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Final SADA Report for the

Kagera Basin System

Draft Report




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This report is a compilation of the information organized by national teams from the four riparian countries of the Kagera Aquifer with each team comprising a hydrogeologist and a social expert. Coordination between the team members and the national authorities in each of the four countries was provided for by a focal person from each country. The support, input and efforts of these team members listed hereinafter is duly acknowledged.

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EXECUTIVE SUMMARY

Aquifer Characteristics: The Kagera aquifer is for the most part defined as the low areas of alluvium deposits around the Kagera River. The transboundary aquifer thickness is not precisely mapped but is expected to be in the order of 50-80m at the downstream part of the aquifer and shallower at the upstream. It is underlain in either by a fractured basement complex / Metasedimentary rocks or by consolidated sedimentary formations. The area of the whole aquifer is estimated to be 6300 Km^2 with 1 % of it within Burundi, 13 % within Rwanda, 22 % within Uganda and 64 % within Tanzania. Population living within the aquifer boundary is estimated to be about 900,000 (59% in Tanzania, 22% in Uganda, 17% in Rwanda and 3% in Burundi. The Kagera aquifer may be the most prominent groundwater resource in the Kagera Basin which is known for its mountainous terrain, significant rainfall, flowing rivers and lakes. The basement complex rocks that cover most of the terrain of the Kagera Basin allow for limited storage and transmission of groundwater through their fissures.

Recharge to the Kagera aquifer is not quantified and the available data and information are insufficient to ascertain this information. Sources of recharge to the alluvium aquifer were identified to occur from three potential sources;

- Direct Recharge from the Kagera River: Aquifer replenishment apparently occurs when the river stage is higher than the groundwater level thus generating a hydraulic gradient where by the river loses to the aquifer. The process may be reversed when the river stage becomes lower than the groundwater level in which condition the river gains water from the aquifer
- Direct Recharge from Wetlands: The Kagera basin features a number of wetlands in its low elevation areas, a number of which around the depressions of the Kagera River. These wetlands are contact zone through which the aquifer may be recharged. Wetlands may also be points of groundwater discharge to the surface of the land.
- Flow from the surrounding fractured basement complex: The heterogeneous mixture of crystalline rocks forming the basement complex around the Kagera River are highly fissured and thus have the ability to store and transmit rain water through these fissures. Water moves slowly through these fissures and often emerge in the study area in the form of spring in the side of the mountain, the flow may also emerge below the ground surface to latterly recharge the alluvium aquifer in the pediplain. The storage of the basement complex is finite and relatively small, however the large contact area of these hills along the boundaries of the aquifer means that significant volumes of recharge may be introduced to the aquifer with recharge sources as far west as the Congo-Nile Ridge.

Socioeconomic Background: The total population of the four riparian countries of Kagera is estimated to be more than 120 million with Tanzania being the most populous (~49%) followed by Uganda (~32%), then Rwanda (~10%) and Burundi (~9%). The average annual population growth rate in the four countries is about 3% and about half of the total population is below the age of 15. The population within the Kagera aquifer area is estimated to be about 900,000 distributed between the four countries as follows; Tanzania 59%, Uganda 21%, Rwanda 17% and Burundi 3%

Farming activities are the most dominant livelihood activity in Kagera aquifer area. The main livelihoods structure in the aquifer are dominated by subsistence farming; crop and livestock production. The main food crops include finger millet, maize, beans, bananas, cassava, potatoes, in addition to fruits and vegetables with Coffee being a major cash crop.

Other livelihood activities include small scale fish farming, agroforestry and brick making. Agricultural activities are dominated by women, while the remaining aforementioned activities are dominated by men. The aquifer region is generally one of high poverty, with poverty status varying from one location to another depending on existing opportunities for economic activities. Urban centres within the aquifer serve as regional trade and service centres relying primarily on trade and services and small manufacturing activities.

Precipitation and surface water from rivers and lakes are the source of water for the different livelihood activities in the Kagera region. Groundwater is used primarily as a source of drinking water and for animal watering accounting for about 70% of water supply (springs and boreholes). Women and children are mostly responsible for the collection of water. The average time spent to collect the water ranges between 20-30 minutes. Access to improved safe water sources varies greatly within the project areas and ranges in average from 60% to 80% with average per capita water use of about 25L/day. The development of groundwater resources in the area is increasingly sought by the authorities in the four riparian countries to improve access to safe water in a declared effort by the four countries to achieve universal access by 2030 in line with the sustainable development goals. Groundwater can contribute to the reduction of the risks of waterborne diseases as in general it is of better quality than surface water sources. The challenge however, is to prevent groundwater contamination from anthropogenic sources. While the development of groundwater can effectively contribute to the enhancement of the domestic water supply, it is generally hampered by a number of technical, financial and/or managerial factors.

The Kagera aquifer in not well mapped within the four riparian countries. Its extent and storage capacity are not delineated. Basic data pertaining to aquifer properties and its current level of development are lacking, there are no operational monitoring activities within the aquifer and none of the riparian countries have a plan for the aquifer development.

Data Gaps: Groundwater is hidden resource, the characterization of which requires the collection of various types of data. Identification of data gaps and continuous data collected efforts are required to enhance the level of knowledge of aquifer and its properties. A narrative of some of the basic data used to characterize the Kagera Aquifer and identified gaps is given hereinafter:

- Geological Maps: Geological maps for the project area were compiled from the geological maps of the four riparian countries. These country maps are available in different formats and scales. The variability of the maps' scales and the adoption of different formation names and lithological description details, pose a challenge to the compilation of the available data into one geological map. Detailed geological surveys in parts of Kagera Aquifer area to produce a joint geological map for the aquifer at a scale of 1:20,00 for the four countries will enhance the aquifer characterization efforts.
- Information about aquifer thickness, depth to water, water quality, groundwater use and aquifer stratification can be ascertained from well data. This information is usually obtained during the well drilling process. Indeed, the regulations in Uganda and Tanzania stipulate the attainment of a license from the ordained authority prior to well drilling, and the submission of well log sheet after the drilling process. However, the enforcement of these regulation is not consistent and the well logs of drilled wells are either missing or dispersed among different drilling companies and NGOs. Furthermore, when available these logs for the most part are not electronically archived nor are they prepared with consistent standards. From the hundreds of well logs compiled during the study, very few were found to be within the delineated boundary of Kagera Aquifer, and primarily located within Uganda and Tanzania. The compiled data provided local information about the aquifer thickness. However, they were not accurate nor sufficient to provide information about groundwater flow directions or water quality.
- The determination of groundwater level from the available log data was hampered by the limited size of data and the absence of accurate elevation data at the points of measurements as the information was available in the form of depth below ground level. Errors within the digital elevation model used to reduce the groundwater level and the differences in the

resolutions of the models available for the four countries is bound to smear the ascertained results of groundwater level. The low frequency of measurement, the limited spatial distribution of measurements and the inaccuracies associated with the measurement and the reference data make to difficult to detect or filter out seasonal fluctuations in groundwater levels.

- Field surveys to compile an inventory of all wells within the Kagera Aquifer and the establishment of a spatial database to archive this data is needed for the assessment of flow dynamics within the aquifer and its use. The establishment of a monitoring system for the aquifer is essential for the successful implementation of an effective system for its management.

