand

The common water uses in the catchment were identified through literature and in consultation with the catchment stakeholders. The main water demand categories in the catchment area are:

- Domestic water demand
- Industrial water demand.
- Agricultural water demand-livestock, aquaculture, crop cultivation and irrigation

3.2.4.1 Domestic/Urban water demand

Taking into consideration the demographic factors of Rwizi catchment as well as the sub sector targets, the current and projected water demand has been computed (Table 6) based on population figures obtained from UBOS and a per capita water consumption of 25 litres per day in accordance with the basic service levels catered for in the Uganda National Water Policy 1999. The current (2020) and projected domestic water demand in the Rwizi catchment by the 2040 are 17.4 and 28.1 million cubic meters per annum respectively. The domestic water demand will increase by 62% by the year 2040. The major principal abstractors in the catchment for domestic water use are National Water and Sewerage Corporation (NWSC).

Table 6: Current (2020) and projected domestic water demands in Rwizi Catchment

District	%age of district in the catchment	Population growth rate	Current (2020)			2040 (projected)		
			Population		Domestic water demand	Population		Domestic water demand
			Rural	Urban	m3/year	Rural	Urban	m3/year
Buhweju	38	3.36	46,554	2,757	449,958	90,158	5,339	871,410
Bushenyi	10	1.13	27,861	1,651	269,300	34,882	2,067	337,160
Isingiro	60	3.69	331,397	8,721	3,103,575	675,848	17,786	6,329,410
Kiruhura	30	3.64	120,875	3,099	1,131,266	247,107	6,336	2,312,667
Lwengo	30	1.09	96,654	2,990	909,246	119,463	3,695	1,123,817

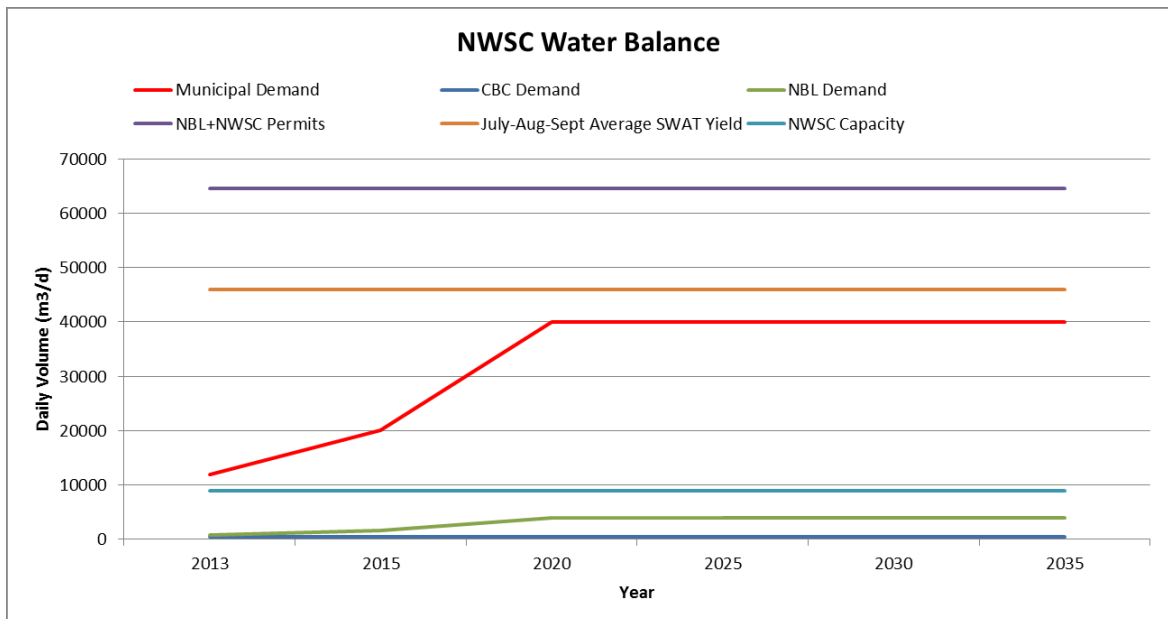
District	%age of district in the catchment	Population growth rate	Current (2020)			2040 (projected)		
			Population		Domestic water demand	Population		Domestic water demand
			Rural	Urban	m3/year	Rural	Urban	m3/year
Lyantonde	10	2.99	10,506	324	98,828	18,938	585	178,147
Mbarara	80	2.26	419,818	41,520	4,209,709	656,413	64,919	6,582,155
Ntungamo	10	3.57	63,839	3,159	611,355	90,286	4,468	864,630
Rakai	80	2.06	483,564	17,539	4,572,566	727,052	26,370	6,874,976
Sheema	80	1.34	215,014	4,389	2,002,053	280,599	6836	2,622,844
Total			1,816,082	86,149	17,357,857	2,940,746	138,401	28,097,216

NWSC demand

Mbarara Municipality water demand forms about 25% of the current catchment domestic water demand. The current demand was reported by NWSC to be 10,000 – 12,000 m³/d. The demand increases in the dry season and supersedes the total available water treatment capacity; at the same time the actual production capacity drops by up to a third because of low water levels in the river. As a result, water rationing is common in Mbarara during the dry season between June and September.

According to ARUP’s 2014 study, NWSC anticipates that water demand in Mbarara, that has been designated as a city, will grow to 40,000m³/d, in the next 5 – 15 years, largely due to urbanization. This represents a 300% increase on current demand. NWSC’s Strategic Plan 2013-18 contains a proposal to extend water services to at least 50 new towns in Uganda under the Small Towns Water Rehabilitation and Expansion Programme. This expansion is likely to include growth centres within the catchment. The long-term NWSC supply-demand balance is therefore projected to change as illustrated in Figure 23.

Figure 23: Long term NWSC supply-demand



3.2.4.2 Industrial water demand

Industrial water use includes water used for such purposes as processing, washing, diluting, cooling, or transporting a product; incorporating water into a product; or for sanitation needs within the manufacturing facility among others. Due to increasing urbanisation, the industrial water demand for both small scale and large-scale industries is increasing exponentially, directly impacting water resources in the region.

The industrial water demand was estimated by summing up all the water withdrawals of all existing industries in each district. The water withdrawal for each industry was obtained from secondary water use data obtained from the Ministry of Tourism, Trade and Industry (MTTI).

Industrial demand in Rwizi catchment is mainly within the districts of Mbarara, Rakai and Sheema, with Mbarara District presenting the highest demand (69%) (Table 7). The industrial water demand will increase by 106% by the year 2040.

Table 7: Present industrial water demand in Rwizi Catchment

District	%age of district in R. Rwizi basin	Industrial Water demand (m ³ /year)				
		2020	2025	2030	2035	2040
Buhweju	38%	12,096	13,500	15,200	16,900	20,280
Bushenyi	10%	1,663	1,996	2395	2,874	3,449
Isingiro	60%	13,880	16,656	19,987	23,984	28,780
Kiruhura	30%	13,542	16,247	19,496	23,395	28,074
Lwengo	30%	181	217	260	312	374
Lyantonde	10%	60	72	86	103	124
Mbarara	80%	300,888	361,066	433,279	519,935	623,922
Ntungamo	10%	3,233	3,880	4,656	5,587	6,704
Rakai	80%	89,194	107,034	128,441	154,129	184,955
Sheema	80%	907	1,088	1,306	1,567	1,880
Total		435,664	521,756	625,106	748,786	898,542

3.2.4.3 Agricultural water demand

Irrigation water demand

Currently, agriculture in the Rwizi catchment is predominantly rain-fed. In recent decades increasing incidences of climate change characterized by droughts (in the dry season) and floods (in the wet season), general increase in food demand as a result of high population growth, nutritional deficiencies and periodic famines have been fairly rampant. This condition is partly blamed on occasional poor harvests due to erratic rain seasons which have a very significant impact on the largely rain-fed subsistence farming system. No major irrigation schemes are currently developed in the catchment.

There is currently a total of approximately 774,119 hectares of potential irrigable land area. The 2010-2035 National Irrigation Master Plan for Uganda (MWE, 2011) quotes an irrigation expansion rate of less than 0.05%. The projected irrigable area was estimated using the following formula: where, A_n is the potential irrigable area after n years; A_0 is the present potential irrigable area and r is the estimated irrigation expansion rate (0.05%).

The deficit between total annual rainfall and potential evapotranspiration over the catchment formed

the basis for estimation of the irrigation water requirement (Table 8) considering the current and projected potential irrigable area per district.

The irrigation water demand in the catchment is anticipated to increase due to more erratic rains in future and increased demand for food due to increasing population. The current irrigation water demand in catchment was estimated to be 3.53 million cubic meters per annum, however this is anticipated to rise to 3.57 million cubic meters per annum in year 2040 (Table 8).

Table 8: Current (2020) and projected irrigation water demand in Rwizi Catchment

District	%age of district in R. Rwizi basin	Potential irrigable area (ha) 2020	Industrial Water demand (m3/year)				
			2020	2025	2030	2035	2040
Buhweju	3%	26,242	220,661	221,213	221,767	222,322	222,878
Bushenyi	1%	9,100	190,571	191,048	191,526	192,005	192,485
Isingiro	15%	16,006	802,403	804,411	806,424	808,442	810,465
Kiruhura	17%	138,655	361,081	361,985	362,891	363,799	364,709
Lwengo	7%	30,811	290,871	291,599	292,329	293,060	293,794
Lyantonde	3%	8,909	180,541	180,992	181,445	181,899	182,355
Mbarara	15%	143,459	361,081	361,985	362,891	363,799	364,709
Ntungamo	2%	20,550	180,541	180,992	181,445	181,899	182,355
Rakai	31%	324,212	581,742	583,198	584,657	586,121	587,587
Sheema	7%	56,176	361,081	361,985	362,891	363,799	364,709
Total	100%	774,119	3,530,573	3,539,408	3,548,266	3,557,145	3,566,047

Livestock water demand

The current livestock water demand per district was computed by summing the water demand for each livestock type (i.e. cattle, goats, sheep, pigs and poultry). The current water demand for each livestock type was estimated by multiplying the livestock count for each livestock type with the unit water demand for one (1) Tropical Livestock Unit (TLU) and the respective livestock coefficient.

The current (2020) livestock counts (Table 9) were projected from UBOS's 2014 livestock census using the following formula: Where, is the livestock count after n years; the baseline (2014) livestock count and is the annual growth rate (%). A similar study in the sub-Saharan region recommends growth rates of 0.002, -0.048, -0.041 and 0.061 for cattle, sheep, goats and pigs respectively. According to FAO (2010) the poultry growth rate in Africa is 3.1%. The same formula was used to project the livestock counts for the subsequent years as presented in Annex 2.

Table 9: Current (2020) Livestock numbers for different livestock in Rwizi Catchment

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	574	50	121	28
Bushenyi	1%	23	23	4	3	21
Isingiro	15%	27,112	33,210	4,541	1,139	36,921
Kiruhura	17%	53,455	17,206	2,554	734	13,285
Lwengo	7%	3,136	4,358	393	1,266	14,879
Lyantonde	3%	2,117	1,316	155	290	2,079
Mbarara	15%	143,217	83,792	7,409	10,705	152,768
Ntungamo	2%	4,634	5,516	838	181	4,494
Rakai	31%	64,363	85,273	9,944	42,097	258,586
Sheema	7%	3,343	6,060	1,283	931	23,754
Total	100%	301,689	237,329	27,171	57,467	506,814

The current (2020) and future water demand (m³/year) per district was estimated by summing the product of the livestock count, the unit water demand for one (1) Tropical Livestock Unit (TLU) and the respective livestock coefficient. According to DWD (2000), one TLU needs 50 litres/day; one head of cattle shall be deemed to be 0.7, one goat shall be deemed to be 0.15, one sheep shall be deemed to be 0.15 and one pig shall be deemed to be 0.4 of a TLU respectively. The conversion factor for poultry as proposed by Winchell (2001) is 0.005. Table 10 summarizes the current (2020) and future annual livestock water demand (m³/year) per district.

Table 10: Current (2020) and future annual livestock water demand

District	%age of district in R. Rwizi basin	Total Livestock Water Demand (m ³ /year)				
		2020	2025	2030	2035	2040
Buhweju	3%	6,293	6,293	6,293	6,294	6,294
Bushenyi	1%	394	394	394	394	394
Isingiro	15%	460,722	460,549	460,424	460,339	460,289
Kiruhura	17%	743,245	743,156	743,084	743,026	742,981
Lwengo	7%	63,238	63,100	62,981	62,878	62,790
Lyantonde	3%	33,325	33,306	33,289	33,275	33,262
Mbarara	15%	2,167,311	2,166,046	2,164,977	2,164,075	2,163,318
Ntungamo	2%	78,261	78,248	78,240	78,238	78,239
Rakai	31%	1,405,426	1,402,646	1,400,199	1,398,037	1,396,120
Sheema	7%	71,150	70,955	70,790	70,652	70,535
Total		5,029,365	5,024,693	5,020,671	5,017,207	5,014,224

3.2.4.4 Environmental flows

Environmental and ecosystem water needs are not straight forward to estimate. They vary with season, and thus ecosystems are usually adapted to seasonal occurrences such as droughts and floods. The environmental flow that should be left in the river at all times is estimated as the flow in the river equaled or exceeded 95% of the time (Q95), equivalent to 1.93 m³/s (60,864,480 m³/year) accordingly to the Rwizi River flow attributes in Table 3. In the absence of detailed environmental asset mapping in the catchment, the Q95 considered for the environmental flow would be sufficient for maintaining the river natural ecosystem functions.

3.2.4.5 Total water demand

The total current (2020) consumptive water demand for Rwizi catchment is about 26.35 MCM/year. The total consumptive water demand is expected to rise to an estimated 37.58 MCM/year in 2040. Table 11 provides sectorial breakdown of this projection. Crop irrigation is projected to become even more dominant in future, when plans for new irrigation projects are implemented.

Table 11: Total current (2020) and projected consumptive water demand by different sectors

Category	Million cubic meters per year				
	2020	2025	2030	2035	2040
Domestic	17.36	19.60	22.18	25.13	28.10
Irrigation	3.53	3.54	3.55	3.56	3.57
Livestock	5.03	5.02	5.02	5.02	5.01
Industrial	0.44	0.52	0.63	0.75	0.90
Total	26.35	28.69	31.37	34.46	37.58

3.2.5 Water balance

While the water availability assessment provides ideas on the quantity of water available in time and space, and the water demand assessment quantifies the required amounts in time and space, the water balance weighs the available water resources in the catchment (both surface water and groundwater) against the estimated water demands in order to determine if the demands can be met currently and in the future. Where a water surplus is evident from the assessment, an opportunity for increased productive water use can be indicated in the management plan. More so, if water demands are currently not met or cannot be met in future, identification of the areas that require measures to improve water use efficiency and to manage water deficits is done.

With the current (2020) and projected (2040) consumptive water demands for the Rwizi catchment being 26.35 MCM/year and 37.58 MCM/year respectively, the consumptive demands are seen to be accommodated by the low flows at 95% time exceedance (Q95), equivalent to 1.93 m³/s (60,864,480 m³/year) accordingly to the Rwizi River flow attributes Table 3. The available water resources are further supplemented by the sustainable groundwater resources estimated to be 109.3 mm/year (875 MCM/year).

Currently therefore, the water available surpasses the consumptive water demand and therefore there are no consumptive water demands that are not met. The projected (2040) consumptive water demands will also be met.

3.2.6 Issues on water resources

3.2.6.1 Water scarcity and increasing water demand

Increased water demands for industrial, livestock, urban development and domestic use has

contributed to the drying of the river, an indication of the general decrease in water availability in the entire catchment. This is especially true of Mbarara where there is rapid urban and industrial development with unpredicted ever-increasing population. This has resulted in direct effluent discharge into the river since most of the major polluters cannot meet cost of wastewater treatment. This is compounded by the fact that some buildings/facilities have old or no sewer lines. The combination of the overwhelming water demand and the outcome of direct solid waste and effluent discharge have led to the declining water levels and water quality of river Rwizi.

The Ministry of Water State of Water Resources Basin Report for Victoria Water Management Zone for the year 2017 provides different scenarios for domestic demand, agricultural demand, irrigation demand, livestock water demand, industrial water demand for the years 2020 – 2040 (see Table 11 above)⁹. The table below summarizes the consumptive water demand for the different sectors within the Rwizi Catchment.

3.2.6.2 Water quality issues and low water supply coverage

Districts that form part of the Ankole cattle corridor have low water supply coverage. Access to water supply in Isingiro district for example, stands at 43%, although the safe water access rates vary significantly from 13% in Rushasha sub-county to 95% in Kabingo sub-county according to the Uganda Water Supply Atlas, 2020. Water quality for boreholes gives results indicating less satisfactory physical and chemical particles at water sources, specifically with high iron and suspended solids content. As a result, water colour and turbidity are higher than national standards for potable water in Isingiro District (Plate 1). There is water scarcity leading to high water costs (particularly due to water trucking to schools, health facilities and households).

Surface water shows significant levels of water turbidity and iron. Borehole water shows high levels of hardness and high contents of elements such as calcium, magnesium, iron, fluoride and manganese and other elements which spoil the taste of water. Water supply access in Kiruhura stands at 42% and Lyantonde at 49% (MWE, 2020).

Plate 1: River Nyamuyanza, Isingiro district, exhibiting high turbidity



⁹ Source: MWE, 2017: State of Water Resources Basin Report for Victoria Water Management Zone

3.2.6.3 Pollution of water resources

The rapid urbanisation and industrial development within the environs of Mbarara and Ntungamo Municipalities with no clear physical planning are impacting heavily on the already degraded water resources, in terms of water quality and quantity (Plate 3). Key environmental issues with regard to these municipalities as pollution hotspots include:

- i. Discharge of untreated wastewater into R. Rwizi
- ii. Lack of proper wastewater treatment facilities for industries.
- iii. Improper solid waste management at collection site and sites identified as dumping sites such as TASO Village, Kolanoolya, Kenkombe in Mbarara municipality among others.
- iv. Indiscriminate waste disposal in wetlands near Mbarara Municipality
- v. Non-permitted / Illegal waste-water discharges from factories into rivers and wetlands.
- vi. Reduced water levels during the dry season leading conflicts on water use
- vii. Soil erosion due to run-off as a result of storm drainage system discharging into all rivers (including ephemeral river systems).