Governance and Institutional Setup: The beginning of the third millennium witnessed the development of national visions within the four riparian countries that share the Kagera aquifer to reduce poverty, and health problems and improve access safe clean water and adequate sanitation within 20 to 25 years. National policies to achieve the set targets were subsequently developed. At the core of these policies were the water policies which embraced the UN sustainable development goals for water and sanitation to achieve the equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, and the protection of the environment.

The policies adopted by the four counties were similar in that they followed the same principles which regarded water as human resource which is to be used for the public good, emphasized the human right of access to water, and adopted the concepts of Integrated Water Resources Management (IWRM) for water management with emphasis on participatory approach. The policies embraced the concepts of catchment-based water resources management, management of water taking into consideration conservation of water sources, environmental impacts and consideration to the aspect of internationally shared water resources. If not specifically cited in these policies groundwater is addressed as in the case of Burundi as part of the water resources to be conserved and sustainably managed. The water policies of the four countries have in essence the same core set of guiding principles and goals and do provide a coherent set of strategies to guide the sector and allows for the establishment of joint legal framework for joint management of transboundary water resources.

The evolution of the legal frameworks for the governance of water resources was influenced in each of the four riparian countries by the adopted water policies, history, socio-cultural structures and practices as well as the existing political climate. In spite of the existence of differences in focus and

structure the legal frame works governing water resources management in the four countries have similar perspective elements. They provide binding set of rules that govern the vision established in the country's policy and establish the institutional setup responsible for water resources management within the country. Furthermore, they provide aligned legal frameworks that address the use and management of water resources including its protection from pollution. Existing legislations also allows for cooperation and sharing of data with riparian countries for the management of transboundary water resources. Legislations however are more centred towards the use and management of surface water and address groundwater with different levels of emphasis. Groundwater management regulations are more developed in the four countries in the following order Tanzania, Uganda, Rwanda and Burundi which apparently reflect the order of prevalence of use of groundwater within the four countries.

Legislations and regulations pertaining to groundwater management in the legislative frameworks of the four riparian countries include:

Water Allocation: Development of groundwater resources requires the attainment of water permits and the legislations specifies the level of government from which the water allocation permits can be obtained. The amount of water that can be allocated and time for which water rights are granted are subject to the discretions of the authorizing agency. It is bound to be different within the four countries as it is most likely influenced by local legal traditions. Water allocation for human consumption is considered as basic right and can apparently be readily obtained. The issue groundwater allocation for irrigation or other industrial purposes may be a source of controversy in establishing joint management efforts of the transboundary aquifer.

Water Tariffs: The concept of payment of tariffs for used Groundwater is enshrined in the water resources legislative frameworks of the four riparian countries. The basis for the fee determination is not set and may differ in different areas within the same country. Water tariff may be specified based on cost recovery principles, market value principle or as a conducive element for the efficient use of water. Agreement on the basis of water tariff specification will be conducive to efforts of developing transboundary aquifer management systems.

Environmental Considerations: Environmental legislations are similar within the four countries in that they take into consideration water quality when issuing groundwater allocation, require environmental impact processes for proposed interventions and put controls on discharge to water sources.

The water management structure practiced in the four riparian countries is a state-centered or technocratic system of management. This system is based on the notion that the state, through its administrative and political institutions can and should allocate and plan the nation's water resources in the interest of the common good.

Water resources management is sought in the riparian countries within the framework of the river basin adopting IWRM principles. Planning management and conflict resolution is undertaken by the government with emphasis on decentralization through governing boards and regional and local authorities/agencies with the involvement of Primary stakeholders (local communities, farmers, water users).

The water governance institutional setup in the four countries can be divided into four levels (i) the National level responsible for formulating national policies, oversight, budgeting, resource mobilization, regulating and overall performance monitoring. (ii) The regional level (or Basin/Catchment Level) which is responsible for the development, management of water facilities. (iii)The local level (subbasin/subcatchment level), responsible for the direct operation of water facilities, monitoring, conflict resolution, regulation enforcement. (iv) Community Level: This may comprise individuals or water user committees whose role is to monitor service delivery and functionality, report problems and sensitize users to pay for water services.

The implementation of existing water resources regulations requires the establishment of a range of mechanisms aiming to ensure compliance with existing regulations. These mechanisms, situation monitoring, issuing warnings, imposing fines, revoking water licenses or suspending operations. There is an apparent weakness in the performance of the enforcement mechanisms within the four countries which attributed to number of factors:

- Lack of funding for monitoring activities
- Shortage of trained enforcement officers
- Weak involvement of primary stakeholders due to lack of awareness and/or poor communication with stakeholders at the local level.
- Poor coordination between stakeholders at the national, regional, and local levels

The development of an enabling environment for attaining the effective joint management of the Kagera Aquifer requires the alignment of the water resources policies and legislations, the establishment of effective regulatory agencies, and monitoring systems and the full engagement of the primary stakeholders in the decision-making process.

Impact of Climate Change: The analysis of the impact of climate change on the Kagera basin area was conduced conducted through the World Climate Research Program (WCRP) Coupled The analysis projected the changes to three climate parameters; Temperature, Precipitation and Evapotranspiration to the year 2100 under four Representative Concertation Pathways, namely RCP2.6, RCP4.5, RCP6.0 and RCP8.5. The results of the analysis projected that the Kagera Basin Catchment area will witness the following changes:

The average surface temperatures are expected to rise by $1^{O}C$ to $4^{O}C$ by the year 2100 depending on the level of success to reduce CO2 emissions.

The basin is projected to witness an increase in average annual precipitation and the number of effective rainy days per year, with an increase in the frequency of occurrence of serve events. The rainfall pattern is not projected to significantly change. December is projected to replace November as the month with the highest monthly precipitation rates.

Failure to reduce CO2 emissions to zero by 2100 (RCP2.6) will cause a gradual and marked increase of annual evapotranspiration rates as of 2050. An increase of 70 mm/year can be expected according to the RCP8.5 Scenario.

Indications are that the Kagera basin catchment area is one of the regions that is projected to experience increases in precipitation. In spite of this, surface and groundwater resources may still be negatively impacted. Increased precipitation variability, the inevitable surface temperature rise and potential increase of evapotranspiration may affect hydrological responses within the catchment, reduce the surface runoff and cause drying of the wetlands. The issue of impact of climate change is not trivial and indications of the increase precipitation is not an assurance of an increase in groundwater recharge. Changes of environmental flow and the periodicity of replenishment event may lead to reduction of groundwater recharge in spite of increases in total annual precipitation. Without quantification of the amount of recharge to the Kagera aquifer from the different identified recharge sources, the impact of climate change on aquifer cannot be discerned. In addition to the quantification of the recharge rates to the Kagera Aquifer, tools to assess the effect of climate change on environmental flows and model the climate change groundwater linkages are needed.

It should be noted that climate change direct impacts are not limited to water resources, temperature rise may cause events of shock (floods/droughts) which may lead to loss of vegetation and lower yields for crops thus causing food insecurity for the affected areas.