Poor waste management by upcoming small-scale industries and urbanization in small towns and urban centres like Buhweju, Sheema (Kabwohe), and Lyantonde have affected the water quality in the downstream. In Buhweju for example, the river and streams are points for waragi distilling which also affects the downstream in Rakai. Animals directly get water from water dams than from established watering points (Plate 2), oftentimes defecating into the water source and potentially leading to easy spread of livestock diseases. In Mbarara, at Kolanoolya and in Lyantonde, the waste dumping sites do not have mechanisms for handling waste, with the residual liquids let to flow into streams and channels that later find their way into water bodies (Plate 3).

Plate 2: Cows being watered directly from a water source

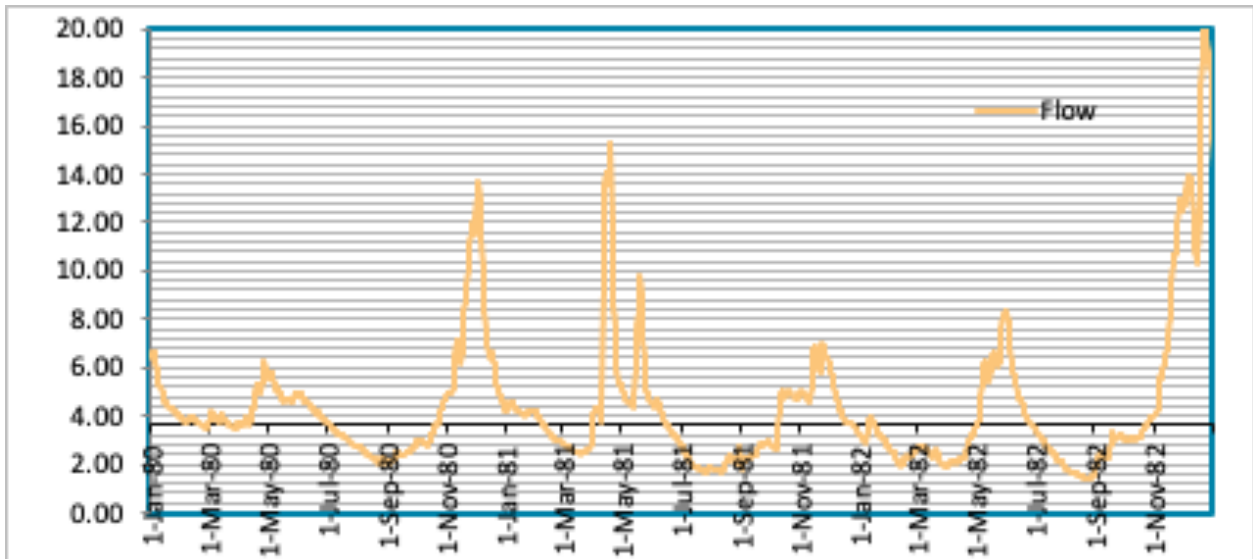


Plate 3: Part of the dumping site at Kolanoolya, Mbarara Municipality



3.2.6.4 Drought

Rwizi catchment has always been in news due to frequent occurrences of drought particularly during the mid-year dry season from June to October. Drought flows are similar to low flows, except that the duration of the period is defined in months instead of days. The values are average low flows developed from monthly records (as opposed to daily records). These values are useful in determining reservoir yields for which drought severity over a lengthy period is a critical parameter. The drought durations and severities for all stream flow drought events were calculated based on stream flow drought concept and threshold levels. A series of drought parameters were obtained by considering values below a threshold. The threshold value was obtained as 70% exceeded flow (3.63m³/s) from the flow duration curve. The frequency of drought minimum flows was highest in months of October and September. Though the mean frequency of drought amounted to less than one per year. The drought duration analysis showed years with droughts grouping in 2 to 3 years cycle and even multi-annual ones, a fact also observed within the catchment (Figure 24).

Figure 24: Low flows below 7 day moving average for hydrological drought analysis

The most frequent number of droughts per year was 3 while the maximum droughts were 7 which occurred in 2006. Though the most frequent droughts per year were 3, the mean numbers of droughts per year were 2 with a minimum of 1 drought. Rwizi catchment therefore has higher prevalence of hydrological droughts. The course of minimum annual discharge-AM (1-day) identified within the period of record corresponds with the number of days with the discharges equal or less than 90%. The mean minimum flow for drought periods considered was 2.75m³/s while minimum and maximum flows during the drought periods were 1.12m³/s and 3.62m³/s respectively.

3.3 STAKEHOLDERS

3.3.1 Inventory of stakeholders

Key stakeholders in the Rwizi catchment were identified and categorized at different levels. These are the central government; local government; political representatives, local community; civil society; water supply and sanitation operators; private sector, semi-autonomous agencies, representatives of ongoing water/ environment projects within the catchment.

3.3.1.1 Central Government

One key category of stakeholders has been grouped as central government and this includes ministries, departments and agencies of central government. They include Directorate of Water Resources Management, Directorate of Water Development, Directorate of Environment Affairs, Wetland Management Department, National Environment Management Authority, (National Forestry Authority, National Water and Sewerage Cooperation, Uganda wildlife Authority, Ministry of Health, Ministry of Lands, Housing and Urban Development, Ministry of Agriculture Animal Industries and Fisheries, among others). These are interested in ensuring sustainable resource use and management. They have the responsibility to put in place the enabling environment for catchment management in form of relevant resource use and management guidelines, policies, and institutional frameworks. They also bear the responsibility to provide relevant information and technical support to the rest of the stakeholders. They should therefore be involved early enough in the catchment planning process through the implementation phase to provide technical oversight.

3.3.1.2 Districts and Lower Local Governments

These largely include districts, sub-counties and village councils. They are interested in ensuring that the persons they represent have access to resources & services, and that they meet development

needs (water, food, income, social services, infrastructure etc.). They bear responsibility to put in place local policies and byelaws that guide access to, and use of, resources. They should also be engaged early enough in the catchment planning stage to seek their buy-in; and later during the implementation phase for them to put in place the necessary policy, legal and institutional frameworks for plan implementation, including providing for local co-financing for plan implementation.

3.3.1.3 Catchment Management Committee

There exists a Catchment Management Committee that is made up of 42 members drawn from each of the DLGs in the catchment. The number can be increased as new stakeholder groups are identified. The Catchment Management Committee (CMC) made a reconnaissance of the entire catchment in August 2013 and this has been basis for development of this management plan. The CMC continues to visit specific sites prior to their quarterly meetings, to acquaint themselves of the hotspots requiring immediate attention. The committee provides recommendations for interventions, informed by technical oversight by the Victoria Water Management Zone.

3.3.1.4 Local community members

These are the day-to-day users of the resources available within the catchment (crop and livestock farmers, fisher folk, women, men, youth, vulnerable persons etc.). They are interested in accessing the catchment's resources and services (water, land, trees, fish, minerals, art and crafts materials from wetlands etc.) to meet their livelihood and development aspirations. One key category of local community members are the landlords, who make key decisions on utilisation of plots of land and related resources (decisions on farming, wetland/woodland reclamation to pave way for grazing land, mining minerals among others). They therefore have the responsibility to participate in the catchment planning process by identifying watershed issues, presenting their own views and concerns, discussing options, and providing recommendations and approaches to address the issues. During plan implementation, they should be engaged to adopt wise resource use and management strategies to ensure sustainable productivity of the catchment. The local community members view themselves with little influence and power, though they are aware that they are important or key stakeholders in water resource management. On the other hand, they view the Local government officials to have a lot of power and influence on water resource management especially wetlands. To mediate in these power and relation struggles are the faith based and cultural institutions at community level. These command a lot of respect and have a big constituency. Their interest is a community that lives sustainably and a society free of struggles.

3.3.1.5 Civil Society

These are the NGOs and CBOs in the water, community development, natural resources, land and environment sub-sectors. They are interested in sustainable resource use and management, community livelihoods & development as well as playing the public watchdog role to monitor good governance of the sector. They therefore have responsibility to fully participate in the catchment planning process - identifying watershed issues, presenting community views and concerns, discussing options, and providing recommendations and approaches to address the issues alongside demanding that the political and civil leadership deliver water resources development as provided for in the policy aspirations of the country. In addition, civil society are partners of choice to the government in delivering development, by way of sourcing for complementary resources to support development initiatives. During plan implementation, they should be engaged to guide wise use of catchment resources for sustainable community development; and provide knowledge and experiences on best practice gained from elsewhere.

3.3.1.6 Water Supply and Sanitation operators

Water supply and sanitation operators include National Water & Sewerage Corporation, water boards, water user associations, etc. In the catchment, they are mainly interested in availability of

water and demand for water and sanitation services. They therefore have responsibility to support plan implementation if they are to be assured of sustainable catchment with goods and services. They can be engaged through Corporate Social Responsibility approaches e.g. investing resources towards management of catchment areas for sustainable water supply. This category of stakeholders is supported by structures such as the environment committees and village health teams (already playing a role in the environment and healthy sector).

3.3.1.7 Private sector & semi-autonomous agencies

The private sector and semi-autonomous agencies' interests are in catchment goods and services e.g. water, agricultural produce, livestock and livestock products, etc. They have a role to play in maintaining sustainable catchment goods and services; investing in programs that support catchment sustainability e.g. tree planting, sustainable agriculture, wetland rehabilitation, etc. These are key stakeholders as viewed by the respondents during consultations however they view themselves with medium to low power and influence due to the fact that they do not have full mandate over decision making over the management of water resources in the catchment. The major sector players include industries e.g. Nile Breweries, Century Bottling Company, Pearl Dairy, Amos Diaries, GBK, Tip Top Diaries, Hotels etc. In fact, already some of these have identified resources to support projects and programs related to catchment restoration in Upper Rwizi sub-catchment.

3.3.1.8 Development partners

These are mainly partners supporting development initiatives in the water, community development, natural resources, land and environment sub-sectors. They are interested in sustainable resource use and management, community livelihoods & development. Their role is to provide technical and financial support towards the proposed investments in the Catchment Management Plan. Their interest is to identify bankable proposals for sustainable investment and therefore should be brought on board during planning as well as implementation phase.

3.3.1.9 Academic and research institutions

The sustainability of the catchment requires research related to water resources management, aquatic biodiversity, ecosystem services restoration, impacts of climate change on water resources and related livelihoods and research in social issues. Academic and research institutions such as Mbarara University of Science and Technology, National Fisheries Resources Research Institute, National Forestry Resources Research Institute, the World Agroforestry Centre among others, should be part of the development and implementation of the catchment management plan.

3.3.2 Current partnership

Partnerships exist between public authorities, companies and civil society to address shared threats to water security in the Rwizi Catchment. These include:

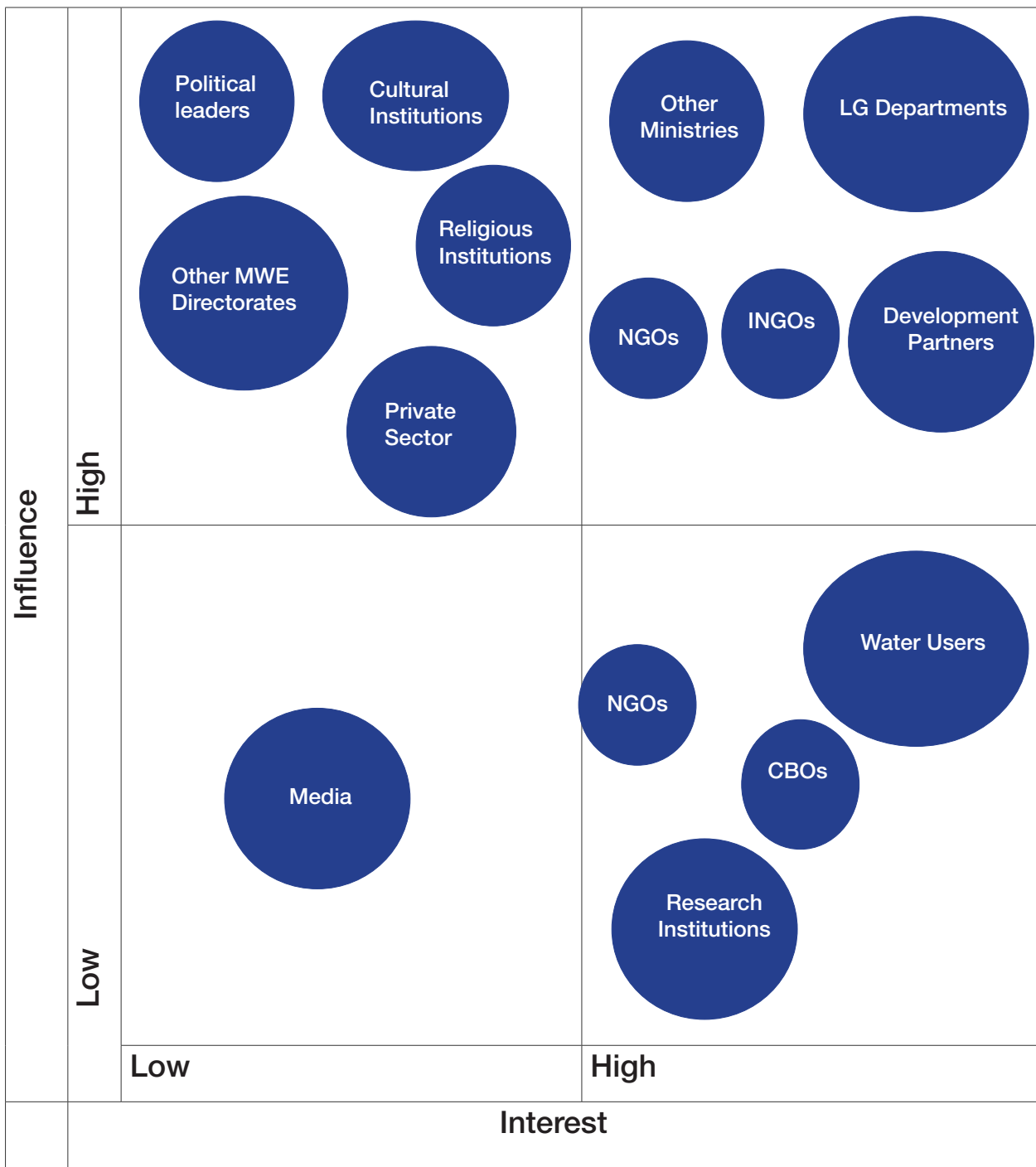
- Various NGOs and faith-based organizations: IUCN, ACODE, ACORD, WWF, Mbarara Diocese, Kigezi Diocese, CECODE, Active Citizen, UNHCR among others
- Development partners: World Bank, DANIDA, Austria Development Aid, DFID, GIZ, FAO,
- Other government programmes: Operation Wealth Creation, Inclusive Green Growth for Poverty Reduction, Youth Livelihoods Programs
- Private sector: Coca Cola, Nile Breweries, Hotels in Mbarara, Banks.
- Local governments – 11 DLGs that will implement the CMP but also rollout CbWRM
- The Green Economy Network – engaging civil society to play their role in galvanizing good governance in the catchment.

3.3.3 Power dynamics

Analysis of the interests and influencing power of the different stakeholder groups is visualized in Figure 25. The position in the chart and the extent of their circle (of influence) shows their position regarding Catchment based Water Resources Management (CbWRM), and thus whether they form strong allies or potential brokers.

The stakeholders positioned in the top right corner with high influence and high interest could be strong allies for CBWRM in Rwizi Catchment, and DWRM must fully engage and make the greatest efforts to satisfy and ensure that the interests of these stakeholders are addressed. The stakeholders with a larger circle would potentially form stronger partners than the others, because of their roles and responsibilities within the catchment and in Uganda.

Figure 25: Rwizi catchment Stakeholder Power dynamics



The stakeholders positioned top left with high influence and little interest have the potential to be brokers of the catchment management process and its therefore important to keep them well-informed and lobby towards their support for improved water resources management in collaboration with other stakeholders. Here it shows that these stakeholders are all very influential and a strategy for their engagement carefully needs to be rolled out, like DWRM keeping these stakeholders informed, but not so much that they become bored with the message.

The stakeholders positioned bottom right with high interest, but low influence could become stronger participants in CbWRM through the CMP. However, their capacity in this (e.g. negotiation skills) should be strengthened to become strong discussion partners and collaborators. It is mostly this group of stakeholders (water users) that are highly affected by a lack of proper CbWRM frameworks and probably have thought through themselves some strategies to overcome issues they are faced with. It is important that these (representatives of) primary beneficiaries participate in catchment management processes.

A few NGOs have also been found to have high interest in CbWRM issues but have limited influence. In as much as they may not be very influential, they are key in engaging to tap into their contribution to mobilization of stakeholders, capacity building, and their financial muscle to implement actions in this Rwizi Catchment Management Plan.

3.3.4 Issues on stakeholders

The challenges highlighted by stakeholders in the Rwizi Catchment range from limited awareness of importance of water resources management, limited prioritization (and therefore funding) for WRM by government and district local governments, inadequate capacity for WRM, low level of coordination and collaboration among stakeholders, inadequate integrated planning and development as well as rampant environmental degradation associated with attitude and behavior. Table 12 below summarizes the concerns, their causes and associated impacts.

Table 12: Voices of concern raised by stakeholders

Voice of concern	Immediate cause	Proposed solutions
Deterioration in attitude and behavior towards management of natural resources	<ul style="list-style-type: none"> • Failure to attach economic value on environment and natural resource • Failure in extension service delivery at household level to raise awareness about the importance of environment and natural resources. 	<ul style="list-style-type: none"> • Undertake an economic evaluation of natural resources • Improve and fund the provision of extension services • Create awareness about environment and natural resources
Failure of environment and natural resources management institution to collaborate	<ul style="list-style-type: none"> • Lack of capacity especially financial and human capacity for the institutions to implement their mandate. • Uncoordinated planning and implementation of projects and programs. 	<ul style="list-style-type: none"> • Improve the funding of institutions responsible for environment and natural resources management. • Improve the coordination of government projects and programs • Mainstream environment and natural resources management into projects and programs of sectors with high impact on natural resources

Voice of concern	Immediate cause	Proposed solutions
Lack of information and data related to water resources management in the catchment	<ul style="list-style-type: none"> Weak mechanisms for collection, analysis and sharing information on water resources management 	<ul style="list-style-type: none"> Improve the collection, storage and management of data and information relating to water resources management across the board

3.4 SOCIAL AND ENVIRONMENTAL CONTEXT

3.4.1 Demography in the catchment

According to UBOS, the catchment has a total population of 2,454,611 persons (National Population and Housing Census, 2014), and this has been estimated to have increased to approximately 3,000,000 by 2019. Within the catchment, the estimated average population density in the catchment is 174 persons per sq. Km of land area, which is the same as the national figures and which have risen from 123 persons per sq. Km of land area in 2002. (National Population and Housing Census 2014). It is expected that by 2035, 15% of the population will live in urban areas (Ntale, 2012), that number potentially increasing to 50% by 2050 (UN Habitat, 2012).

The catchment is facing increased pressures due to the increasing human and animal population, seasonal migrations by pastoralists, land reclamation for farming and construction, clearing of hill slopes for agriculture and sand mining from the river bed. This has resulted in degradation of the natural environment, particularly along livestock corridors, in the wetlands and hill slopes.

In addition to the settled population, the catchment hosts a significant number of important industries, secondary schools, tertiary educational institutions, universities and hospitals. Tourism is also a vital sector of the economy due to the presence of Lake Mburo National Park in the catchment, and the proximity of Queen Elizabeth National Park. Schools, universities and hotels, therefore, represent a significant transient population that varies over the year.

The main economic activities carried out in the districts in the catchment are:

- subsistence and commercial crop agriculture, including eucalyptus plantations;
- livestock rearing (and the associated livelihoods opportunities);
- fish farming and rudimentary fishing on lakes such as Lake Kachera;
- tourism, even outside the gazette protected areas;
- manufacturing and processing industries;
- local industries such as brick making, sand mining, use of the papyrus reed for making baskets; mats and art pieces, and;
- Local subsistence activities such as motor vehicle/motor cycle washing and motor vehicle garages;
- Sand mining along river beds;
- Gold mining especially within the Upper Rwizi sub-catchment;
- Charcoal production, transportation and trade; and,
- Trade in agricultural products in market places that are mushrooming across the board.

The growing population in the catchment has the following impacts:

- All the water demand and pollution loading trends examined are increasing, mainly as a result of population growth and increasing urbanizations (increases in the range of 300 -500%, by 2035).
- There are significant demands on the catchment resources, which are projected to grow, including domestic and agricultural demand.
- Population growth has led to individualization of land through various forms of tenure, which has greatly changed land use in the catchment.
- 90% of the population in the catchment is involved in subsistence farming with an exponential impact on the catchment and the ecosystem.

3.4.2 The Nakivale refugee settlement

Nakivale refugee settlement is a settlement located in Isingiro District. It was officially established in 1960 and has 95,633 households covering an area of 185km². The settlement has become an ecological hotspot because of the increasing population with densities of 590/km² and related demand for environment and natural resources. By April 2019, refugee statistics stood at 104,169 refugees and 5,651 asylum seekers. These were mainly from the Democratic Republic of Congo (54, 336), Burundi (31,037), Somalia (13,050), Rwanda (9,278), Eritrea (1,041) and Ethiopia (852). Population within the settlement grows by way of new registrations and child birth. New registration statistics grew from 1,852 in November 2018 to 2,868 in March 2019. New births increased from 55 in November 2018 to 1,331 in April 2019.

The impacts associated with the refugee settlement include:

- i. More land is opened for settlement as each of the adult refugees is assigned a plot of land for settlement.
- ii. Refugees largely depend on charcoal and firewood for cooking and this has an impact on the ecosystem.
- iii. Refugees, too, require water which is not readily available especially in the dry season
- iv. Refugees generate waste which is dumped within the ecosystem and this has a direct impact on the quantity and quality of water.
- v. Refugees keep animals which depend on the ecosystem for survival but also require water; which is a challenge in the dry season.
- vi. Because of the high densities, areas around Nakivale are highly degraded requiring a comprehensive ecosystem restoration plan.

3.4.3 Land ownership

Stakeholders pointed out that historically land use in Rwizi catchment was under communal grazing and cultivation, particularly in the districts of Kiruhura, Isingiro and Ntungamo. Population growth has led to individualization through various forms of tenure and this has greatly changed the land use in this catchment. Lake Mbuho National Park in Kiruhura district is a protected and gazetted area for wildlife. One hundred and sixty-eight (168) hectares of Mbarara Forest Reserve are encroached since 2007 for urban development. There is pressure to de-gazette more forest reserves and encroachment on wetlands. The sub-region is reported to be one of the most highly deforested (ARUP, 2014) and this is greatly contributing to soil erosion. Currently the common land tenure systems in Rwizi catchment area are freehold, leasehold, customary, and common property land ownership. The latter is the most common involving communal grazing on natural pasture.

3.4.4 Economic activities

River Rwizi is an important direct and indirect source of water for agricultural, domestic, industrial and small-scale economic activities across the catchment. It is the only source of water for Mbarara Municipality, the largest urban centre in Western Uganda. Mbarara also hosts a significant number of important industries, secondary schools, tertiary educational institutions, universities and hospitals. Tourism is also a vital sector of the economy due to the presence of Lake Mburu National Park in the catchment, and the proximity of Queen Elizabeth National Park. Schools, universities and hotels, therefore, represent a significant transient population that varies over the year.

The main economic activities in the Rwizi catchment are subsistence and commercial crop agriculture, livestock rearing, fish farming, tourism and local industries (brick making, sand mining, motor vehicle washing, motor vehicle repair garages, use of the papyrus reeds for making baskets, mats and art pieces and wide-spread growing of eucalyptus trees). Artisanal gold mining is the main economic activity in Buhweju.

River Rwizi is an important direct and indirect source of water for agricultural, domestic, industrial and small-scale economic activities across the catchment. It is the only source of water for Mbarara Municipality, the largest urban centre in Western Uganda. Mbarara also hosts a significant number of important industries, secondary schools, tertiary educational institutions, universities and hospitals. Tourism is also a vital sector of the economy due to the presence of Lake Mburu National Park in the catchment, and the proximity of Queen Elizabeth National Park. Schools, universities and hotels, therefore, represent a significant transient population that varies over the year.

The main economic activities carried out in the 10 districts in the catchment rely on water from the river and the rest of the surface water system, mainly through naturally occurring wetlands and constructed valley dams and tanks.

3.4.4.1 Crop farming

Major crops in the Rwizi catchment are fruits, perennial pulses, root crops, cereal grains, and vegetables and include: Bananas, Beans, Millet, Coffee, tea and Ground nuts among others. The cash crops include coffee and tea and the rest are mainly food crops. Fruits and vegetables are also grown, and they include citrus, tomatoes, cabbages onions and pineapples.

The farmers are organized under a network of Cooperative societies mainly under the umbrella of Banyankole Kweterana Cooperative Union specializing in coffee, ranching and distribution of Agro-chemicals. Uganda Crane Creameries Cooperative is also supporting dairy farmers in improved production and productivity and marketing of milk and dairy products.

3.4.4.2 Livestock rearing

River Rwizi is one of the main rivers in south western Uganda and is source of water for thousands of local people and their livestock. Cattle keeping is a major economic activity and the indigenous Ankore long-horned, exotic and cross-bred cattle are reared for beef and dairy products. A diverse range of small, medium and large water users rely on the catchment's water resources for their supply, which include groundwater and surface water (from the river, lakes, naturally occurring wetlands and constructed valley dams and tanks).

The parts of Isingiro and Kiruhura districts within the catchment, as well as the northern area of Mbarara district are typically semi-arid rangelands dominated by shrubby habitat. Natural vegetation in these areas is mainly an open formation of shrubs and small trees, utilized for grazing and fuel wood collection. Other livestock types kept in the catchment include pigs, sheep, goats and poultry.

3.4.4.3 Fisheries

Fishing and fish farming is also common in the lakes, rivers and wetlands within the catchment.

Fishing of mudfish from River Rwizi and the catchment lakes is on a declining trend with some species almost getting extinct. There is small scale fishing on Lakes Mburo, Kachera, Kijjanibarola and Nakivale as well as rudimentary fishing practices on rivers and major wetlands within the catchment.

3.4.4.4 Tourism

Wildlife and Tourism are the other economic ventures in the Rwizi catchment. Lake Mburo Conservation Area located in Kiruhura district is the main National Park in the Rwizi catchment. It is popularly known as “home of zebras”. The wild animals include zebra, warthogs, impala, topi, oribi, eland, klipspringer, buffalo, waterbuck, reedbuck, baboon, vervet monkeys etc. (Uganda Districts Information Handbook 2011).

Wetlands and forests in the catchment are home of wildlife. These habitats are however threatened by human destruction. Some of the wildlife also pose a threat to people as they are vermin that destroy their crops (e.g. baboons and monkeys). Antelopes mainly in swamps (e.g. enjobe), were hunted by the people and provided a cheap source of protein but these are currently rare as most wetlands have been disturbed by human activity.

Tourist attractions in the Rwizi catchment include Lake Mburo Conservation area wild game; Sanga Cultural Village – a cultural centre for Hima ethnic group; Lake Kachera’s location next to wild game of Lake Mburo Conservation Area; Lake Nakivale sandy beaches and expansive open grounds around the lake, hilly terrain of Buhweju provides opportunity for climbing and sightseeing; Igongo Cultural Centre for cultural education; Lake Kijanebarola; the landing sites/beaches on the lakes are ideal for campsites. Kasensero landing site has been developed into an eco-tourism and picnic site; Musambwa Island and Serinya tombs in Rakai, are important cultural sites. The lakes are used for tourist activities which include boat rides and sport fishing - an arrangement between UWA and the Lake Mburo riparian communities.

3.4.4.5 Industries

Industries in the catchment include bee honey, coffee and tea processing; weaving and knitting, manufacture of textiles and wearing apparel; gold, limestone, clay and sand mining, brick and furniture making, metal fabrications, grain milling products, bakery products, processing dairy products, manufacture of animal feeds; foot wear, leather tanning, dyeing of fur, agricultural machinery repairing; printing and publishing, making laundry soap, manufacture of food products and beverages (soft drinks and beer brewing), jaggery, and tobacco curing.

3.4.4.6 Gold mining in Buhweju district

Gold in the Buhweju-Mashonga goldfield was first discovered in 1933, mining commenced the next year in 1934. Buhweju district has eight sub counties and half of them are said to have gold deposits (Plate 4).

Plate 4: Gold mining in Buhweju District, one of the causes of degradation



There are artisanal mining activities in Rwizi catchment especially in the swamps and river valleys in the upstream of the catchment (Bushenyi, Buhweju and Sheema districts) already presents challenges to water quality downstream. There are fears that artisanal miners could be utilising heavy metals such as mercury in the process of mining. These activities are expected to have significant impacts on water resources in the catchment (pollution/poor water quality, reduced water flows, silting of the rivers and streams). The implementation of this plan should take due consideration of the challenges associated with artisanal mining. Therefore, a comprehensive study on the impact of mining on water resources is proposed to provide information on these mining activities in the catchment in order to have a clear idea of the impacts these activities have on the water resources availability and possible remedial measures to take.

3.4.5 Land cover and land use

The water resources assessment report for the Victoria Water Management Zone (2017), describes the Rwizi catchment as being degraded by runoff, deforestation, encroachment on wetlands, sand mining, brick making, overgrazing and poor agricultural practices. The Rwizi catchment is also characterized with a number of land cover types including built up areas, farmland, bush land, grass land, wood land, wetland, forests and open water.

Based on the image classification of LandSat Imagery, the Rwizi catchment land cover images were analyzed for a period of 15 years i.e for 2005, 2010 and 2019. The analysis (Figure 27 and Table 13) indicates that Bushland, Forest and woodland have sharply reduced by 64%, 634%, and 849% from 2379.6km² to 1166.5km² and 785.5km² to 1451km², 159km² to 82.7km² respectively between the years 2005 and 2019. On the other hand, the area under Built up area, and farmland increased by 77% and 85% from 199.8 km² and 503.4km² to 868 kms and 3452km² respectively between 2005 and 2019.

The land use/land cover change is attributed to the high demand for land by the increasing human populations that has led to encroachment on bush land, Forests, woodland and wetlands in the entire Rwizi catchment. It is further observed that there is a sharp reduction in forests and woodland which is attributed to the high demand for land for settlement, opening up land for farming that combines both commercial and subsistence farming, high demand for charcoal and wood products

in the catchment. This has been worsened by the increasing human population and the refugee influx especially in the middle Rwizi catchment in Nakivale camp located in Isingiro District. The sharp reduction in land cover is also attributed to built-up areas especially in the urban centers within the sub-catchments of Rwizi Upper, Rwizi middle, Kashara and lake Kachera.