Aquifer Management and Development: The joint development and management of Kagera Aquifer requires the development of a management structure that will be entrusted with the coordination of the process of allocation and development of groundwater resources in the riparian countries to meet the needs of designated end users as well as conserve, protect or improve groundwater basins in terms quantity and quality. Some of the factors that constrain the development of these structures and their ability to operate if established include:

- Poor groundwater information database in terms of data quality and the ability to readily consolidate data for the purpose of planning and management.
- Lack of the basic hydrogeological data required to adequately map the groundwater basins and plan their development. This may include: lithology data, values of hydrogeological parameters, recharge rates, water level data, water quality data…
- Absence of the monitoring systems necessary to fully ascertain water level and water quality as well as the behavior of the water table to pumping and recharge within the different groundwater basins.
- Lack of information about end user current and projected needs.
- Poor connection and coordination with decision makers and planers to adequately plan or implement projects relying on groundwater.
- Poor public awareness about the susceptibility of groundwater resources to depletion and contamination.
- Absence of national plans for the aquifer development.
- Absence/deficiencies of adequate laws and institutional setups

Policies, plans and regulations pertaining to the management of water resources within the four riparian countries of Kagera Aquifer (Burundi, Rwanda, Uganda and Tanzania) are primarily centered on surface waters. While the management structures for the planning and development of groundwater resources do exist within the water resources governing bodies in the four countries, regulations and policies specifically targeting groundwater resources may not exist or are insufficient. Rules pertaining to groundwater development and protection are usually inferred from those intended for the management of surface water resources if specific rules for groundwater are lacking.

Bylaws pertaining to the regulation and licensing of groundwater development are either not fully developed or are not enforced due to budgetary constraints and the absence of the mechanisms and protocols needed to enforce these regulations if they exist.

Enhancing the capacity of the water governance sector in the four countries should be addressed. Some of the issues that should be targeted in the capacity development process of groundwater resources governing institutions in the four countries include.

- Establishment of a stable management structure for Kagera aquifer in particular and transboundary aquifers in general in the four countries, and ensure their stability in the case of the occurrence of national institutional changes
- Enhance the capacity of national to conduct exploration and aquifer assessment research activities including the training and retainment of qualified and trained staff, equipment and tools as well securing the necessary budgets.
- Improve coordination between national water resources management bodies in each of the four countries and eliminate conflicting responsibilities between key national institutions.
- Improve linkage and cooperation among national institutions working in the groundwater research and development sector (e.g., research centers, universities, drilling companies), as well as agencies in other sectors related to groundwater.
- Prepare well-developed training and capacity building plans for national staff.

Planning the development of groundwater resources may sometimes contest the land right or customary laws of local population. Such land tenure or water rights issues may differ within the different countries and/or communities in the aquifer area. Attention to the resolution of such conflicts should be part of any long-term development plans for the Kagera Aquifer.

A main step towards establishing transboundary aquifer management system/process for the Kagera Aquifer is the sharing of comprehensive aquifer development plan based on the national plans of the riparian countries. The joint management plan should determine a set of realistic goals and objectives and consolidate all the available resources thereafter to formulate and achieve these objectives

Recommendations: The sustainable development of groundwater resources requires the acquisition of the knowledge about the resource, the required development tools, identifying achievable goals, mobilization of the needed resources as well as employing adequate administration and control mechanisms for the resource management. The following recommendations are hereby made to outline some of the actions needed to enable the sustainable development of the Kagera Aquifer

1- Establishing a Repository of Existing Data: A concerted effort by each of the four riparian countries to compile the available groundwater related information and data within their institutions into a dynamic and easily accessible spatial database will enhance the knowledge

about the current state of the aquifer. The repository should consolidate all the existing data ad maps obtained from previous studies and development activities within the aquifer and include all the data needed for the aquifer planning whether physical or social.

2- Data Sharing Protocols to ease the accessibility to available data and information for the purpose of aquifer development and research will expand and disseminate knowledge about the aquifer and its status. The data sharing should include stakeholders at all levels including the end users and should facilitate the sharing of data and information between the four riparian countries.

3- The development of a transboundary groundwater monitoring systems for the Kagera Aquifer is urgently needed. The proposed system should monitor groundwater levels and quality and should be integrated with the climatic and surface water resources monitoring network in the basin. The monitoring system should be designed and optimized to provide regional and local information about the aquifer.

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4- A joint exploratory program to assess the aquifer extent, storage and hydrogeologic properties is needed. The program which could be undertaken by each country within its national borders could include detailed geological mapping, exploratory drilling, geophysical investigations, pumping tests and well inventory surveys to determine aquifer abstractions.

5- It is paramount to engage and actively include the local communities in the aquifer management and planning. Undertaking community outreach programs to assess the needs of the local communities and enlist their efforts in the aquifer protection and monitoring is highly recommended. Awareness, outreach and training programs should be designed to attain this objective with a focus on sharing the aquifer development plans and engaging local communities' efforts in implementing them.

6- Field investigations to identify the sources of recharge to Kagera aquifer and assess its quantity are highly recommended. This could include isotope studies. Studies to investigate the correlation between precipitation levels and patterns in the Kagera Basin with groundwater recharge should be undertaken.

7- There seems to be no clear long term and well-structured plans for the Kagera aquifer development within the four riparian countries. Aquifer development is driven by immediate needs to provide water sources for local communities with little coordination between the various stakeholders. Preparation of national development plans for the aquifer development, sharing of these plans with the other riparian countries are the first steps for developing a regional development plan for the Kagera Aquifer.

8- It is recommended given the limited current state of knowledge about the aquifer and until a full-fledged aquifer management system is in place, that aquifer development be limited to providing access to safe water and avoiding large scale concentrated development.

9- The objective of establishing and maintaining an aquifer management system for the Kagera aquifer that employs state of the art decision making tools including numerical modelling should be sought. The time line to realize it should be identified and the resources required to implement it should be availed.

10- Future planning of the Kagera aquifer development should take into consideration the impact of climate change.

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AFBAD	African Development Bank
AGCM	Atmospheric General Circulation Models
AHAMIR	Rural Hydraulics and Sanitation Agency
AHAMR	Rural Water and Sanitation supply Agency
AHS	Agriculture household Survey
AREEN	the Regulatory Authority for the Drinking Water and Energy Sectors
ATS	Average Temperature at Surface
AVEDEC	Village Association for Mutual Aid and Community Development
AWV	African Water Vision
BPEAE	Provincial Office for Environment, Agriculture et Livestock

CBOs	Community-Based Organizations
CICR	The International Committee of the Red Cross
CLTS	National Community-led Total Sanitation
CMC	Catchment Management Committee
CMOs	Catchment Management Organisations
CMS	Catchment Management Secretariat
COP	Groundwater Vulnerability Map
CPEA	Provincial Coordination for Water and Sanitation
CSF	Catchment Stakeholder Forum
CTC	Catchment Technical Committee
DDCA	Drilling and Dam Construction Agency
DDS	District Development Strategies
DEA	Directorate of Environmental Affairs
DEC	Dietary Energy Consumption
DGEREA	Directorate General for Environment, Water Resources and Sanitation
DHS	Demographic and Health Survey
DPSHA	Directorate for Promotion of Health, Hygiene and Sanitation
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
EAC	East African Community
EC	European Commission
ESA	European Space Agency
ESRI	Environmental System Research Institute
EU	European Union
FBOs	Faith Based Organizations
FDI	Foreign Direct Investment
FY	Financial Year
GCM	General Circulation models
GDP	Gross Domestic Product