Figure 26: Land use/land cover change for Rwizi Catchment 2005, 2010 and 2019

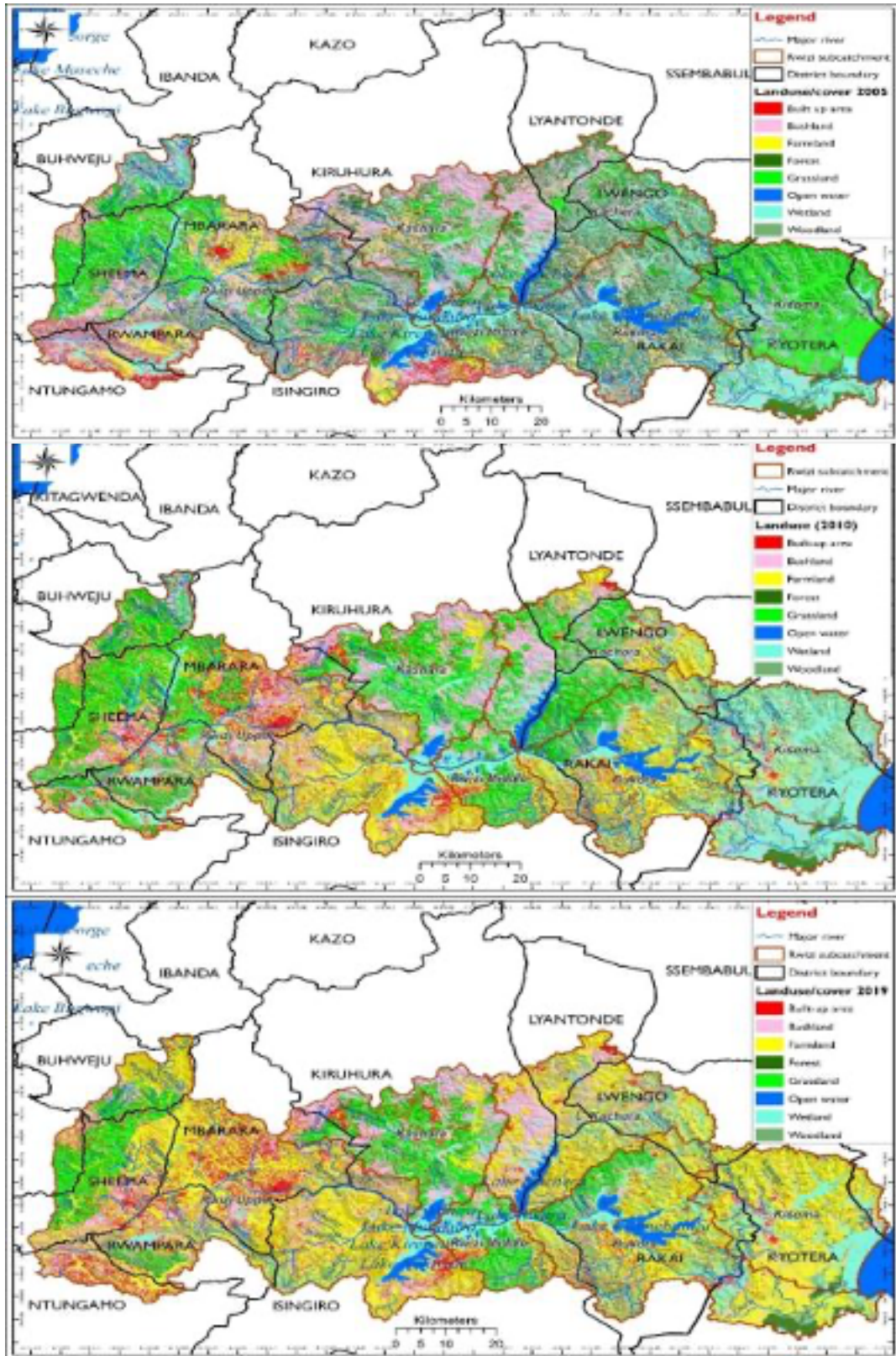


Table 13: Land use/land cover changes for the Rwizi Catchment

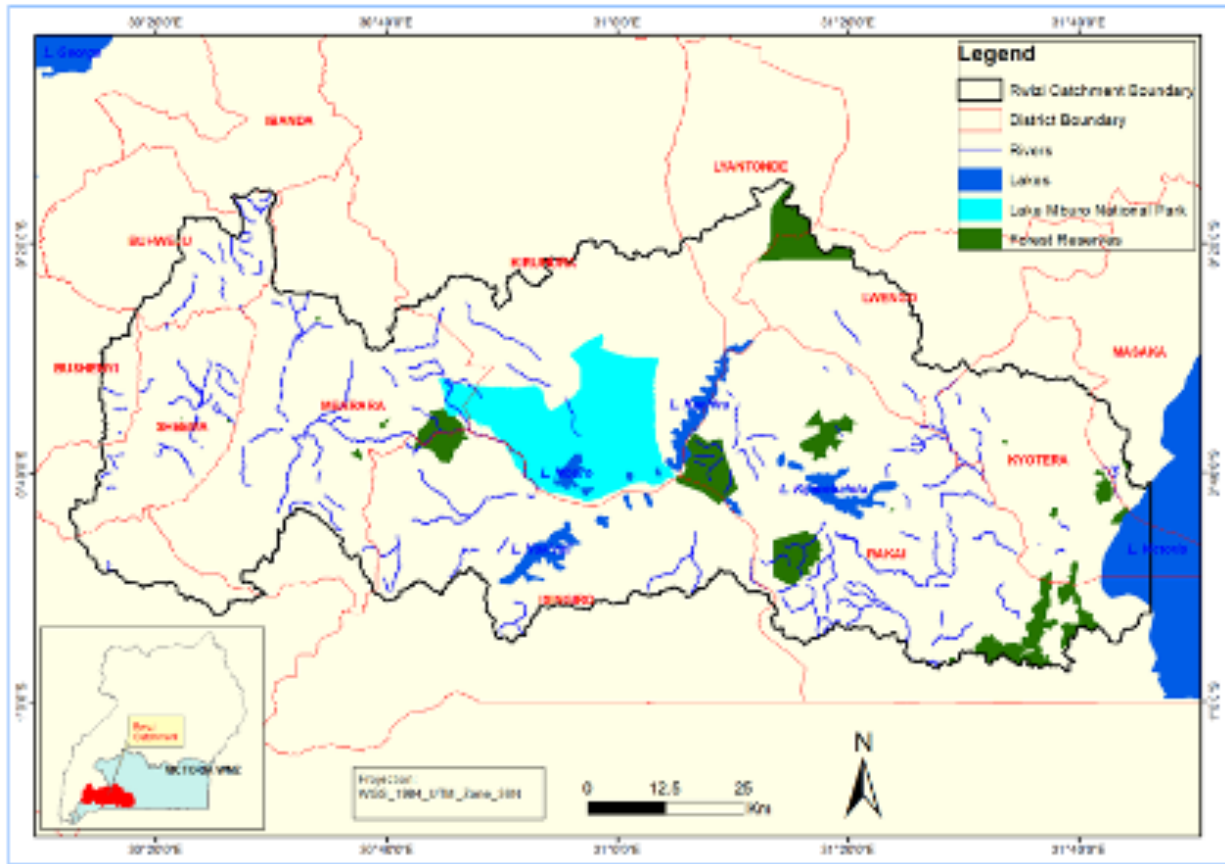
LANDUSE/COVER	2005	2010	2019	%age change in land use/land cover
Built up area	199.75	790.32	867.87	77.0
Bushland	2379.57	1526.37	1451.13	-64.0
Farmland	503.37	1899.37	3452.04	85.4
Forest	1166.45	164.73	158.99	-633.7
Grassland	1336.79	1662.99	900.72	-48.4
Open water	156.80	153.28	153.24	-2.3
Wetland	1710.26	1961.38	1174.08	-45.7

3.4.6 Protected sites and nature reserves

Rwizi catchment is endowed with enormous wildlife resources found within National Parks, Ramsar sites and Forest Reserves (local and central forest reserves) harboring a lot of fauna and flora. As shown in Figure 27, Rwizi catchment has a number of National Parks, Ramsar sites and forest reserves harboring a diversity of fauna and flora.

In the upper catchment is found Mbarara and Kyahi central forest reserves (CFRs) in the districts of Mbarara and Isingiro. In the mid catchment is found L. Mburu National Park and L. Mburu-Nakivale Ramsar¹⁰ Site in the districts Kiruhura and Isingiro. In addition, the mid catchment is Kijanebarola and Kyamazzi central forest reserves in Rakai district harboring a lot of fauna and flora. The areas surrounding the main Rwizi catchment outlet around the L. Victoria shore are dominated by wetland vegetation where is located the Nabajuzi Ramsar site an important bird area. The area also has extensive forest cover including the Kigona, Kabira Tero and Namalala central forest reserves in Rakai District.

¹⁰ A Ramsar site is an important bird area harboring the diversity of birds and other biodiversity both fauna and flora

Figure 27: Protected areas of Rwizi Catchment.

3.4.7 Issues on the social and environment context

Current utilization of the river and its environment for water supply, animal watering, irrigation and waste disposal has led to significant environmental degradation in the catchment. The catchment is facing increased pressures due to the increasing human and animal population, seasonal migrations by pastoralists land reclamation for farming and construction, clearing of hill slopes for agriculture and sand mining from the riverbed. This has resulted in degradation of the natural environment, particularly along livestock corridors, in the wetland sand hill slopes.

From the cause - effect relationship of issues identified from stakeholder consultation, it is clear that most of the issues have socio-economic implications and they are also anthropogenic in nature or result from human activity. This has caused an imbalanced human - environment interaction which inevitably leads to poverty. Stakeholders mentioned high poverty levels as one of the key problems, affecting socio-economic progress and also fueling environmental degradation. For example, it is the poor households that are placed on the front line to clear wetlands as labourers. This later benefits the rich ones who turn the wetland into livestock farms.

3.4.7.1 Wetlands degradation

Wetlands are some of the most productive ecosystems, comparable to tropical ecosystems in the biosphere and play a significant role in the ecological sustainability of the catchment. They are an essential part of community sustainability, meeting many crucial needs for life in the catchment such as drinking water, protein production, water purification, energy, fodder, biodiversity, flood storage, recreation, sinks and climate stabilizers. The values of wetlands though overlapping, like the cultural, economic and ecological factors, are inseparable. In the Rwizi catchment, wetlands are degrading due to intensified human activity (for example brick making; see Plate 5), unplanned development, absence of management structure, inadequate legislation, and lack of awareness about the vital role

played by these ecosystems (functions, values, etc.). All these challenges emanate from increased population pressure and livelihood activities which lead to permanent destruction of wetland diminished potential for rehabilitation.

Plate 5: Wetland degradation in Mbarara municipality



The aquatic ecosystem services of the catchment include tourism, food (tilapia, catfish, mudfish, and lung fish); local materials for the arts and crafts industry; and drainage as the Rwizi wetland system drains most of Rwampara and parts of Kashari and Nyabushozi. The narrow and wide valleys are occupied with permanent and seasonal swamps which drain into River Rwizi, Lake Nakivale and other inland lakes. However, the aforementioned systems have been greatly affected due to excessive encroachment and uncontrolled utilization.

Draining of wetlands for eucalyptus planting in Ntungamo, Buhweju and Sheema has contributed to the disappearance of valuable wetland flora and fauna. Communities plant eucalyptus in wetlands so as to create a basis for clearing land for livestock farms, arable farming activities like in Ntungamo where Orusindura wetland is being encroached on with millet growing alongside eucalyptus, as well as targeting of additional income at the time of harvesting.

3.4.7.2 Deforestation and biomass loss

Deforestation is the permanent destruction of vegetation cover in order to make the land available for other uses. The major cause of deforestation in the catchment is population pressure. Trees are cut to create more land for settlement and agricultural activities. The loss of trees and other vegetation can lead to climate change, soil erosion, reduced crop yields due to removal of top fertile soil through erosion, flooding and increased greenhouse gases in the atmosphere. Trees help control the level of water vapour in the atmosphere by helping to regulate the water cycle. With fewer trees left in the catchment, due to deforestation, there is less water in the air to be returned to the soil. Lack of vegetation can also lead to flooding since there is no vegetation to intercept the water. This explains why the catchment experiences unpredictable rainfall patterns.

Fuel wood/charcoal is the primary fuel used by the majority households in Rwizi Catchment to

meet most of their domestic energy demands. There is increased need for fuel wood in schools (on average a school uses 15 ten tonne trucks of fuelwood per year), homes and factories. Fuel wood consumption is rated at 1 tonne per capita annually. Average household consumption is estimated at 25 - 40kgs of firewood wood or 2.5kgs of charcoal per day.

The per capita consumption of construction for dwelling houses and timber is estimated at 1.5m³ per annum. To this, is an additional toll exerted by agricultural and pastoral activities on the forest resources, with agriculture considered to contribute more destruction of the forests than the search for fuel wood. The expansion of agricultural and pastoral lands to meet the increasing demand for food has led to depletion of and encroachment on the forest reserves. With an estimated population of 1,727,959 (UBOS 2017 projections), fuel wood consumption is estimated at 1.7 million tonnes annually for Rwizi catchment. The estimates for construction of dwelling houses and timber is 2.6 million m³ per annum.

3.4.7.3 Climate change and its effect on the environment and livelihoods

Climatic change/climatic variability and global warming that are hitting almost all districts within the catchment have made it impossible for communities to predict planting seasons and maintaining their crop fields for good crop yields. Communities mainly depend on subsistence agriculture for their livelihood. Extended dry spells with unpredictable onset and cessation of rains, however, have limited their ability to produce on the dry lands. This has seen communities encroaching on wetlands and emerging ownership trends include acquiring land titles in wetlands especially in Mbarara, Buhweju, Sheema, Lyantonde, Rakai, Kyotera and Ntungamo. The unpredictable rain seasons have seen croplands washed down by floods (Plate 6).

Plate 6: Banana plantation in Isingiro flooded after heavy down pour.



Heavy storms during rainy seasons destroy crops and cause flooding in lowlands, soil erosion in hilly areas and silting of wetlands. This is particularly due to increased agriculture using poor land and soil management systems, including overgrazing which have resulted into bare hills which can't hold and filter water and thus end up increasing the erosive power in these areas. This is especially so in Buhweju, Ntungamo and Sheema districts.

In rocky and hilly places like Buhweju, the terraces are very expensive and practicing them becomes hard especially for the poor, whereas use of stone bands across crop fields is also not easy for local

people. This has resulted into soil erosion especially in Buhweju and Sheema and thus rendering the land that used to be more productive, infertile. Banana plantations in Buhweju and some parts of Sheema are dying off because of poor practices and erosion.

The districts of Isingiro, Kiruhura, Lyantonde, Lwengo and Rakai which forms part of the cattle corridor experience relatively high drought conditions and are characterized by reduced rainfall and increased evapotranspiration resulting into acute water shortage especially for animals and domestic use. These areas have large livestock numbers estimated at 574,912 (as shown in Table 5 below). The cost of water during the dry seasons goes up to Uganda Shillings 1000/= per 20 litre jerry can. The water supply technologies used majorly include valley tanks and small earth dams. The water supply coverage is still low standing at 38% Kiruhura, 34% Isingiro, 45% Lyantonde, and 41% Rakai. During the dry season, animals fail to get sufficient water and pasture and therefore become malnourished (Plate 7).

Plate 7: An emaciated cow due to lack of pasture and water during one of the severe droughts in Isingiro



3.4.7.4 Environmental consequences of gold mining

Buhweju is facing serious environmental concerns as a result of the ongoing artisanal gold mining activities that make use of mercury as well as Cyanide in processing the ore (Waiswa, 2019). Swamps/wetlands have been destroyed as a result of the open cast mining method and it seems little is being done to halt this trend. There is loss of valuable fauna and flora, water quality degradation, flooding of wetlands, soil erosion among others.

3.4.7.5 Increased siltation of water bodies

There is a National Water Sewerage Cooperation intake in Mbarara where there has been an appreciation of water level fluctuations largely due to increased levels of siltation that present abstraction challenges. Water abstraction points by NWSC and other users in the landscape face

similar challenges (Plate 8).

Plate 8: Heavily silted abstraction point in Mbarara



3.5 ON-GOING AND PLANNED ACTIVITIES

There are several ongoing and planned interventions in Rwizi catchment in the water and environment sector.

3.5.1 Catchment management initiatives

A water stewardship under a Public Private Partnership (PPP) project between MWE, GIZ and the Coca Cola system is supporting catchment management initiatives through a project called “Improved Community Livelihoods and Sustainable Water Management in River Rwizi Catchment”. The project is aimed at increasing water availability within the R. Rwizi in particular and sustainable water use and resources management within the catchment. The ongoing work includes restoration of degraded wetlands of Nyakambu, Masheruka, Nyakaikara, Kashasha, Katara, Kanyabakajja and Nyaruteme among others.

Besides the PPP, there are several government initiatives by Victoria Water Management Zone of the Directorate of Water Resources Management in Rwizi catchment which include landscape restorations in Masyoro, Sheema district and Rubara, Buhweju district and demarcation of the river protection zone in Mbarara Municipality, rollout of the Community Environment Conservation Fund (CECF) among others. There is a multi-stakeholder Partnerships for Water Stewardship and Community Livelihoods in the Rwizi catchment with Government of Uganda, World Wide Fund for nature, Uganda Country Office (WWF UCO) and InBev (ABInBev), a parent company to Nile Breweries Limited.

3.5.2 Water and natural resources related activities

A number of projects have been proposed under the Ministry of Water and Environment, Ministry of Agriculture, Animal Industry and Fisheries, Ministry of Energy and Mineral Development, District Local Governments, NGOs/CBOs and the private sector to enhance water availability for use by the communities. These include:

- Planning and development of Gravity Flow Schemes for domestic water use
- Planning and development of water for production infrastructure (valley tanks and earth dams) to provide water for livestock and small-scale irrigation development.
- Planning and development of Bulk Water Transfer Schemes from areas of sufficient water resources to the water stressed areas
- Implementation of water source protection measures including tree planting, soil and water conservation measures.
- Planning and development of on farm and off farm irrigation infrastructure
- Wetlands, riverbanks and lakeshores restoration and management
- Planning and implementation of catchment afforestation measures
- Water resources planning, monitoring and regulation
- Implementation of environmental and social management and mitigation measures for water resources related investment projects
- Planning and development of micro, mini and small hydropower schemes
- Climate adaptation measures

3.5.3 Completed and on-going interventions in the catchment

Since 2013, several interventions of integrated management of water and related natural resources have been piloted in hotspot micro catchments identified through a participatory process involving key stakeholders including the Rwizi catchment management committee, local leaders and community members. Some of the interventions are highlighted below, based on information drawn from VWMZ factsheets and reports.

3.5.3.1 Restoration of Rubara micro catchment

The challenges faced in Rubara Micro Catchment (Figure 28), Buhweju District include flash floods, soil erosion, occasional landslides, crop loss, loss of agricultural land as well as great seasonal fluctuations in water quantity at a gravity flow scheme. Further, the water supply scheme infrastructure was on two occasions been washed away by away by landslides.

Figure 28: Location of Rubara in Rwizi catchment

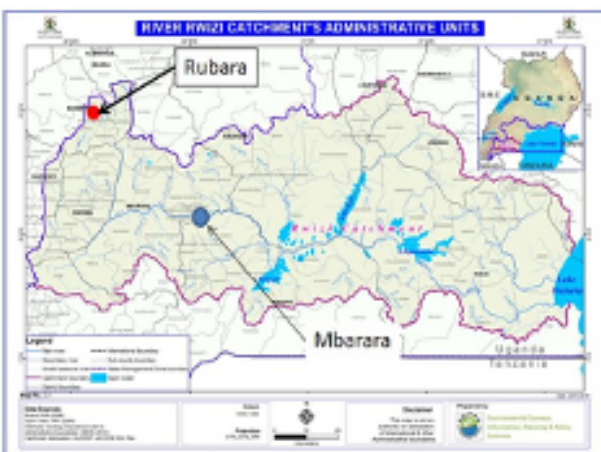


Figure 29: Gullies (Top) and check dams (bottom) constructed in gullies to regulate water flow and to trap debris from upstream



The main interventions include construction of infiltration pits, contour bunds, stone bunds, gully plugs, and trenches; promoting of tree planting on bare hill slopes; and awareness creation (targeting community members) about good practises in soil and water conservation management measures.

The major changes observed after the interventions were implemented include: a reduction of the runoff at the restoration site; an increase in the water table at the Rubara gravity flow scheme; and improved crop yields in farmers' gardens.

3.5.3.2 Restoration of Mashyoro micro catchment

Figure 30: Location of Mashyoro micro catchment in Rwizi catchment



Masyoro Micro Catchment (Figure 30), Sheema district is characterised by ragged bare ridges that are intensively cultivated for cereals and legumes with occasional bush burning in between planting seasons (upstream) and very gentle to flat fertile planes with major economic activity being bananas and coffee growing (lower stream). At the foot of the ridge is a gravity flow scheme that supplies three sub counties in Sheema district.

Major challenges faced before restoration were periodic flash floods and landslides, soil erosion, loss of soil fertility, crop loss and loss of agricultural land.

implementation include:

The main changes observed after

- Reduction of flash floods in the lower planes during rainy seasons: no flash flood were recorded during the October-December 2018 rains in the area.
- Stoppage of landslides due to containment of storm flow.
- An increase in the water table at the Masyoro gravity flow scheme. There was observed overflow at the GFS spring box throughout the December 2016 - March 2017 dry spell, an occurrence that had not been observed in the last 10 years

Figure 31: Some of the measures implemented in Mashyoro Micro catchment: stonebunds (top and right) and infiltration pits (bottom left)



3.5.3.3 Restoration of Nyakambu wetland

Nyakambu wetland (Figure 32) lies in upstream Rwizi catchment on the northern tributary of the river and is shared by two districts of Sheema and Mbarara. Water Risk and Sustainability Assessment for Rwizi catchment conducted in 2013 identified this wetland system as one of the very critical eco systems that had been greatly degraded and recommended for its urgent restoration.