GEF	Global Environmental Facility
GIZ	German Development Partner
HDI	Human Development Index
HH	Household
IDP	Internally Displaced People
IGEBU	Geographic Institute of Burundi
IGRAC	International Groundwater Resources Assessment Centre
IPCC	Inter-Governmental Panel on Climate Change
IRA	Institute of Resource Assessment
ITWAD	International Transboundary and Water Affairs Department
IWRM	Integrated Water Resources Management
KFW	German Development Bank
KS	Key Stakeholders
LC	Local Council
LVBCS	Lake Victoria Basin Commission Secretariat
LVBWB	Lake Victoria Basin Water Board
LVEMP	Lake Victoria Environmental Management Project
m.a.s.l.	Meters Above Sea Level
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MEMD	Ministry of Energy and Mineral Development
MHEM	Ministry of Hydraulics, Energy and Mines
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture, Animal Resources
MINALOC	Ministry of Local Government
MINEAGRIE	Ministry of Environment, Agriculture and Livestock
MINECOFIN	Ministry of Finance and Economic Planning
MINIFRA	Ministry of Infrastructure
MINISANTE	Ministry of Health
MLG	Ministry of Local Government

MOE	Ministry of Environment
MoES	Ministry of Education and Sports
MOH	Ministry of Health
MSPLS	Ministry of Public Health and fight against AIDs
MTI	Ministry of Tourism and Industry
MWE	Ministry of Water and Environment
NAWAPO	National Water policy
NBI	Nile Basin Initiative
NDC	National Development Cooperation
NDP	National Development Plan
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEMA	National Environment Management Authority
NFA	National Forest Authority
NFA	National Forestry Authority
NIC	National Irrigation Commission
Nile Sec	NBI Secretariat (Nile-Sec
NISR	National institute of Statistics of Rwanda
NSCC	National Water Sector Coordination Committee
NST	National Strategy for Transformation
NWSC	National Water and Sewerage Corporation
O&M	Operation and Maintenance
OBPE	Burundian Authority for the Protection of the Environment
OBUHA	Burundi Authority for Habitat
OGCM	Oceanic General Circulation Models
PDNE	National Water Master Plan
PNA	National Sanitation Policy
PPP	Public Private partnership
Pr	Precipitation
PS	Primary Stakeholders

PWDs	People with Disabilities
RBS	Rwanda Bureau of Standards
RCEs	Communal Water Authorities
RCP	Representative Concentration Pathway
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RPHC	Rwanda Population and Household Census
RURA	Rwanda Utilities Regulatory Agency
RUWASA	Rural Water Supply and Sanitation Agency
RWB	Rwanda Water Resources Board
RWH	Rain Water Harvesting
SACCOs	Savings and Credit Cooperatives
SADA	Shared Aquifer Diagnostic Analysis
SAT	Average Temperature at Surface
SDGs	Sustainable Development Goals
SS	Secondary Stakeholders
TANESCO	Tanzania Electric Supply Company
TIC	Tanzania Investment Centre
TSU	Technical Support Units
UBOS	Uganda Bureau of Statistics
UGX	Ugandan Shilling
UNDP	United Nations Development Program
UNFCCC	UN Framework Convention on Climate Change
UNMA	Uganda National Meteorological Authority
UO	Umbrella Organizations
UWASNET	Uganda Water and Sanitation NGO Network
VICOBA	Village Community Banks
VP	Veto Players
VUP	Vulnerable People

VUP	Village Umurenge Program
WAG	Wetlands Advisory Group
WASAC	Water and Sanitation Corporation
WASSA	Water Supply and Sanitation Act
WB	World Bank
WCRP	World Climate Research Program
WESWG	Water and Environment Sector Working Group
WMZ	Water Management Zones
WQMD	Water Quality Management Department
WRMA	Water Resources Management Act
WRMAD	Water Resources Monitoring and Assessment Department
WRPRD	Water Resources Planning and Regulation Department
WSSB	Water Supply and Sanitation Boards
WUA	Water User Associations
WUC	Water User Committees

1. INTRODUCTION

1.1. Project Background

The Nile, one of the world's major rivers, has a coverage area that traverses eleven countries including Burundi, the DRC, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda. The Nile serves a vital role in the social and economic development of these countries which are highly dependent on surface water resources within the river basin for basic needs, agriculture and hydropower. Recognizing the need to preserve and sustainably benefit the Nile, global, regional and national attention has been drawn towards the riparian countries in ensuring inter-country cooperation and sustainable and equitable utilization of the resource.

With the growing populations in all eleven countries, increasing demand for water, and the risks posed by climatic and land use change there is a growing need for alternative sources of water. One target area is the groundwater that tends to hold the key for bridging the gap between the heightened demand for water and available supply volume. According to available literature Water bearing geologic formations are known to cover most of the area of the Nile basin with some of them crossing international boundaries forming significant transboundary aquifers. Most of these aquifers are of high storage and possess high yield.

In spite of its abundance within the Nile Basin as a reliable source of perennial good quality water, groundwater is nevertheless a hidden resource which must be explored and well mapped before it can be exploited in an effective and sustainable fashion. The fact that these groundwater resources are not well measured in terms of quantity or quality is what hampers the efforts to plan for the effective development and utilization of this valuable resource.

The Nile Basin Initiative (NBI) is a cooperative arrangement initiated and led by the Nile riparian countries to promote joint development, protection and management of the common Nile Basin water resources. The NBI Secretariat (Nile-Sec) with the financial support of the Global Environment Facility (GEF) and in collaboration with the United Nations Development Program (UNDP), is in the process of implementation of a Nile Basin wide program which focuses on transboundary groundwater aquifers. The aim of the project of the five phase project to strengthen the overall water resources management nationally and basin-wide. The first phase of the program is geared towards the enhancement of knowledge and capacity for sustainable use and management of transboundary aquifers and aquifers of regional significance in the Nile Basin.

Three aquifer areas have been chosen for intervention, namely the Kagera aquifer shared among Uganda, Tanzania, Rwanda and Burundi; the Mt Elgon aquifer shared between Uganda and Kenya; and the Gedaref-Adigrat aquifer shared between Sudan and Ethiopia. The aquifers are located in diverse ecological zones ranging between arid, semi-arid and tropical.

1.2. Project Objective

The study will aim to enhance knowledge and capacity needed for sustainable use and management of trans-boundary aquifers and aquifers of regional significance in the Nile Basin. It intended to foster current mutual understanding of the flow regime and mechanism of recharge, policies, management systems, community engagement of the three selected aquifers, and to enhance the conjunctive management of surface and groundwater resources of these basins. The specific objectives of the study are:

- Improve knowledge and understanding of groundwater resources in the Nile Basin
- Strengthen overall water resources management nationally and basin-wide
- Respond to climate change impacts through effective risk-reduction adaptation measures.
- Ensure a health ecosystem and strengthened livelihood
- Undertake a Shared Aquifer Diagnostic Analysis (SADA) that serves as a baseline fact-based representation of current status of the aquifer.

1.3. Project Components

The project has five components that are expected to be implemented during the project phases namely:

- Component 1: Furthering knowledge and understanding about availability of groundwater resources in the selected aquifers underlying watersheds in the subbasins of the Eastern Nile and the Nile Equatorial Lakes.
- Component 2: Development of action plans on groundwater resources governance, management, and protection for inclusion in national, sub-basin frameworks: – also including consideration of surface water/groundwater resources conjunctive use.
- Component 3: Targeted pilot projects to explore conjunctive use of surface and ground waters, and links to biodiversity conservation and climate change adaptation.
- Component 4: Further strengthening capacity to address groundwater issues at the national and regional levels.

- Component 5: Communications and awareness raising

1.4. Objective and Scope of the Report

This report will present the first compilation of the data and information collected by the four national team from the four riparian countries of Kagera Aquifer (Uganda, Tanzania, Rwanda and Burundi). It will undertake a Shared Aquifer Diagnostic Analysis (SADA) and produce a report that serves as baseline fact-based representation of current status of the aquifer's threats (immediate causes, root causes), use/abstraction; surface-groundwater connection, socio economics, climate change and extreme climate events. The scope of conducted work the result of which reported herein include the following:

- Develop conceptual framework and plan the SADA study
- Identify the data needs and tools/resources required
- Supervise national consultants from Burundi, Rwanda, Tanzania and Uganda who will collect relevant information on groundwater management in the countries, and specifically, data and information for the Kagera aquifer
- Carry out a review of the existing data and/or prior hydrogeological related assessment reports that are available
- Conduct analysis and provide assessment reports, including hydrogeological maps with recommendations for suitable groundwater interventions as adaptive measures based on the findings of the assessments.
- Provide an updated knowledge/information with maps of groundwater distribution and availability by conducting groundwater assessments for The Kagera shared aquifer.

1.5. Study Approach

1.5.1. Background

A study group comprised of four national teams from each of the riparian counties of the basin (namely Burundi, Rwanda, Tanzania and Uganda) and one international consultant were selected to conduct the study and prepare the Kagera SADA Report. Each of the national trams was mainly responsible for the collection, compilation and preparation of all the information that is pertinent to the preparation of the SADA report from their respective countries. In addition, the national teams are to provide expert input during the course of the study in support of preparation and finalization of the Kagera SADA report. The role of the (International consultant) during the course of the study was to coordinate and direct the efforts of the national consultants to ensure the production of a harmonized and standardized spatial groundwater

knowledge database for the Kagera Aquifer. The International consultant was responsible of conducting the necessary analysis of the compiled data to identify the data gaps and assess the aquifer potential to identify its recharge sources, its interaction with the surface water, the impact of groundwater abstraction as well as the potential impact of climate change.

1.5.2. Data Collection

Data collection is a key stage in this study. The type of data that is to be collected by the national teams and the level of required detail and the data submission formats to be used were identified by the international consultant. The international consultant did specify to the national consultants after conducting the necessary consultations the data to be collected which included the following:

- Administrative and political boundaries
- Physiography and Climate (Topographic data, Temperature, Precipitation, Evapotranspiration and landuse data
- Geological Data
- Hydrological data particularly data pertaining to the Kagera basin and Kagera River including (River flow data, River stage data and water quality data, Pumping Test Data)
- Hydrogeological Data including (Water level data, lithology data, geophysical investigation data, groundwater development and groundwater abstraction data)
- Environmental Data including (Groundwater Quality Data, potential contamination sources)
- Socioeconomic Data including (Population and population distribution, economic activities, groundwater uses, general water uses, water rates.)
- Governance and Institutional Setup, including (Water and groundwater legislation, Administrative and institutional setup, land and water resources ownership, water rights, Existing aquifer monitoring and management protocols)

1.5.3. Data Harmonization and Aggregation

Harmonization and aggregation of the data compiled by the national experts was conducted by the international expert. The harmonization process included

- Harmonization of classification (similar land uses and geologic formations have different classifications and designations)
- Harmonization of standards
- Harmonization of interpretation and interpolation methods

- Harmonization of scales, legends and map production specifications.

1.5.4. Data Assessment

Following the Data Harmonization and aggregation process, the compiled database was assessed for completeness and general thematic maps of the Kagera Aquifer were produced. The process did include augmentation of data where specific data was deemed as missing or incomplete, the resolution of data contradictions and differences in data interpretation between national consultants was sought.

1.5.5. Assessment Aquifer Management and Development

An assessment of the existing aquifer management practices in the riparian countries was conducted as part of the SADA report which included a summary and diagnostic analysis of the following:

- Institutional setup in the riparian countries, and assessment of the degree to which they are aligned to work with each other in implementing an effective aquifer management setup for the Kagera. This included, legislations, exchange of information, aquifer monitoring development plans/priorities, Aquifer development strategies.
- Assessment of the existing groundwater monitoring systems.
- Identification of outstanding socioeconomic that may necessitate or hamper aquifer development
- Identification potential sources of threat to groundwater in the Aquifer (e.g., sources of aquifer contamination, upstream river interventions)
- Identification and mapping of various stakeholders and transboundary problems

1.5.6. Data Sources

The data compiled for the purpose of the study was primarily complied by the national teams of the four riparian countries. The compiled data included data from official sources, existing literature, field visits, previous studies, regional data and open data sources.

2. CHARACTERISTICS OF THE KAGERA BASIN

2.1. Background

The Kagera River is the single largest of the 23 rivers that drain into Lake Victoria. Given its 34% annual tributary flow, its contribution into the lake, is over twice as much as the next largest river, the Nzoia in Kenya. This proportion of contribution to the lake, drops to 24 % when the input of rain less evaporation on the lake surface is taken into account.

The Kagera River (400 km long) is formed by two headstreams, which rise in the East Central African highlands (alt. 2500 m.a.s.l.) near the divide with the Congo basin. The Ruvubu rises just north of Lake Tanganyika in Burundi and the Nyabarongo rises in north-west Rwanda. These two main headstreams converge at Rusumo Falls, close to the Rwanda-Tanzania border, from where the Kagera flows north along the border and then abruptly east through the lowland floodplain in Tanzania and Uganda, before entering Lake Victoria (alt. 1145 m) to the south of Sango Bay in Uganda. The Kagera River is estimated to contribute 10% of the outflow from Lake Victoria to the Nile, and is important for sustaining the flow of the Nile

The Kagera basin is spread over Burundi, Rwanda, Tanzania and Uganda with a total area of 59,800 Km2, contributed as shown in Table 2-1. Figure 2-1 shows the extent of the R. Kagera basin. In Rwanda, the basin covers 75% of the land area while in Burundi, the basin makes up 52% of the country. It lends its name to Akagera National Park in northern Rwanda, as well as to the Kagera Region of Tanzania.

Table 2-1: Countries Sharing the Kagera Basin and Catchment Areas they cover

Country	Catchment Area (Km^2)	% Of Total Catchment Area
Burundi	13,060	22
Rwanda	20,550	34
Tanzania	20,210	34
Uganda	5,980	10
Basin	59,800	100

The hydrology of Kagera Basin is mainly defined by Lake Victoria which lies to the east of the basin.