Major challenges experienced before restoration were encroachment and perceived ownership of the wetland by cattle keepers, and crop farmers. The

Figure 32: Location of Nyakambu wetland in Rwizi catchment



wetland was being drained through digging of channels to drive away the water and then burning of the papyrus and subsequent uprooting of the rhizomes.

The restoration was done under a Public Private Partnership (PPP) between Ministry of Water and Environment (MWE), GIZ and the Coca Cola System following a Water Stewardship approach Under a project, “Improved community livelihood and sustainable Water Resources Management in Rwizi”.

Some of the key achievements include:

- 118 ha of wetland in Nyakambu, Bukiro and Katwe villages were recovered (Plate 9).
- Awareness raised on sustainable wetland use; Training of local members conducted on sustainable wetland use.
- Increased quality and quantity of water in the immediate River Rwizi system at Nyakambu
- Introduced Community Environment Conservation Fund (CECF) amounting to 53.7million to 3 wetland conservation groups of Nyakambu, Bukiro and Katwe to promote sustainable water resources management and livelihood improvement
- Piped water extended to serve approximately 2700 community members around the wetland system (villages of Nyakambu, Bukiro and Katwe) 9 tap stands were constructed.
- Currently community members are enjoying the benefits of the restoration through harvesting, handcrafts making materials, mulching materials for the Banana plantation management, fish mongering has also increased among others.

Plate 9: Progress of Nyakambu wetland restoration since 2013



3.5.3.4 Survey and demarcation of River Rwizi buffer zone in Mbarara City

In 2013, a rapid assessment of the catchment was conducted by the Rwizi Catchment Management Committee (CMC) which identified degradation of the ecosystems and pollution as the biggest threats to the catchment. Pollution was found to be highest in Mbarara municipality section of the river. The CMC recommended urgent action to be undertaken. In 2015, resource mapping through transect walks and stakeholders’ engagement were conducted, which revealed a number of issues (Figure 33).

Figure 33: Some of the issues identified in the Mbarara Municipality section of R. Rwizi



- 238 persons claim land ownership in the buffer zone, some with unverified land titles.
- pollution through direct discharge of solid and liquid waste into the river
- Direct sand mining in the river
- Crop Cultivation up to the river itself.
- Siltation from upstream

In a bid to restore Rwizi buffer zone, the extent of the buffer zone was measured and over 300 pillars have been installed along the buffer zone of River Rwizi within Mbarara city (Plate 10). Prior to planting of the pillars, sensitization of communities owning land adjacent to the river was undertaken. This was followed by of the zones. Upon completion of the survey, pillars were installed, and restoration work commenced. This happened between 2015 – 2018.

Plate 10: Installing a boundary pillar near GBK premises



3.6 STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS TO THE MANAGEMENT OF RWIZI CATCHMENT

Related to the mapping of issues across the catchment, was an analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT). Table 14 below shows the SWOT, based on consultations, field excursion to the different sub-catchments, social and environmental assessment as well as a review of literature on water resources assessment reports, 2017.

Table 14: SWOT analysis of the current situation in the Rwizi Catchment

<p>STRENGTH</p> <ul style="list-style-type: none"> a. Good rainfall - surface water flow is estimated at 1,386 million cubic meters against an estimated total demand (Year 2020) of 55 million cubic meters. b. Wetlands – that can be restored to improve quantity and quality of water in the landscape c. The catchment has potential for cultivation of a diversity of crops d. In the dry sub-catchment, animal husbandry is a great potential e. Lakes Kacheera, Mbuuro and Kijanebarora have potential for green/blue economy approaches (tourism, fisheries, transport) f. Protected areas are a potential for tourism development (and livelihoods for neighboring communities) 	<p>WEAKNESSES</p> <ul style="list-style-type: none"> a. The bare hills are susceptible to forces of denudation, including erosion b. Cultivation of crops on the riverbanks, including encroachment on wetlands c. Underdeveloped water transport and water tourism on Lake Mbuuro, Kacheera and Kijanebarola d. Low level of electrification in the rural areas e. Poor road networks characterized by collapsed bridges in some instances such as in Isingiro f. Limited/no restoration of the bare hills g. Untapped hydro-power potential
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> a. Willingness of the private sector to invest in restoration activities b. Potential for hydropower production c. Water-based tourism and water sports on the lakes in the catchment d. Irrigated agriculture, especially in the dry corridors of Isingiro and Kiruhura e. Ecosystem restoration through planting, growing and protection of trees on the bare hills f. Improved and regulated mining sector, include gold mining, sand mining and stone quarrying g. Restoration of encroached wetlands with reference to success stories of Nyakambu. 	<p>THREATS</p> <ul style="list-style-type: none"> a. Land uptake by various forms of development b. Increased urbanisation in the catchment c. Increased population d. Over-cultivation of matooke in the landscape versus existence of forests and trees e. Deforestation, soil erosion, overgrazing leading to degradation of the landscape f. Encroachment on protected areas g. Changing climate and elements of weather.

3.6.1 Threats, pressures and impacts analysis

Through consultations, literature review and field excursions in the Rwizi Catchment, the following threats and pressures are observable:

- i. Changes in consumption demand and production – more demand for piped water will mean more demand for quantity of water demanded over time. The pressures arise from innovation such as production of horticultural products in wetlands in dry seasons and small-scale irrigation (such as those around Lake Kacheera) to supply emerging niche markets, use of chemicals (pesticides and herbicides among others).
- ii. Developments in the Rwizi Catchment will interfere with river catchments and catchment functions and this will threaten the quality and quantity of water resources. The pressures are that there will be increase in land take for economic development, settlement in fragile land/or catchment and increased demand for biomass energy (firewood and charcoal).
- iii. Industrialization and urbanization in the greater Mbarara metro-politan area will present an additional demand for water in future. The pressures are that industries will clear more vegetation, establish workers camps, construct access roads, abstract more water, generate

more waste among others.

- iv. Land uptake by various forms of development will lead to land use changes that will affect recharge. The pressures are from mining, agriculture, settlements, increased industrial development, increased need for production, increased number of herded livestock among others.
- v. Oil spillage (accidental) from the proposed East African Crude Oil Pipeline that will traverse the lower catchment.) The pressure is due to fragility of ecosystems where pipelines will pass, proximity to lakes, rivers, to streams and wetlands, security of pipelines/conflict with communities, operational/technical issues (human error), natural disaster risks and human-made disasters.
- vi. Water for agricultural production through proposed irrigation schemes. The pressure arises from the proposed irrigation infrastructure and associated agro-chemicals associated with agricultural production that will pollute water bodies, as well as spatial temporal distribution of micro-irrigation projects.
- vii. With changes in weather and elements of climate, there is a threat that water might not be enough in future (especially for Isingiro, Kiruhura, Lyatonde) to sustain alternative economic activities (hydropower, tourism, irrigation among others). The pressure is the high vulnerability to impacts of climate change/low resilience of existing farming systems and livelihoods.

The threats and pressures will give rise to impacts if unattended to. Such impacts may include among others:

- a. Permanent loss of vegetation cover (forests, wetlands) leading to soil erosion and siltation of lakes and rivers impacting on the physical and chemical quality of water.
- b. Catchment degradation leading to reduction in water levels (both surface and ground water) impacting on water availability for utility water supply, agriculture irrigation
- c. Surface and ground water contamination (chemical pollution of rivers, lakes and aquifers) with impacts on human and other aquatic organisms
- d. Excessive abstraction of water reducing volume for other uses (hydropower and water for the environment)
- e. Sedimentation/Siltation of rivers/lakes leading to loss of fisheries (breeding sites and fish stock)
- f. Nutrient enrichment and eutrophication impact on fisheries production and communities lose access of water for use
- g. Loss of current livelihoods due to water stress e.g. agriculture irrigated crops, livestock
- h. Poor waste disposal and poor urban sanitation; disease risks such as cholera, diarrhoea, typhoid, dysentery etc,
- i. Contamination/pollution of water bodies from storm and wastewater run-off impacting on the physical and chemical water quality of water.
- j. Reduced water availability for local people & livestock; walking long distances and more time spent in search of water, increased workload for the women as well as men.
- k. Increased conflicts of water access for livestock, crop damages and diseases transmission.

4. VISIONS, OBJECTIVES, AND OPTIONS ANALYSIS

4.1 VISION AND STRATEGIC OBJECTIVES

A workshop held in Masaka on 7th April 2016, catchment stakeholders agreed a vision and strategic objectives for the catchment (Box 1).

Box 1: Vision and strategic objectives for Rwizi catchment

Vision:

A sustainable, beautiful Rwizi Catchment environment for better livelihoods

Strategic Objectives:

- a. To ensure sustainable access to water of adequate quality and quantity for domestic use and production
- b. To ensure that farming, animal husbandry systems and industrial establishments are productive, drought and climate resilient, and improve household income.
- c. To restore degraded natural resources.
- d. To strengthen natural resources management systems and structures.

Alongside the above strategic objectives is the need to:

1. Reduce unregulated diversion of flows (or artificial retention) in the catchment by providing bulk water transfer systems for the cattle corridor areas
2. To equalize flow between the wet and dry seasons, create artificial surface dam storage at the outlet of the Rwizi upper catchment
3. Incentivize the restoration of borrow pits (clay & sand mining) and gold mines through credit systems and collaborative networks for miners, construction firms and transporters
4. Restore to their original state 30% of all wetlands in the catchment to achieve increased storage in the upper catchment and reduce sediment loads on the lakes
5. Ensuring equity and accountability in resource utilization and management
6. Measuring and monitoring of temporal and spatial hydrogeological characteristics, hydrology, erosion, sediment, meteorology, flow, channel characteristics and water quality in the catchment.
7. Enforcing standards, guidelines and regulations on abstraction, disposal and demarcation and coordination of public and private investments using strengthened CMC institutions.

4.2 ISSUES AND PROPOSED INTERVENTIONS

In addition to spot-checks in the districts of Mbarara, Buhweju, Ntungamo, Kiruhura and Lyantonde, by the consultant team, District Local Government officials were asked to identify hotspots in their respective districts and suggest suitable interventions. Based on this information, and the experience from elsewhere, Strategic Options were identified. Table 15 presents the main issues, their locations and proposed interventions – these should be confirmed at the start of implementation. Annex 3 presents the information as received from the District Local Government officials.

Table 15: Main Issues, their locations, and Proposed Interventions

Sub catchment	Main Issues	Locations	Proposed strategic interventions
Upper Rwizi	Deforestation and de-vegetation of hills, resulting into soil erosion	Buhweju: Karungu, Nyakishana, Rwengwe Shema: Kakindo Isingiro; Nyamuyanja, Kabingo, Birere	<ul style="list-style-type: none"> • Landscape restoration including soil and water (SWC) measures • Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover
	Encroachment of wetlands and riverbanks for settlement, farmland, eucalyptus growing and other economic activities	Nyakambu wetland, Nyamuyanja wetland	<ul style="list-style-type: none"> • Wetland and riverbank demarcation and restoration • Support alternative sources of income e.g. practicing sustainable arable farming through establishment of irrigation schemes and mulching of plantations alongside cattle rearing • Strengthening awareness and enforcement of relevant laws and regulations
	Increasing demand for surface water for domestic, agricultural and industrial uses	Widespread	<ul style="list-style-type: none"> • Promote rainwater harvesting at household level • Multipurpose water storage reservoirs (Valley Tanks, Earth Dams) • Bulk water transfer schemes
	Poor solid waste management especially in the urban areas	Mbarara municipality, Kaberebere	<ul style="list-style-type: none"> • Improve solid waste collection and management systems in collaboration with local entrepreneurs • Stakeholder sensitization on proper handling and disposal of waste (including sorting) • Encourage and support ventures that can utilize (reuse or recycle) solid waste, especially by working with community groups and/or local entrepreneurs
Kashara	Poor yield of water sources and deteriorating water quality	Widespread	<p>Further assess the causes of poor yield and quality. Potential interventions could be:</p> <ul style="list-style-type: none"> • Enforce effluent standards • Emphasize treatment of wastes by industries • Monitoring of chemical utilization and land use

Sub catchment	Main Issues	Locations	Proposed strategic interventions
	Poor waste disposal especially in the urban area	Sanga TC (Kiruhura) Part of Biharwe division (Mbarara)	<ul style="list-style-type: none"> Improve solid waste collection and management systems in collaboration with local entrepreneurs Stakeholder sensitization on proper handling and disposal of waste (including sorting) Encourage and support ventures that can utilize (reuse or recycle) solid waste, especially by working with community groups and/or local entrepreneurs
	Loss of tree cover due to charcoal burning and tree cutting for creating farmland	Widespread	<ul style="list-style-type: none"> Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover Support alternative sources of income
	Water shortages especially during the dry season, for humans and animals	Widespread	<ul style="list-style-type: none"> Multipurpose water storage reservoirs Promote rainwater harvesting at household level
Middle Rwizi	Deforestation for charcoal production	Kiruhura: Sanga, Kanyaryeru, Kikaatsi	<ul style="list-style-type: none"> Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover Support alternative sources of income
	Rangeland degradation due to overgrazing and uncontrolled communal grazing	Widespread	<ul style="list-style-type: none"> Ensure sustainable grazing e.g. by paddocking
	Water shortages especially during the dry season, for humans and animals	Widespread	<ul style="list-style-type: none"> Multipurpose water storage reservoirs Rainwater harvesting at household level Bulk water transfer schemes
Lake Kacheera	Poor sanitation especially at landing sites, including disposal of human excreta into the lake	Kiruhura: Nyakasharara Rakai: Kacheera, Lwamaggwa	<ul style="list-style-type: none"> Public latrine facilities for landing sites
	Cultivation along lakeshores and riverbanks and wetlands resulting into deposition of sediment into the water	Rakai: Lwamaggwa, Kacheera	<ul style="list-style-type: none"> Wetland and riverbank demarcation and restoration Support alternative sources of income e.g. practicing sustainable arable farming through establishment of irrigation schemes and mulching of plantations alongside cattle rearing Strengthening awareness and enforcement of relevant laws and regulations

Sub catchment	Main Issues	Locations	Proposed strategic interventions
	Poor waste management especially in the town councils	Lyantonde TC (Lyantonde), Kyazanga TC (Lwengo district)	<ul style="list-style-type: none"> • Improve solid waste collection and management systems in collaboration with local entrepreneurs • Stakeholder sensitization on proper handling and disposal of waste (including sorting) • Encourage and support ventures that can utilize (reuse or recycle) solid waste, especially by working with community groups and/or local entrepreneurs
	Deforestation and de-vegetation of hills and cultivation without adequate soil and water conservation measures	Malongo, Lwengo, Ndagwe (Lwengo district)	<ul style="list-style-type: none"> • Landscape restoration including soil and water (SWC) measures • Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover
	Poor fishing practices including overfishing and extraction of immature fish	Laka Kacheera	<ul style="list-style-type: none"> • Ensure sustainable fishing on Lake Kachera
Bukora	Poor waste disposal especially in the town councils	Rakai: Rakai TC	<ul style="list-style-type: none"> • Improve solid waste collection and management systems in collaboration with local entrepreneurs • Stakeholder sensitization on proper handling and disposal of waste (including sorting) • Encourage and support ventures that can utilize (reuse or recycle) solid waste, especially by working with community groups and/or local entrepreneurs
	Poor agriculture practices such as over cultivation on steep slopes without adequate soil and water conservation measures, and cultivation along riverbanks	Rakai: Kasaali, Ddwaniro, Lwamaggwa, Kacheera	<ul style="list-style-type: none"> • Landscape restoration including soil and water (SWC) measures • Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover • Strengthening awareness and enforcement of relevant laws and regulations • Ensure sustainable farming practices especially riverbanks and hilly areas
	Bush burning and tree cutting for firewood, charcoal and timber	Rakai: Kifamba Kyotera: Kyebe	<ul style="list-style-type: none"> • Community tree growing initiatives to facilitate reforestation, afforestation and agroforestry to increase tree cover • Support alternative sources of income

Sub catchment	Main Issues	Locations	Proposed strategic interventions
	Encroachment of wetlands for crop farming, settlement, and growing of eucalyptus	Kyotera: Wetlands in Kyebe and Kakuuto Subcounties, Katengo wetland in Kyotera TC	<ul style="list-style-type: none"> Wetland demarcation and restoration Support alternative sources of income e.g. practicing sustainable arable farming through establishment of irrigation schemes and mulching of plantations alongside cattle rearing Strengthening enforcement of relevant laws and regulations
Kisoma	Poor waste disposal especially in the town councils	Kyotera: Kyotera TC, Kalisizo TC	<ul style="list-style-type: none"> Improve solid waste collection and management systems in collaboration with local entrepreneurs Stakeholder sensitization on proper handling and disposal of waste (including sorting) Encourage and support ventures that can utilize (reuse or recycle) solid waste, especially by working with community groups and/or local entrepreneurs
	Encroachment of wetlands and riverbanks for crop farming, settlement, establishing cattle farms, and growing of eucalyptus	Kyotera: Kisoma wetlands (Kisasa Sub county)	<ul style="list-style-type: none"> Wetland and riverbank demarcation and restoration Support alternative sources of income e.g. practicing sustainable arable farming through establishment of irrigation schemes and mulching of plantations alongside cattle rearing Strengthening enforcement of relevant laws and regulations

4.3 SCENARIOS

In order to cause positive change in the catchment, three scenarios have been considered and these are (i) ecosystem protection and conservation, (ii) water resources infrastructure development, and (iii) which is a combination of ecosystem protection and conservation as well as water resources infrastructure development. These are further explained in the sections below.