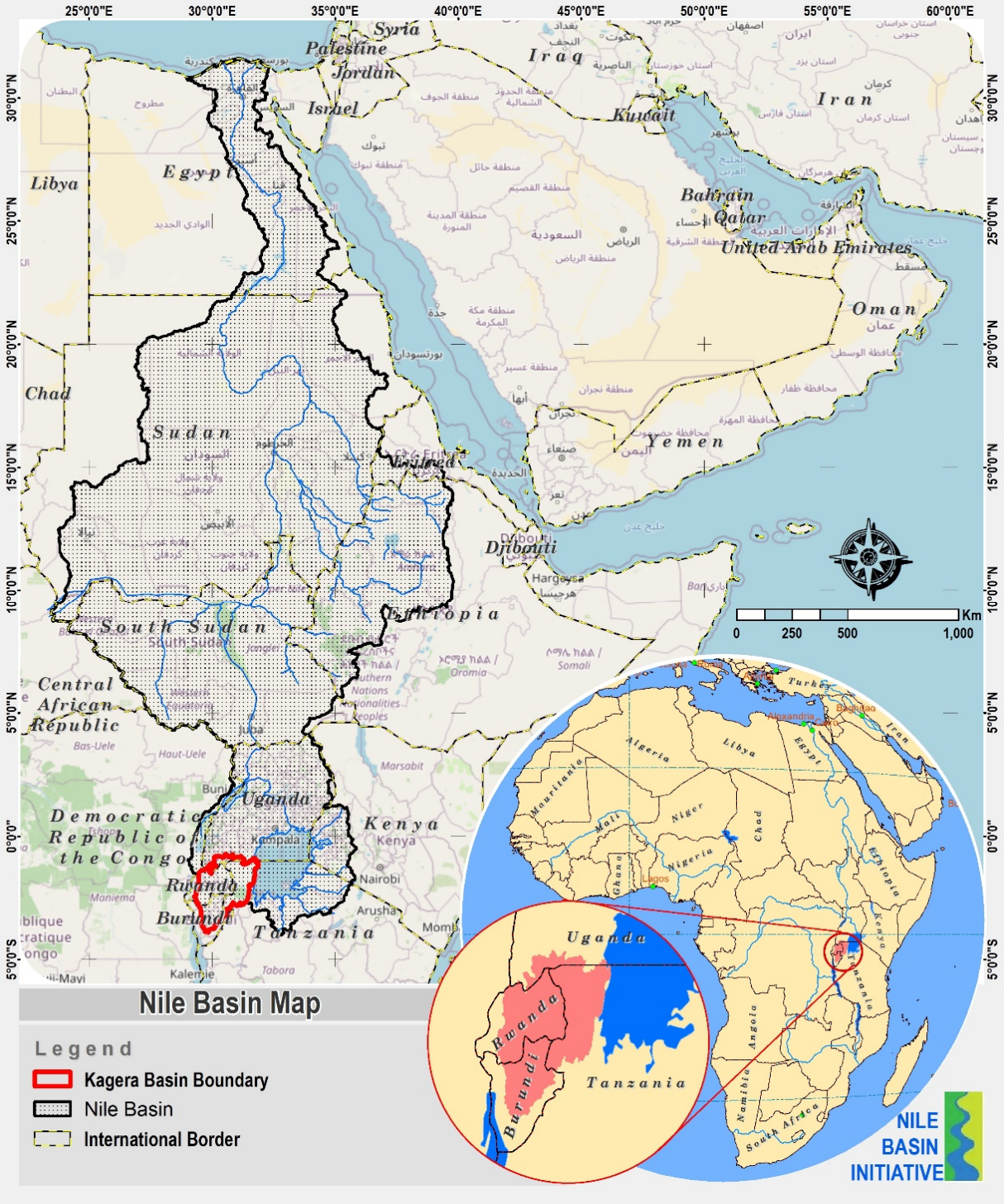


Figure 2-1: Nile Basin Map

The study area is also endowed with several of wetlands, they are formed in the depressions within the elevated (plateau) part of the basin. The most significant of these depressions are those within the path of the Kagera River.

Figure 2-2: Location Map of the Study Area

2.2. Topography

The Kagera basin extend from the Congo-Nile water divide which forms the western border of the sub basin to the Lake Victoria in the east. The elevation decreases from the West and South-West to North-East and East (Figure 2-3). The topography of the basin can be classified into three different zones/segments (Figure 2-4):

The High Ridge Areas: Starting from the Congo-Nile ridge, it comprises North to South elongated mountain range with an average altitude which varies between 2000 m and 4500 m (Highest peak Mt. Karisimbi (4,519 m) with high slopes (>30%) and constitutes about 39% of the Kagera Basin Areas.

The Plateau Area: The elevation decreases gradually from the High Ridge Area towards the East and North East forming a central plateau in about 39% of the basin area which is characterized by rolling hills and a landscape dissected by several valleys the most significant of which is the of the Kagera River. The average altitude this region varies between 1400 and 2000 m.a.s.l. and the slopes vary between 10%-30%.

The Low Land Areas: The third segment which constitute about (22%) of the basin total area is generally flat (slope <10%), gently sloping in a north east direction from elevations of about 1400 m.a.s.l towards Victoria Lake where to drop to elevations of around 1200 m.a.s.l.

2.3. Climate

The climate in Kagera Basin is moderated by altitude relief and many water bodies (lakes, rivers and wetlands), ranging from tropical to humid with a bimodal rainfall pattern with two distinguishable rainy seasons, one centred around March to May and the other October to December with the wettest months in April and November. The average rainfall for the whole basin is between 700 to 2000 mm per year. The basin can be divided into three climatic zones

The High ridge areas which correspond to the high-altitude areas in the basin along the Congo-Nile Ridge at the western part of the basin. This area has a humid climate with annual rainfall between 1000 to 1600 mm and average annual temperature ranges between 12°C and 17°C. This zone covers 39 % of the basin areas.

The plateaus area 39 % of the total surface area of basin with a sub-humid climate characterized by a mean annual rainfall which fluctuates between 800 mm and 1200 mm and average temperatures ranging between 16°C and 20°C.

The lowlands correspond to low-lying lands in the eastern part of the basin in which the climate is affected in by Lake Victoria which cause an increase in relative humidity and annual precipitation. Total annual precipitation gradually increases eastwards from about 800 mm/year to about 1400 mm/year towards the Lake. The mean annual temperature exceeds 20°C.