4.3.1 Scenario 1: Ecosystem Protection and Conservation

This scenario envisages investments towards ecosystem protection and conservation (Table 16) with limited development of water resources infrastructure for multipurpose uses. A number of trends which affect the catchment that can be addressed by options that fall under the ecosystem protection and restoration scenario include the increase in population thereby intensifying unsustainable and destructive practices in livestock herding and agriculture (Figure 34) which threaten the ecosystem functions of woodlands and wetlands (Figure 35 to Figure 38).

Table 16: Strategic options for consideration under scenario 1

Trends	Options	Impact at Catchment Level
<p>Increased deforestation caused by charcoal burning and agricultural encroachment likely to take place in Middle Rwizi, Kashara, Bukora and Kisoma Sub Catchments</p> <p>Increased forest encroachment in search for firewood and charcoal by people from within the catchment, but also outside seeking to make business of charcoal.</p> <p>Increased demand of forest products such as neem will help to create more forest cover</p>	<p>1.1 Productive and protected forests and woodlands</p>	<p>The proposed collaborative forest management will lead to an increase in tree coverage and water infiltration. The regulation of charcoal business should lead to a decrease in denudation in critical zones. Provision of alternative tree products will also reduce runoff if interventions are strategically planned. Thereby option 1.1 presents huge opportunities for improvement of the catchment's water balance</p>
<p>Increased encroachment on wetlands for agriculture, brick making - Buriro-Nyakambu, Rwanyamahembe, Orukorohwa, Kooga, Nyakisharara, Rwibogo, Nyaruhandagazi, Kashsha, Orunyeri, Kibingo, Rushanje, Nyakekara, Bujaga, Kibuba, Nyabikungu, Kinoni, Katereza, Mwizi central, Mucucu, Kashojwa, Rwemigina, Mankanke, Katengyeto, Rwagaju.</p>	<p>1.2 Productive and protected wetlands</p>	<p>The proposed wetlands rehabilitation and management will lead to an increase in vegetation cover and water retention. This will help in the regulation of flows out of the catchment. Option 1.2 provides huge opportunities for improvement of the catchment's water balance</p>

In addition, wetlands in the Rwizi Upper and Rwizi Middle will silt up more due to erosion arising from an increase of agriculture which will substantially change the water balance. There is also a risk that arable land will deteriorate, and more people will fall in the poverty trap which makes them turn to the towns or alternative livelihoods such as brickmaking or charcoal burning.

The lower sub catchments might also feel the impact due to changes in the water balance due to siltation of wetlands and local flooding due to encroachment and water logging. The risks of this scenario could be further worsened by the impacts of climate change making agricultural lands more prone to erosion.

The development path envisaged is majorly through:

- Wetlands, rivers and flood plain protection (wetlands, riverbanks protection and stabilization - gabion, protection of riparian vegetation)
- Mapping, demarcation of riparian protection zones and identification and implementation of water source protection measures for existing water supply schemes.
- Promoting productive and sustainable rangelands
- Productive and protected forests and woodlands (supporting tree nurseries development for provision of seedlings and establishing distribution, training and management systems in all districts of the catchment).

- Supporting improved farming practices

The envisaged limited infrastructure investments include reconstruction of valley tanks and earth dams for livestock watering, gravity flow schemes for domestic water supplies, boreholes equipped with hand pumps and motorised groundwater abstractions for rural domestic/urban water supplies and direct water abstractions from River Rwizi for urban water supplies. The scenario envisages no major infrastructure for irrigation development in the catchment, hence demands for water for irrigation are low.

4.3.2 Scenario 2: Water Resources Infrastructure Development

Infrastructure development for water storage

An assessment previously carried shows that the rainfall and annual flow are sufficient for the project demands. However spatial and temporal variability as well as the anticipated droughts due to climate change results in periods with insufficient water resources. As such it is necessary to equalise and balance the flows between the dry and wet seasons and provide water for bulk transfer. To achieve this, an assessment of a number of areas with potential for storage especially, gorges, tributary confluences and areas upstream of major water demands was undertaken (Table 17). Moreover, the selected areas would provide areas for wetland restoration.

Table 17: Identified strategic water storage sites

Dam	Sub county	District	Latitude (°S)	Longitude (°E)	Dam crest level (m.a.m.s.l)	Dam height (m)	Embankment length (m)	Reservoir inundation area (ha)	Capacity (Mm ³)	Catchment area (km ²)	Mean annual runoff (Mm ³ /y)	Potable demand (m ³ /y)	Irrigation area (ha)	Irrigation demand (m ³ /y)	Total supply capacity (m ³ /y)	Cost estimate (MUS\$)
Rugaaga	Rugaaga	Isingiro	-0.793	31.108	1,249	6.6	350	43	3.53	21.9	25.6	691,825	748	2,206,175	2,826,000	18.6
Ngarama	Ngarama	Isingiro	-0.868	30.866	1,330	9.3	300	12	2.58	15	11.5	0	699	2,063,000	2,063,000	28.2
Kakuuto	Kakuuto	Rakai	-0.805	31.370	1,191	17.0	600	50	3.11	5,812	55.0	2,462,014	6	25,986	2,488,000	14.9
Byakabanda	Byakabanda	Rakai	-0.733	31.420	1,248	13.4	545	172	3.35	11.4	0.108	2,036,559	153	641,441	2,678,000	10.7
Ddwaniro	Ddwaniro	Rakai	-0.618	31.380	1,249	19.0	502	106	3.41	11.2	0.106	2,495,948	55	229,052	2,725,000	10.6
Lwanda	Lwanda	Rakai	-0.696	31.433	1,239	3.0	384	143	1.86	12.9	0.122	1,447,998	10	43,002	1,491,000	5.4
Kagamba	Kagamba	Rakai	-0.601	31.317	1,258	9.2	259	7	1.95	6.4	0.060	0	371	1,560,000	1,560,000	6.2
Ndejja	Ndejja	Mbarara	-0.707	30.377	1,424	7	526	267	7.4	641	7	2,000,000	500	2,000,000	4,000,000	20
Lake Kacheera WSS Intake*		Kiruhura	-0.570	31.117	1,238a	n/a	n/a	n/a	n/a	n/a	n/a	759,200	0	0	759,200	6.5

This scenario envisages investments towards development of potential multipurpose water storage reservoirs in the catchment, bulk water transfer schemes to meet water demands in the long term within the catchment (Table 18).

Table 18: Water Supply Options for different locations in the catchment

No.	Water Supply Demand Sites	Available Water Supply Options
1.	Middle Rwizi - Kiruhura, Isingiro	<ul style="list-style-type: none"> • Lake Kacheera Water Supply and Sanitation Intake (Bulk Water Transfer), • Rugaaga Dam • Ngarama Dam, • Rugongi Dam in Kiruhura • Kigabagaba Dam in Kikatsi Sub-county • Rwabigyemano Dam in Keshunga Sub-county • Kenwa Dam • Rubare Dam
2.	Middle Rwizi - Mbarara	<ul style="list-style-type: none"> • Ndaija Dam, • Rwizi NWSC Intakes
3.	Upper Rwizi - Sheema, Buhweju, Ntungamo, Igara	Gravity Flow Schemes <ul style="list-style-type: none"> • Biswa GFS • Nyabuhikye GFS • Shuku GFS
4.	Lower Rwizi Catchment – Rakai, Masaka and Lyantonde	Small Earth Dams <ul style="list-style-type: none"> • Kakuuto, • Byakabanda, • Ddwaniro, • Lwanda and • Kagamba

The investments to be implemented under this scenario include:

- Rugaaga and Ngarama Earth Dams
- Ndaija Earth Dam
- Kakuuto, Byakabanda, Ddwaniro, Lwanda and Kagamba Small Earth Dams
- Lake Kacheera Water Supply and Sanitation Intake (Bulk Water Supply Transfer Schemes)
- Large scale irrigation projects
- Gravity Fed Water Supply Schemes

4.3.3 Scenario 3: Ecosystem Protection and Conservation and Water Resources Infrastructure Development

This scenario envisages optimal development of identified potential multipurpose water storage reservoir sites in the catchment, bulk water transfer schemes to meet water demands for 2040 as well as optimal development of irrigation potentials within the catchment. This scenario also envisages investments in ecosystem protection and conservation. This scenario will aim at attaining the sustainable development goals (SDGs) of universal access to water. The investments to be implemented within this scenario include (Table 19):

- Multipurpose Water Resources Management and Development Projects (domestic water

supply, irrigation water use, flood control, livestock watering)

- Bulk Water Transfer Schemes
- Large scale irrigation projects
- Green infrastructure
- Restoration and protection of ecosystems (forests, wetlands and agricultural landscapes).

Table 19: Strategic options for consideration under scenario 3.

Scenario	Environmental options	Development of socio-economic options	
		Options related to small water storage infrastructures	Option related to Large Water Resources Infrastructure and Irrigation Development
Scenario 1: Environmental conservation and Protection	Priority for the scenario	Only options with an impact on environment are considered (e.g. improvement of sanitation)	Not developed
Scenario 2: Full Development of Water Resources Infrastructure	No effort toward this type of option	Priority for the scenario	Developed up to the maximum with all the areas identified as irrigable in uplands developed (type B)
Scenario 3: Optimal Water Resources Infrastructure Development and Environmental conservation and protection	Priority for this scenario	Priority for the scenario	Identified strategic water resources infrastructure for multipurpose uses developed

4.3.4 Scenario Comparison

The scenarios identified include both generic actions that are common among scenarios and set of specific actions that characterize each scenario. Actions vary and may be related to construction of water resources infrastructure for domestic water supply and sanitation systems, multipurpose water storages reservoirs or may be related to implementation of actions on water governance, information systems, institutional strengthening, capacity building, etc. The scenarios analysis is based on the output of the water resources assessment, with identification of critical issues and opportunities in the Rwizi catchment. A set of scenarios is elaborated considering the frameworks and the specific issues of the catchment.

A water resources analysis has been undertaken in order to check the feasibility of the scenarios and see if the resource available can meet the projected demand and to estimate the need for storage associated to each one in the different sub-catchments (or group of sub-catchments).

From the table above more than 27million m³ of water storage could be secured for multipurpose

Table 20: Characteristics of Dam Sites in Rwizi Catchment

Dam	Sub county	District	Easting (m)	Northing (m)	Latitude (°S)	Longitude (°E)	Dam crest level (m.a.m.s.l)	Dam height (m)	Embankment length (m)	Reservoir inundation area (ha)	Capacity (Mm3)	Mean annual runoff (Mm3/y)	Potable demand (m3/y)	Irrigation area (ha)	Irrigation demand (m3/y)	Total supply capacity (m3/y)	Cost estimate (MUS\$)
Rugaaga	Rugaaga	Isingiro	289,500	9,912,300	-0.793	31.108	1,249	6.6	350	43	3.53	25.6	691,825	748	2,206,175	2,826,000	18.6
Ngarama	Ngarama	Isingiro	284,100	9,903,750	-0.868	30.866	1,330	9.3	300	12	2.58	11.5	0	699	2,063,000	2,063,000	28.2
Kakuuto	Kakuuto	Rakai	318,600	9,911,000	-0.805	31.370	1,191	17.0	600	50	3.11	55.0	2,462,014	6	25,986	2,488,000	14.9
Byakabanda	Byakabanda	Rakai	324,200	9,919,000	-0.733	31.420	1,248	13.4	545	172	3.35	0.108	2,036,559	153	641,441	2,678,000	10.7
Ddwaniro	Ddwaniro	Rakai	319,700	9,931,700	-0.618	31.380	1,249	19.0	502	106	3.41	0.106	2,495,948	55	229,052	2,725,000	10.6
Lwanda	Lwanda	Rakai	325,600	9,923,000	-0.696	31.433	1,239	3.0	384	143	1.86	0.122	1,447,998	10	43,002	1,491,000	5.4
Kagamba	Kagamba	Rakai	312,700	9,933,500	-0.601	31.317	1,258	9.2	259	7	1.95	0.060	0	371	1,560,000	1,560,000	6.2
Ndaija	Ndaija	Mbarara	208,087	9,921,765	-0.707	30.377	1,424	7	526	267	7.4	7	2,000,000	500	2,000,000	4,000,000	20
Lake Kacheera WSS Intake*		Kiruhura			-0.570	31.117	1,238a	n/a	n/a	n/a	n/a	n/a	759,200	0	0	759,200	6.5

uses including drinking water, irrigation, livestock watering, fish farming. Hydropower generation is not one of the expected benefits since the height of the dams would not allow such a use.

Multi-criteria Analysis

Multi-criteria analysis (MCA) establishes preferences between options (e.g. scenario) by reference to an explicit set of objectives identified, and for which were established measurable criteria/indicator to assess the extent to which the objectives have been achieved.

The weighted average method is the proposed method. Where it is possible to describe the consequences of a set of scenarios in terms of a single set of characteristics, their relative merits are expressed in numeric form, for instance ranging from 0 for very unfavourable characteristics to 100 for very favourable ones.

Using the weighted-average method, a table is set up where each competing scenario is listed and its scores against each characteristic are tabulated. The scoring rule for each characteristic is the way in which the facts about a scenario are converted into its merit score. Indicator/parameters can be mathematical, like a proportional relationship between cost-benefit ratio or could use indicators and the related score, or they can be based on qualitative considerations, based on expert judgement. Each characteristic corresponds to a criterion, and its scoring rule corresponds to the way the decision-makers want that criterion to be applied.

After these steps, the analysis is simple arithmetic: for each scenario an overall merit score is calculated as the weighted average of its scores under the different criteria. At the end a table with a ranking representing the results of the multi-criteria analysis could easily represent the prioritization of the scenarios (Table 21). In the Rwizi case, the preferred scenario is scenario 2 that looks at ecosystem protection and conservation and water resources infrastructure development.

Multi-criteria approach used to compare alternative/specific sets of options (i.e. scenario) includes:

- Selection of criteria which are the best indicators of progress toward achieving the strategic objectives
- Rating the options against the criteria to evaluate how relevant the options and scenarios are to reach the strategic objectives;
- Weighting the criteria to reflect the relative importance of each in the process of evaluation;
- Calculation of final scores for the options and for the overall scenario.

Table 21: Scores of the Scenarios

Criteria	Scenario 1 Environmental Conservation and Protection	Scenario 2 Water Resources Infrastructure Development	Scenario 3 Ecosystem Protection and Conservation and Water Resources Infrastructure Development
Watershed protection and enhancement	5	0	3
Improvement of water quality	5	2	3
Wetland conservation	5	0	3
Well balanced use of water resources	3	2	5
Mitigation/adaptation to natural disasters and Climate change	3	2	5
Income increase per capita	2	5	5
Improved food production per capita	2	5	5
Feasible cost	5	2	5
Implementability (realistic and acceptable)	2	3	5
Overall Score	32	21	39
Rank	2	3	1

5. IMPLEMENTATION AND INVESTMENT PLAN

5.1 ROLES AND RESPONSIBILITIES

In the implementation plan the roles of various partners are differentiated. A project lead takes the initiative or guides an activity that will be implemented. The project lead is not necessarily the funder or the actual implementer on the action. Following the identified roles and responsibilities MWE, DWRM, VWMZ, the CMC, the district councils, NGOs/CBOs and the private sector can take responsibility to implement a specific intervention.

The lead in project implementation should:

- Direct the project implementer to adhere to interventions as planned for in the CMP.
- Guide the project implementer in stakeholder involvement.
- Provide the project implementer with applicable guidelines and check use.
- Enforce the project implementer to set-up O&M systems for sustainable use.

Project implementers are implementing partners contributing to the implementation of the activity. Project implementers can again be VWMZ, the CMC, the district councils, but also other stakeholders. All stakeholder groups, from the water users as primary stakeholders up to development partners and corporate sector, can collaborate or contribute resources to the implementation to specific interventions included in the CMP.

Table 22: Roles of stakeholders in Catchment Plan Implementation

WMZ	<ul style="list-style-type: none"> • Coordinate all implementation activities • Facilitate and support DWRM coordination of central level implementation and financial resource mobilization • Facilitate implementation of catchment plan projects by central departments • Identify modalities for zonal and catchment level implementation among its public and private sector partners • Mobilize funds (MTEF, budget, donors, private sector) with the assistance of DWRM for implementation of zonal and catchment level projects • Coordinate, manage and undertake project preparation for zonal and catchment level plan projects • Assess water use permit applications under existing regulations • Facilitate implementation and installation of upgraded and expanded monitoring network and WIS, and operate system within the zone • Monitor hydrologic and meteorological conditions, compliance with regulations, implementation of sub-and micro catchment plans and source protection plans • Support and facilitate the continuing role the CMC and CTC and other stakeholder groups including keeping all stakeholders informed of implementation progress
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CMC & CTC	<ul style="list-style-type: none"> Facilitate and promote implementation of catchment management and source protection plans Facilitate inclusion of plan projects and programs into District Development Plans Monitor CMP implementation Promote and facilitate compliance regulations and permitting system
MWE - DWRM	<ul style="list-style-type: none"> Organize and coordinate review of the draft catchment plan and facilitate the Ministry's approval and adoption of the final agreed plan Organize and coordinate the technical review of plan project proposals and assignment of implementation to the appropriate department Mobilize funds for plan implementation and WMZ support Review policy, legal and regulatory revision needs based on plan recommendations and manage the process for updating and revision
MWE - NEMA	<ul style="list-style-type: none"> Review the environmental regulatory needs (actions, new or revised regulations) based on the adopted final plan Issue required regulations, notices, and permits in accordance with legal and regulation requirements
MWE – Line departments	<ul style="list-style-type: none"> Undertake preparation of projects and investments within their area of responsibility that are proposed in the adopted final catchment plan (feasibility studies) Supervise and manage project implementation (designs, tender documents, procurement, construction) Operate the completed project in accordance with the permit and operating rules agreed with the WMZ
Line departments in the concerned sector Ministries	<ul style="list-style-type: none"> Undertake preparation of projects and investments within their area of responsibility that are proposed in the adopted final catchment plan (feasibility studies) Supervise and manage project implementation (designs, tender documents, procurement, construction) Operate the completed project in accordance with the permit and operating rules agreed with the WMZ
District Local government	<ul style="list-style-type: none"> Facilitate and support implementation of the adopted final CMP Incorporate priority projects and program into the District development plan as appropriate
Donor partners and NGOs	<ul style="list-style-type: none"> Implement priority projects and program in collaboration with the WMZ and stakeholders in accordance with agreements and Memoranda of Understanding (MOUs) with the WMZ and DWRM
Private sector	<ul style="list-style-type: none"> Facilitate and support implementation of the adopted final catchment plan

Table 23: Proposed Stakeholders Contributions to CMP Implementation

Category	Stakeholders	Envisioned contribution
Environment & natural resources	<ul style="list-style-type: none"> Regional Wetlands Technical Support Units (RWTSUs) District Natural Resources Departments (NRDs) District Environment Committee (DEC) Local Environment Committee (LEC) District Production Department (DPD) District Land Board Urban Councils Works Departments Development partners NGOs and CSOs Private Sector 	<p>Collaboration and leveraging of funds for:</p> <ul style="list-style-type: none"> Awareness creation and stakeholder mobilization Ecosystem preservation and catchment protection Improving land use planning, practices, and soil and water conservation Wetlands management and boundary demarcation Permits compliance monitoring and enforcement Revenue generation from environment services Village Savings and Loans Association
Water services	<ul style="list-style-type: none"> NWSC area offices WSDf in the interim TSUs UWS District Water Office (DWO) District Health Depts. (DHDs) District Water & Sanitation Coordination Committees (DWSCC) District Works Depts. Health Services Depts. UNICEF, UWASNET, UN FAO, GIZ, C&D, CIDI 	<p>Collaboration and leveraging of funds for:</p> <ul style="list-style-type: none"> Awareness creation and stakeholder mobilization Catchment/water sources protection Public health and hygiene improvement Water supplies quality monitoring and general resource monitoring Water resources demand management Compliance monitoring and enforcement Revenue generation and collection
Planning and development	<ul style="list-style-type: none"> District Land Boards District Planning Units Urban Councils Works depts. CAOs Local Community Associations LC5s LC3s 	<p>Collaboration and leveraging of funds for:</p> <ul style="list-style-type: none"> Pollution control (waste management, wastewater & storm water drainage) Sustainability and disaster risk mitigation planning
Community services	<ul style="list-style-type: none"> District Community Based Services Depts. Community Based Organizations Water User Associations Cultural and religious institutions UWASNET Environment and Natural Resources Civil Society Organizations Network (ENRCSOs) Micro-catchment Management Committees, Community Environmental Conservation Fund Groups. 	<p>Collaboration and leveraging of funds for:</p> <ul style="list-style-type: none"> Awareness creation and public sensitization and mobilization Advocacy

Category	Stakeholders	Envisioned contribution
Capacity development	<ul style="list-style-type: none"> • District Technical Depts. • GIZ, UNICEF, UN FAO, IUCN • OPM 	Collaboration and resource mobilization for: <ul style="list-style-type: none"> • Human resources development • Institutional capacity development • Sensitization and awareness within the workforce
Research, data collection and monitoring	<ul style="list-style-type: none"> • IUCN, • UN FAO, • DWO • Research Institutions 	Collaboration for: <ul style="list-style-type: none"> • Monitoring changes in the ecosystem • Data collection on existing water sources • Monitoring ground water levels • Environment conservation
Advisory	<ul style="list-style-type: none"> • NEMA, NWSC, DEA, DWD • LC5s, CAOs, District Technical Heads • Research institutions 	Collaboration for: <ul style="list-style-type: none"> • Policy and legal framework guidance • Compliance with CBWRM guidelines • Collaboration in building political will and acceptance
Livelihoods enhancement and peace building	<ul style="list-style-type: none"> • DAO, DPO, UNICEF, WFP, UNFAO • Religious and cultural Institutions 	Collaboration for: <ul style="list-style-type: none"> • Food and income security • Resilience building • Conflict resolution • Employment • Health

5.2 FINANCING PLAN

5.2.1 Intervention plan

Table 21 above shows the prioritization of scenarios based on which an intervention plan has been concretized. Table 24 here under shows the identified activities for each of the prioritized interventions. These are further considered in the financial investment plan in Table 25.

Table 24: Prioritized interventions with preferred activities

Intervention	Activity
Water Resources Monitoring Network	<ul style="list-style-type: none"> • Groundwater Network • Surface Water Network • Climate Monitoring • Water Quality Monitoring • Sediment Monitoring
Catchment Afforestation	<ul style="list-style-type: none"> • Establish and support tree nurseries • Support non-wood, agroforestry and timber tree planting

Intervention	Activity
Wetland restoration	<ul style="list-style-type: none"> • Verify maps for wetlands • Establish Wetland Management Committees • Development of Community Based Wetland Management Plans including bush fire management • Demarcate wetlands zones (critical zones, protection, buffer zone, production zone for cultivation and settlement) • Develop by-laws and ordinances for wetland protection • Implementation of by-laws and ordinances • Demarcate protected zones (e.g. using trees and/or pillars) in the wetlands and decide/agree permitted activities for the zone • Enforce regulations on unsustainable activities (environmental degradation) in the protected zones • Support traditional leaders to declare some wetlands as traditional shrines and set up traditional/community by-laws • Establish a fund for wetland protection (e.g. community environment conservation fund)
River Banks and Lake Shores Rehabilitation	<ul style="list-style-type: none"> • Identify, map and designate sites where sand or gold mining can sustainably take place • Demarcate buffer zone using live markers • Restore degraded river banks and buffer zones (tree planting, grassing) • River bank stabilization e.g. use of gabions • Build capacity of extension services on soil and water conservation measures (mulching, composting, manuring), good agricultural practices, pest/disease control
Development of Water Allocation Plan	<ul style="list-style-type: none"> • Develop Rwizi Water Allocation Model • Train Staff in the use of the model • Use model in water resources planning at catchment and sub catchment levels
Rainwater harvesting	<ul style="list-style-type: none"> • Promote rainwater harvesting at household levels • Promote rainwater harvesting at institutional level – schools, health centres, faith based institutions • Promote rainwater harvesting at community level
Bulk water transfer schemes	<ul style="list-style-type: none"> • Undertake feasibility and detailed engineering design studies • Undertake environmental and social impact assessments • Develop Resettlement Action Plan • Implement feasible schemes
Develop Multipurpose Water Resources Infrastructure	<ul style="list-style-type: none"> • Undertake feasibility and detailed engineering design studies for multipurpose water storage infrastructure • Undertake environmental and social impact assessments • Develop Resettlement Action Plan • Implement feasible schemes
Develop Piped Water Supply and Sanitation Systems	<ul style="list-style-type: none"> • Undertake feasibility and detailed engineering design studies for multipurpose water storage infrastructure • Undertake environmental and social impact assessments • Develop Resettlement Action Plan • Implement feasible schemes
Institutional Strengthening and Capacity Development	<ul style="list-style-type: none"> • Implement CMO governance system • Support and strengthen the CMC • Establish technical support team for CMP implementation • Monitoring and evaluation of CMP implementation • Sub-catchment, micro-catchment and community action planning • Awareness raising on CMP

5.2.2 Funding requirements

The bulk of prioritized interventions in Section 5.2.1 have now been grouped into investment priorities described in subsections here under. For each of the investment priority, a cost for investment is attached (based on the prioritized activities).

5.2.2.1 Finalize components of the catchment management plan

The implementation of the CMP will require detailed stakeholder mapping and description at each of the 6 sub-catchments, specifying roles and responsibilities during implementation and map on-going restoration interventions vis a vis existing hotspot. It will also require undertaking field data collection and verification for modeling surface and ground water and establishing water balance (supply versus demand) at each of the sub-catchments.

Additional funds will be required to popularize the CMP within CMC to trigger implementation. This should involve:

- CSOs/CBOs representing various categories of resource users
- Elders, opinion leaders and cultural institution
- Government ministries, departments and agencies
- Private sector

5.2.2.2 Institutional strengthening

Resources are required for strengthening catchment management organizations. The specific interventions include establishing and rolling out CMO governance structures, support and strengthen the CMC, establish and support the Catchment Management Secretariat, supporting and strengthening the CSF and establishing a Catchment Technical Committee for CMP implementation

Resources are also required for monitoring and evaluation of the CMP implementation, developing and implementation of a CMP monitoring and evaluation framework both at catchment and sub-catchment level, carry out quarterly monitoring per catchment / sub-catchment / micro-catchment by Management Committees including quarterly field verification missions and carrying out yearly monitoring and CMP review by CSF alongside carrying out a 2-yearly evaluation.

Resources will also be required to coordinate the 6 districts in the catchment. The resources will go towards preparing districts for CMP implementation, support cross-sectoral district operations, guide lower local governments in CMP implementation and guide implementing partners in resource mobilization and joint fundraising.

The other areas requiring funding under institutional strengthening are sub-catchment, micro-catchment and community action planning, funding for implementation of management plans at each of the above-mentioned levels as well as funds for learning, communications and knowledge management.

5.2.2.3 Ecosystem protection and restoration

Resources will be spent to make sure there are productive and protected forests and woodlands in the catchment. Specifically, resources will be spent on improving the management of central and local forest reserves, improve tree cover on the bare hills in the catchment, regulating charcoal production and firewood use and promoting use of alternative sources of energy.

Resources will be required for productives and sustainable rangelands. This will include spending resources to promote collaborative rangeland management with traditional rangeland management institutions and other stakeholders as well as protecting and rehabilitating rangelands.

Other areas requiring funding under ecosystem protection and restoration include funds for interventions on protecting wetlands and flood plains and protecting rivers and riverbanks.

5.2.2.4 Water and sanitation

Resources will be required for learning and knowledge management that includes promoting capacity building, supporting extension services and improving communication and knowledge management surrounding water and sanitation.

Additionally, resources are required to monitoring and planning of water services and resources (establishing groundwater monitoring systems in catchment, establishing surface water monitoring system, establish water quality monitoring systems and enforcing water abstraction permit system.

On piped water supply, there is need to extend and rehabilitate piped water supply systems and construct new piped water supply systems.

On rural water supply systems, there is need to rehabilitate and close non-functional water points, improve operation and maintenance and promote water harvesting for domestic use.

On sanitation and waste management, there is need to upscale sanitation programmes and promote waste management

5.2.2.5 Agriculture and economic development

One of the proposed interventions is to improve agroforestry in banana growing communities and livestock farming. This will require commensurate research in agroforestry as well as development and implementation of a plan to improve access to water for livestock.

The other priorities requiring funding in the agriculture and economic development are improvement in rain-fed farming, promoting irrigation (small scale (<2ha) and medium scale (>2ha)), promoting road water harvesting and promote Income Generating Activities aimed at improving livelihoods of people in the catchment.

A detailed summary of the funding requirement is summarized in Table 25

Table 25: Funding required to implement the CMP

IMPLEMENTATION PLAN - RWIZI CATCHMENT MANAGEMENT PLAN					
ID	Sub-activities	Budget for implementation (UGX)		Budget for O&M (UGX/year)	
	INTERVENTION P: FINALISE COMPONENTS OF THE CATCHMENT MANAGEMENT PLAN	78,750,000		0	
Sub-total	FINALISE COMPONENTS OF THE CATCHMENT MANAGEMENT PLAN		78,750,000		

IMPLEMENTATION PLAN - RWIZI CATCHMENT MANAGEMENT PLAN					
	Intervention A1. Strengthen the Catchment Management Organization	608,875,000		264,000,000	
	Intervention A2 Monitor and evaluate implementation of the CMP	82,250,000		214,250,000	
	Intervention A3 Coordinate at district level	30,700,000		110,000,000	
	Intervention A4 Sub-catchment, micro-catchment and community action planning	992,250,000		1,600,000,000	
	Intervention A5 Funding of the Catchment Management Plan	854,625,000			
	Intervention A6 Learning and knowledge management	1,406,525,000		36,000,000	
Sub-total	A) INSTITUTIONAL STRENGTHENING		3,975,225,000		2,224,250,000
	Intervention B1 Productive and protected forests and woodlands	33,838,542,143		296,140,000	
	Intervention B2 Promoting productive and sustainable rangelands	321,076,429		20,000,000	
	Intervention B3 Protecting wetlands and flood plains	774,904,301		46,900,000	
	Intervention B4 Protecting rivers and riverbanks	585,628,571		-	
Sub-total	B) ECOSYSTEM PROTECTION AND RESTORATION		35,520,151,444		363,040,000
	Intervention C1 Learning and knowledge management	203,975,000		20,860,000	

IMPLEMENTATION PLAN - RWIZI CATCHMENT MANAGEMENT PLAN					
	Intervention C2 Monitoring and planning of water services and resources	600,498,214		169,200,000	
	Intervention C3 Piped water supply systems	67,848,000,000		3,388,125,000	
	Intervention C4 Rural water supply	763,812,500		18,328,125	
	Intervention C5 Sanitation and waste management	3,683,250,000		220,710,000	
Sub- total	C) WATER AND SANITATION				
	Intervention D1 Improve agroforestry in banana growing communities Livestock farming	995,435,000		15,000,000	
	Intervention D2 Improve Rainfed farming	471,055,000		18,750,000	
	Intervention D3 Promoting irrigation (small scale (<2ha) and medium scale (>2ha))	342,500,000		-	
	Intervention D4 Promote road water harvesting	178,500,000		6,000,000	
	Intervention D5 Promote Income Generating Activities	637,500,000		-	
Sub- total	D) AGRICULTURE AND ECONOMIC DEVELOPMENT		3,067,490,000		39,750,000
Grand total			115,741,152,158		6,444,263,125

5.2.3 Sources of funding

5.2.3.1 Existing Funding streams

Funding for public water related infrastructure development, water resources and environmental management, and livelihood improvement interventions in the catchment and the entire country currently comes from central and government budgets and development partners with limited financing from NGOs. The existing funding streams will continue to finance some elements of the CMP.

Line ministries and agencies of government can finance some of the interventions especially the large water development infrastructure investments. Such projects include valley tanks and earth dams, irrigation infrastructure and bulk water transfer schemes.

In addition, districts in the catchment can use own budgets to implement some interventions especially if the DDPs and the CMP are aligned. For this funding source to be fully exploited, districts

must see that the CMP addresses issues/challenges affecting their district and is aligned within their development priorities.

NGOs and other development partners can continue to mobilize funding (from donors etc.) for implementing interventions in their areas of interest. This funding stream could be focused more on the CMP, for instance by district councils conditioning their development partners and NGOs to align activities to the CMP and DDPs. In addition to proving they have the requisite technical capacities; the development partners and NGOs must demonstrate that activities they are proposing to implement are supported or recommended by the CMP or otherwise present evidence that those activities are appropriate even if not recommended by the CMP.

5.2.3.2 New funding streams

Similar to the previous years, the Uganda water and environment sector performance report 2016 (MWE, 2016) identifies limited funding as a key challenge the water and environment sector faces in pursuit of the national and sector targets. Generally, the cost of managing water resources to achieve social, economic and environmental goals is increasing because of population and economic growth, urbanization, food needs and the threats of droughts and floods (EUWI-FWG, 2012). The consequence is that traditional funding streams (such as government budget and CSOs) will increasingly become inadequate for implementing the CMPs. New funding opportunities have to be pursued. Examples of such new funding sources, suitable for the catchment, are suggested below including ways of positioning the CMO and districts to attract and secure these funding streams.

5.2.3.3 Programme/Project development and fundraising by the CMO

The CMO (through the CS supported by the CTC and advised by the CMC) can either solely or in partnership with individual districts and/or development partners source funding from donors for implementing (parts of) the CMP. For this the CS and districts need to have sufficient capacity to develop proposals and later manage implementation of activities. In addition, the CS should have the legal mandate to source and manage funds. Generally, donors prefer to fund legal entities, therefore it is necessary for the CMO to have some sort of legal status for it to be able to attract external (i.e. non-government) funding.

5.2.3.4 Public Private Partnerships (PPPs)

PPPs are considered as an important tool in Uganda's plan to bridge the infrastructure financing gap in the next years. The PPP Act, passed in 2015, provides methods for procurement and the engagement of private partners in PPPs. It also regulates the roles and responsibilities of government bodies during the development and implementation of PPP projects. The PPP Act established two PPP agencies: the Public-Private Partnerships Committee as well as the Public-Private Partnerships Unit (within the Ministry of Finance).

Furthermore, the vital role of not-for-profit systems (CBOs and NGOs) shall be included in the private sector contribution to the implementation of the catchment WRDM plan.

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ANNEXES

Annex 1: Description of sub-catchments of Rwizi catchments

Rwizi Upper

Rwizi upper covers the districts of Buhweju, Bushenyi, Sheema, Mbarara and Isingiro and these are the sources of Rwizi River. Rwizi upper is mainly hilly, with alternating valleys and gentle slopes in Mbarara and Isingiro. The sub-catchment lies at a higher altitude (2,250m [Buhweju and Sheema] to 1,251m [Isingiro, Mbarara]) as compared to other sub catchments giving it beautiful scenery especially in the folding and conical hills of Buhweju and Sheema respectively. Wetlands dominate most of the riverbanks and streams especially in Buhweju, Sheema and Mbarara (mainly Rwampara). Most of the hills in the landscape are bare. whereas the gentle sloping areas (in Mbarara, Isingiro and the southern part of Sheema) are bush lands and agricultural expanses of banana plantations. Mbarara town is the most built up area with almost no vegetation cover in the urban setting. Other emerging developments are traced in Sheema (Kabwohe).