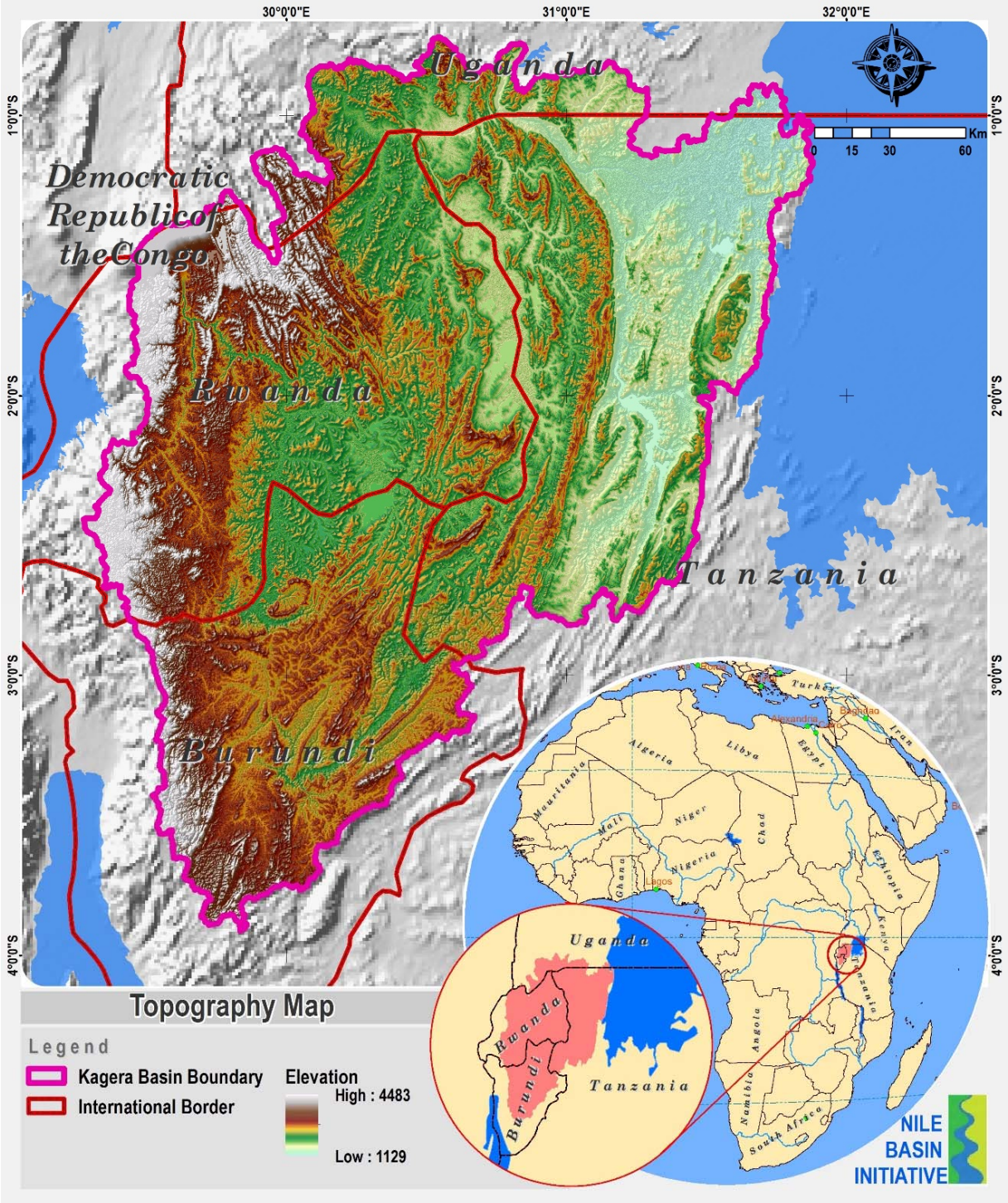


Figure 2-3: Topography Map

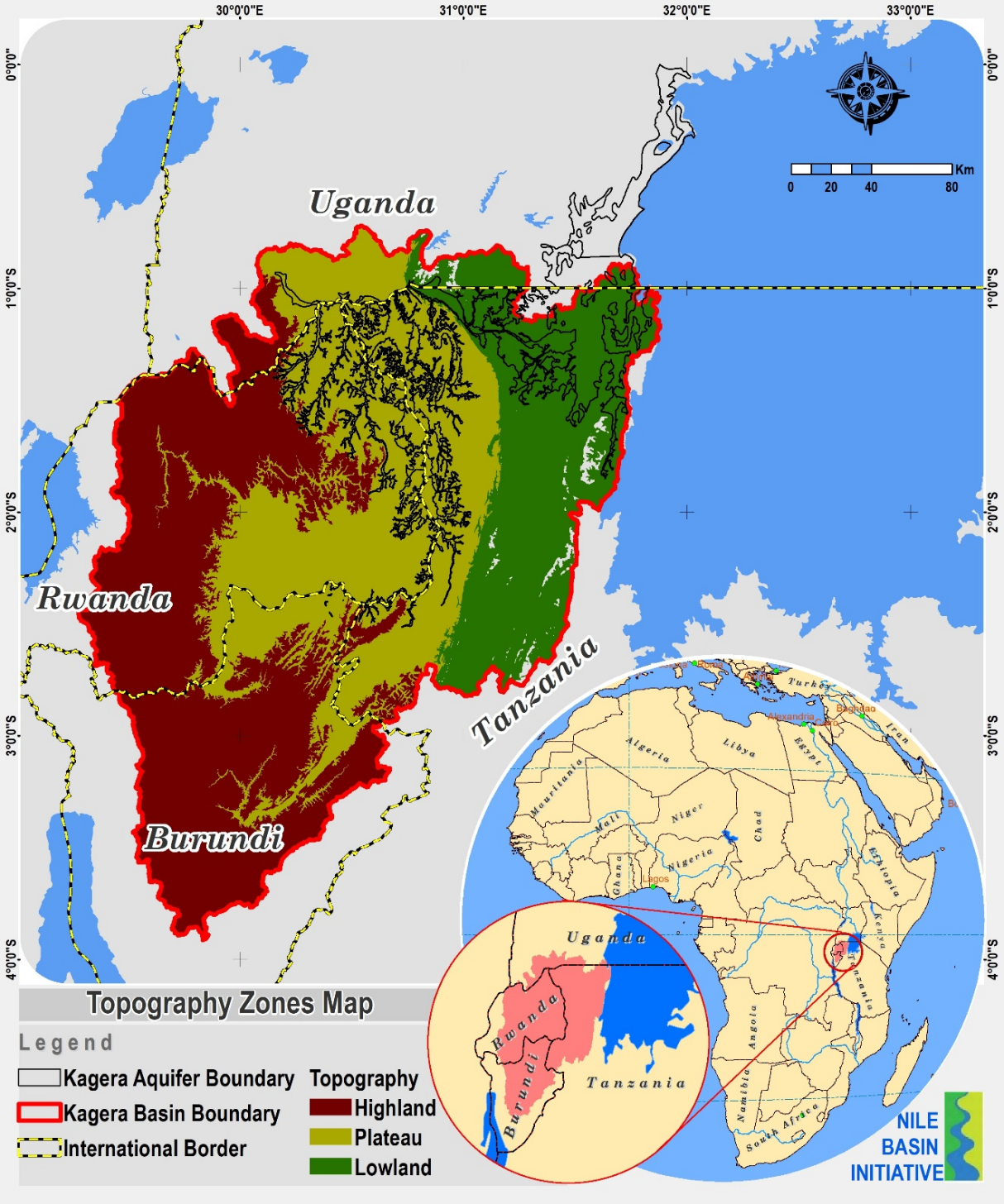


Figure 2-4: Topography Zoning Map