Rwizi upper was previously a very fertile area especially in the gentle slopes of Buhweju, Sheema and Ntungamo with very high food productivity; bananas and millet as the main food crops. Due to various activities, the fertility of these soils has reduced mainly due to massive erosion on hill slopes and thus a declined potential for food production. Soil types include; Acric Ferralsols that dominate most of Buhweju and some parts of Sheema, Luvisols - mainly in Sheema and Mbarara, Planosols and Histosols - in southern parts of Sheema and Mbarara and then Eutric Regosols in most parts of Isingiro. The west and the south western parts of Rwizi upper are hilly with hard rock structure. Swamps and wetlands are dominated by alluvium swamp lacustrine deposits in Nchwezi, Kyania, Kibingo, Rugasha and Rwengiri streams in Sheema. Mica schist with quartzitic interbeds is common in Sheema and Mbarara, pelites with minor quartzite beds in Buhweju, quartzitic sandstone (Mpanga, Lusenyi, Kyerera, Rwabuhesi streams) in Buhweju, and mudstone; shale, slate, phyllite in the northern parts of Ntungamo and southwestern parts of Mbarara.

Middle Rwizi

Middle Rwizi is mainly Isingiro district and the southern part of Kiruhura district. The sub-catchment is characterized by gentle slopes and low-lying areas and thus with an elevation ranging from 1600-1201m. Middle Rwizi is mainly characterized by bare hills due to over grazing and bush lands with wetlands converging on River Kashara and the smaller lakes between Lakes Mburo and Kachera. The vegetation cover has been affected by grazing (in Kiruhura) and cultivation (in Isingiro) alongside changes in weather and climate. Currently, it is described as semi-arid. Regarding lithology, Luvisols dominate most of the catchment and eutric regosols are traced along Nyakagera stream. Other soil types in this sub-catchment include; gleyic arenosols and histosols and acric ferralsols. Isingiro would be a fertile area but because of the semi-arid conditions (characterized by unreliable rainfall) productivity of the area is poor. The geology of Rwizi middle is composed of mudstone, shale, phyllite, oncolite and stromatolite; Quartzitic sandstone, alluvium; sand silt and gravel in seasonal wetlands, and Kasagama granite.

Kashara Sub-Catchment

Kashara sub-catchment mainly covers Kiruhura district, and a small fraction of Mbarara district. The northern part of the sub-catchment is gently sloping with elevation of 1400-1251m whereas middle and southern parts are generally flat lands with minor hills ranging from 1250-1200m. Kashara sub-catchment is characterized by bare hills, bush lands, grasslands and seasonal wetlands. Bare hills are due to the impacts of overgrazing e.g. soil erosion while grass lands, bush lands and seasonal wetlands are due to semi-arid climate of this cattle corridor. The geology of Kashara sub-catchment is composed of mica schist with quartzitic interbeds in Kisalala, Nyabuhama and Lwentanga Stream; Rwamasha granite along Musalala stream north of Kiruhura; mudstone, shale, phyllite, oncolite and stromatolite – east Kashara sub-catchment; alluvium sand, silt and gravel – small deposits along streams in the sub-catchment; alluvium swamp lacustrine deposits along River Kashara and Lake

Mburo. The most common types of soils in this sub-catchment include; planosols (northern part), luvisols, acric ferralsols and histosols. Due to the harsh conditions (prolonged drought), cattle keeping is the main activity in Kiruhura – Kashara sub-catchment.

Kachera Sub-Catchment

Kachera sub-catchment also doubles as the catchment area for Lake Kachera, which forms the boundary between Kiruhura and Lyantonde districts. The sub-catchment covers districts of Kiruhura, Lyantonde, Lwengo and Rakai. The landscape is mainly gentle slopes and flat / low lying areas. The elevation for this sub-catchment ranges from 1400 – 1250m. The only built-up area is Lyantonde. Vegetation in Kachera is composed of mainly bush lands, bare hills and depleted tropical high forests towards Lwengo. Geology is composed of Kasagama granite (north and west of Lake Kachera; mudstone, shale, phyllite, oncolite and stromatolite dominate most of the sub-catchment; mica schist with quartzitic interbeds and alluvium sand silt and gravel along streams). Kachera sub-catchment is dominated by acric ferralsols, patches of leptosols and gleysols.

Kisoma Sub-Catchment

Kisoma sub-catchment is on the downstream side of the river, in Rakai district. It is generally flat with an elevation of 1200 – 1100m. Seasonal and permanent wetlands are traced on the stretch towards Lake Victoria, commercial farmlands along Muguswa stream, tropical high forests northeast wards towards Lake Victoria and woodlands. Regarding geology of the area, Mica schist with quartzitic interbeds dominate most of the sub-catchment. Others include; alluvium, sand, silt and gravel; papyrus swamp, flood plain mud stretch up to Lake Victoria. Soil types include; luvisols, planosols, acric ferralsols, dystric regosols and eutric regosols.

Bukora Sub-Catchment

Like Kisoma, Bukora sub-catchment is on the downstream end of river Rwizi. The upper reaches of the sub-catchment are characterized by gentle slopes, which the lower part is flat as it stretches to Lake Victoria with elevation of 1200-1100m. Bukora has tropical high forests that are well stocked towards Lake Victoria. On the other hand, a stretch of bush lands, bare hills, commercial farmlands are traced towards Lake Kijanebarola along Chiroi stream. Soil types include leptosols, acric ferralsols, gleysols, histosols, dystric regosols and arenosols. Alluvium; sand, silt, gravel; beach terrace; gravel and sand; mudstone, shale, phyllite, oncolite and stromatolite form the geology of Bukora sub-catchment.

Annex 2: Projected Livestock Counts for 2020-2040

Livestock count (2020)

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	574	50	121	28
Bushenyi	1%	23	23	4	3	21
Isingiro	15%	27,112	33,210	4,541	1,139	36,921
Kiruhura	17%	53,455	17,206	2,554	734	13,285
Lwengo	7%	3,136	4,358	393	1,266	14,879
Lyantonde	3%	2,117	1,316	155	290	2,079
Mbarara	15%	143,217	83,792	7,409	10,705	152,768
Ntungamo	2%	4,634	5,516	838	181	4,494
Rakai	31%	64,363	85,273	9,944	42,097	258,586
Sheema	7%	3,343	6,060	1,283	931	23,754
Total	100%	301,689	237,329	27,171	57,467	506,814

Livestock count (2025)

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	573	50	122	32
Bushenyi	1%	23	23	4	3	24
Isingiro	15%	27,114	33,142	4,530	1,142	43,010
Kiruhura	17%	53,460	17,171	2,548	736	15,475
Lwengo	7%	3,136	4,349	392	1,270	17,332
Lyantonde	3%	2,118	1,313	154	291	2,422
Mbarara	15%	143,232	83,620	7,391	10,738	177,961
Ntungamo	2%	4,634	5,505	836	181	5,235
Rakai	31%	64,369	85,099	9,920	42,225	301,230
Sheema	7%	3,343	6,048	1,280	933	27,671
Total	100%	301,719	236,843	27,106	57,643	590,394

Livestock count (2030)

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	572	50	122	38

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Bushenyi	1%	23	23	4	3	29
Isingiro	15%	27,117	33,074	4,520	1,146	50,103
Kiruhura	17%	53,465	17,136	2,542	738	18,028
Lwengo	7%	3,137	4,340	391	1,274	20,191
Lyantonde	3%	2,118	1,310	154	292	2,822
Mbarara	15%	143,246	83,449	7,373	10,771	207,309
Ntungamo	2%	4,635	5,493	834	182	6,098
Rakai	31%	64,375	84,924	9,897	42,354	350,907
Sheema	7%	3,344	6,036	1,277	936	32,234
Total	100%	301,749	236,358	27,041	57,819	687,757

Livestock count (2035)

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	571	50	122	44
Bushenyi	1%	23	23	4	3	33
Isingiro	15%	27,120	33,007	4,509	1,149	58,365
Kiruhura	17%	53,471	17,100	2,536	741	21,001
Lwengo	7%	3,137	4,331	390	1,278	23,521
Lyantonde	3%	2,118	1,308	154	293	3,287
Mbarara	15%	143,260	83,278	7,355	10,803	241,497
Ntungamo	2%	4,635	5,482	832	182	7,104
Rakai	31%	64,382	84,750	9,873	42,484	408,776
Sheema	7%	3,344	6,023	1,274	939	37,550
Total	100%	301,779	235,874	26,976	57,995	801,177

Livestock count (2040)

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Buhweju	3%	289	570	49	123	51
Bushenyi	1%	23	23	4	3	39
Isingiro	15%	27,122	32,939	4,498	1,153	67,990
Kiruhura	17%	53,476	17,065	2,530	743	24,464

District	%age of district in R. Rwizi basin	Cattle (no)	Goats (no)	Sheep (no)	Pigs (no)	Poultry (no)
Lwengo	7%	3,137	4,322	389	1,282	27,399
Lyantonde	3%	2,118	1,305	153	294	3,829
Mbarara	15%	143,274	83,107	7,338	10,836	281,323
Ntungamo	2%	4,636	5,471	830	183	8,275
Rakai	31%	64,388	84,577	9,849	42,613	476,188
Sheema	7%	3,344	6,011	1,271	942	43,742
Total	100%	301,809	235,390	26,911	58,172	933,301

Annex 3: Location of hotspot areas


Challenges	Location Sub county, Village	What has been done	Proposed interventions	Actors available to support the implementation
Kyotera				
<ul style="list-style-type: none"> Climate Change. Siltation of wetlands. Burning in almost all hills and wetlands Overgrazing Over fishing Conversion to cultivation of fragile areas. Deforestation and charcoal burning. Drainage Encroachment (settlement) Uncontrolled hunting. Over Grazing 	<p>Kakuuto, Bukora Jjengere Wetlands, Kakuuto Water Abstraction Point NWSC, Kisoma Wetlands in Kasasa S/C and Kasaali T/C, Sango Bay Wetlands in Kakuuto and Kyebe S/ Cs, Katengo Wetlands Abstraction Point NWSC in Kyotera and Kasaali T/C, Musambwa islands (IBA) in Kabira s/c</p>	<ul style="list-style-type: none"> Preparation of the district state of environment report Eviction and restoration of over 300 hectors of River Bukoola –Kakuuto Sub County section. Continued compliance monitoring and enforcement though support is limited. Intensified raising public environment management awareness, identifying key environmental issues and benefit to Kyotera Local government development especially where sustainable Land management (SLM) issues are concerned. The development is linked up with livelihood issues and is a continuous process. The District is working more closely with other partners in the fight to eradicate poverty through sustainable utilization of natural resources. Some of them are funders like GEF, and others that implement like UNDP, UNEP and World Bank. Improvement on management of forests and woodlands, benefiting the local population. This done through promotion of agro forestry and silvi-pastoralism and efficient utilization of biomass energy and wood. The district is endeavouring to develop the Fisheries potential of the numerous water bodies it has (e.g. Lakes Victoria, plus the Rivers, Bukora and others). District to considered promotion of eco-tourism, with its abundant fauna and flora, as one way of community sustainable participation in direct management of Local resources. 	<ul style="list-style-type: none"> Planting of trees in the bare hills Implementation of soil and water conservation in the individual farm lands. Demarcation and restoration of degraded wetlands. Regulated fishing Compliance monitoring Promoting the energy saving technology (Lorena stoves) at household and institutional level. Promoting road reserve tree planting. Promoting woodlots establishment at Household and institutional level 	<p>District local government, MWE,NGOs, NEMA, MAAIF</p>
Rakai				

Challenges	Location Sub county, Village	What has been done	Proposed interventions	Actors available to support the implementation
<ul style="list-style-type: none"> Deforestation which is rampant in the whole district and people are cutting down trees for both timber and fuel wood which are highly demanded. Poor agriculture practices such as over cultivation on steep slopes which leaves the ground bare and prone for erosion. Encroachment of wetlands for cultivation of both seasonal crops and farms has also resulted into reduction of rain because wetlands no longer exist to help in climate modification. Bush burning during the dry season that leaves the land bare and prone for erosion. This has reduced vegetation that helps in climate modification. Poor waste disposal that has led to many diseases such as water and air born disease. Drainage of wetland and cultivation along the river bank for example along River Kachera catchment that is shared by Lyantonge and Rakai district. Siltation of the rivers and streams due to cultivation of the river banks. 	<p>Lwamagwa and Kasambya Dwaniro and Kasaali sub county Mukogote, Kibaati, Kibaale</p>	<ul style="list-style-type: none"> Sensitization of the communities have been done by district officials about climate change mitigation. Planted trees in some bare hills in the district such as in Lwamagwa and Kasambya sub county. Construction of hand shallow wells to help in reserving water during the rainy season to be used in dry spells hence continuous evaporation. The district officials have also tried to conserve the catchment area such Kijanibarola and other areas which are near river Rwizi and Lake Kakyera by protecting the banks and advising people not to cultivate on them to cause siltation. The district officials are advising the other staff to consider environmental screening of every development to be carried out in the district. The district officials have submitted proposals to different organizations and ministries about climate change for funding though they haven't received replies. The district officials are also advising communities to form groups and request for trees to plant on bare hills. 	<ul style="list-style-type: none"> Promoting the growing of first growing, nitrogen fixing shrubs, firewood species Promotion of the growing of Agro-forestry drought resistant tree species, nutritional and income generating species Promoting the energy saving technology (Lorena stoves) at household and institutional level. Promoting road reserve tree planting. Promoting woodlots establishment at Household and institutional level. Establishing shrub-based contour bunds in banana plantations and other crop lands. Restore degraded bare hills. Facilitate and enforce land use planning in the District. 	<p>DWO, DNRO, DLG, NEMA MWE, MAAIF</p>
<p>Ntungamo</p>				

Challenges	Location Sub county, Village	What has been done	Proposed interventions	Actors available to support the implementation
<ul style="list-style-type: none"> Deforestation which is rampant in the whole district and people are cutting down trees for both timber and fuel wood which are highly demanded. Poor agriculture practices such as over cultivation on steep slopes which leaves the ground bare and prone for erosion. Encroachment of wetlands for cultivation of both seasonal crops and farms has also resulted into reduction of rain because wetlands no longer exist to help in climate modification. Bush burning during the dry season that leaves the land bare and prone for erosion. This has reduced vegetation that helps in climate modification. 	<p>Ihunga, Kibatsi, Rutungu, and Rubaare town council. Orusindra, Nyamukana, Munyere, Buhanama, Karagaano, Nyaruteme, Kakingoora wetlands; Encroached Ntungamo forest reserve, Municipality Waste water treatment plant.</p>	<ul style="list-style-type: none"> Enforcement and eviction of wetland encroachers Radio talk show on wetland management and climate change Training of local environment committees Tree planting Establishment of tree woodlots of eucalyptus on government lands Sustainable land management strategies implementation 	<ul style="list-style-type: none"> Emphasize on awareness creation on wise resource use. Develop a restoration & management plan. Extend the green belt establishment Re-enforce the existing and form & strengthen new Local Environment Committees (LECs) in areas where they don't exist. Emphasize environmental monitoring and compliance enforcement. Demarcation of wetland boundaries Promoting sustainable land management practices Continuous training of communities on environmental protection Promoting of tree planting. 	<p>DNRO, MWE, NEMA, MAAIF</p>
Rwengo				

Challenges	Location Sub county, Village	What has been done	Proposed interventions	Actors available to support the implementation
<ul style="list-style-type: none"> • Encroachment of wetlands • Water stress caused by deteriorating water quality and quantity • Flooding of the lowlands • Bare hills caused by deforestation. • Over Cultivation 	Bukoto	<ul style="list-style-type: none"> • Sensitisation of communities on effects of environmental degradation • Planting of trees on the bare hills 	<ul style="list-style-type: none"> • Emphasize on awareness creation on wise resource use. • Extend the green belt establishment approach already in place. • Re-enforce the existing and form & strengthen new Local Environment Committees (LECs) in areas where they don't exist. • Emphasize environmental monitoring and compliance enforcement. • Mapping and demarcating wetland boundaries; • Reduce eucalyptus dense tree plantations • Develop a District Wetland Action Plan 	DWO, DNRO, DLG, NEMA MWE, MAAIF
Sheema				
<ul style="list-style-type: none"> • Wetland encroachment • Flash floods • Poor agricultural practices • Loss of fauna (including aquatic species) • Bare hills • Deteriorating surface and ground water quality • Flooding 	Nyabwina Village, Kangore village masheruka sub county, Migyera Village Masheruka town council	<ul style="list-style-type: none"> • Enforcement and eviction of encroachers • Marking boundary with concrete pillars • Radio talk show on wetland management and climate change • Training of local environment committees • Compliance monitoring • Tree planting • Establishment of tree woodlots of eucalyptus on government lands • Sustainable land management strategies implementation 	<ul style="list-style-type: none"> • Boundary opening, gazzetement, collaborative tree planting • Sustainable Land Management, energy saving and breed improvement 	DWO, DNRO, DLG, NEMA MWE, MAAIF

Challenges	Location Sub county, Village	What has been done	Proposed interventions	Actors available to support the implementation
<ul style="list-style-type: none"> Deforestation Increased wetland encroachment Poor agricultural methods Deteriorating surface and ground water quality Increasing demand for surface water for domestic, agricultural and industrial uses 	<p>Kakyeera Nyakasharara Rushango Rushere Kazo Buremba Kakyaryeru Buremba Rwemikoma Engari Kitura Kenshunga</p>	<ul style="list-style-type: none"> Enforcement and eviction of encroachers Marking boundary with concrete pillars Radio talk show on wetland management and climate change Training of local environment committees Compliance monitoring Tree planting Establishment of tree woodlots of eucalyptus on government lands Sustainable land management strategies implementation 	<ul style="list-style-type: none"> Conducting Radio talk shows on wetland management, physical planning and land management Marking wetland Boundary with Concrete Pillars Enforcement and eviction of encroachers Compliance monitoring Formation and training of watershed committees Receive and distribute tree seedlings to communities and institutions 	<p>DLGs, NGOs, MWE, MAAIF</p>



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