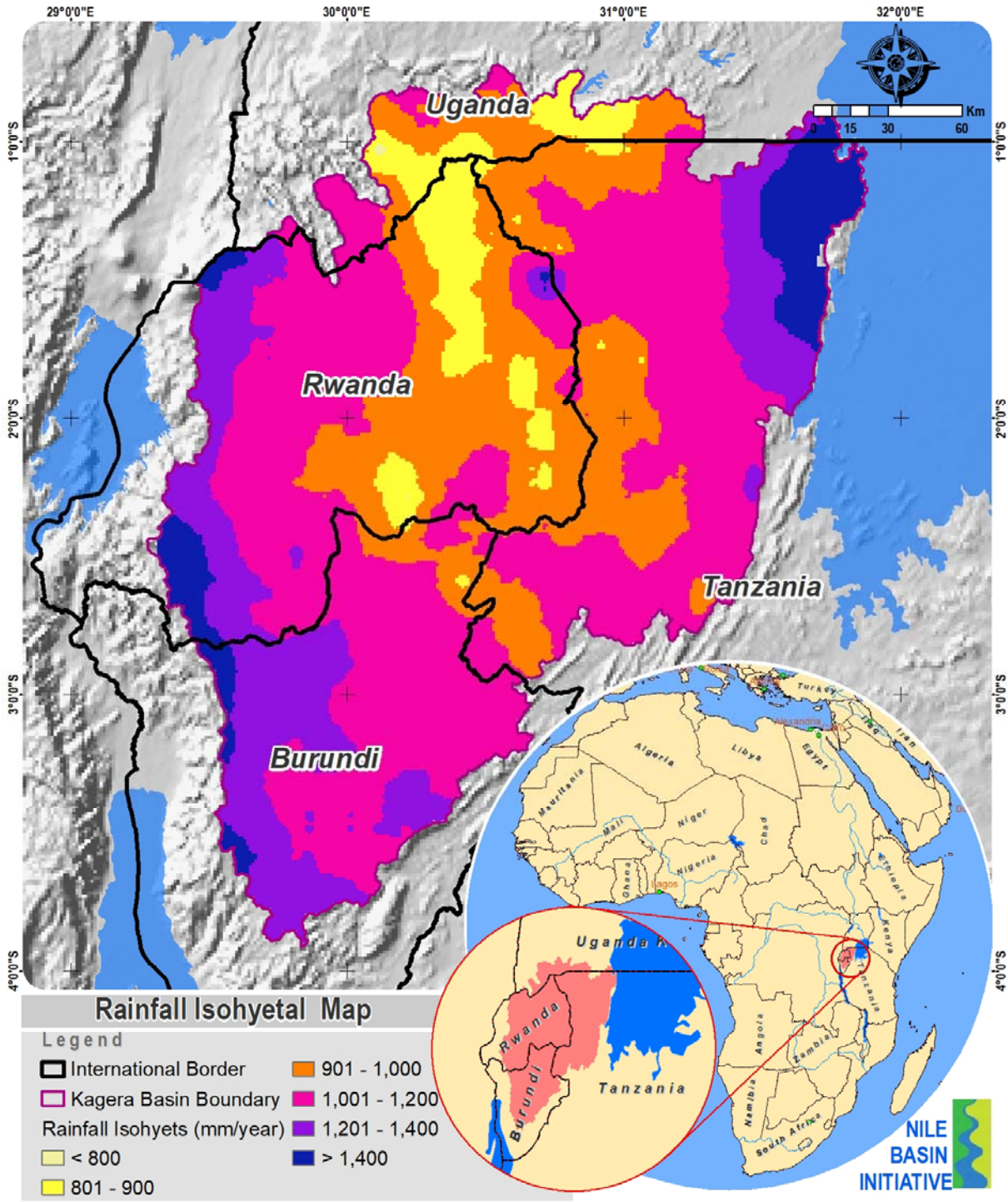


Figure 2-5: Rainfall Isohyet Map

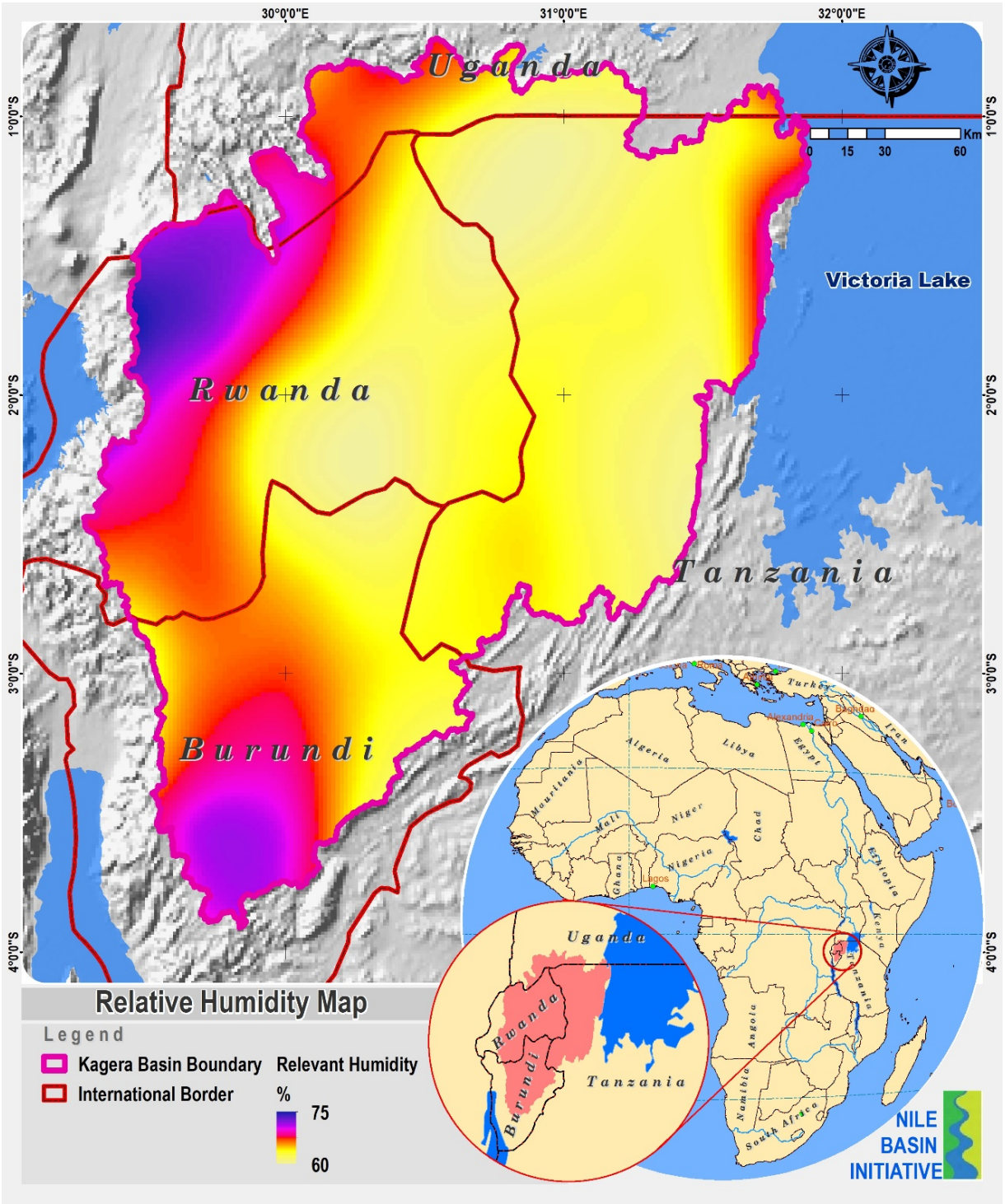


Figure 2-6: Relative Humidity Map

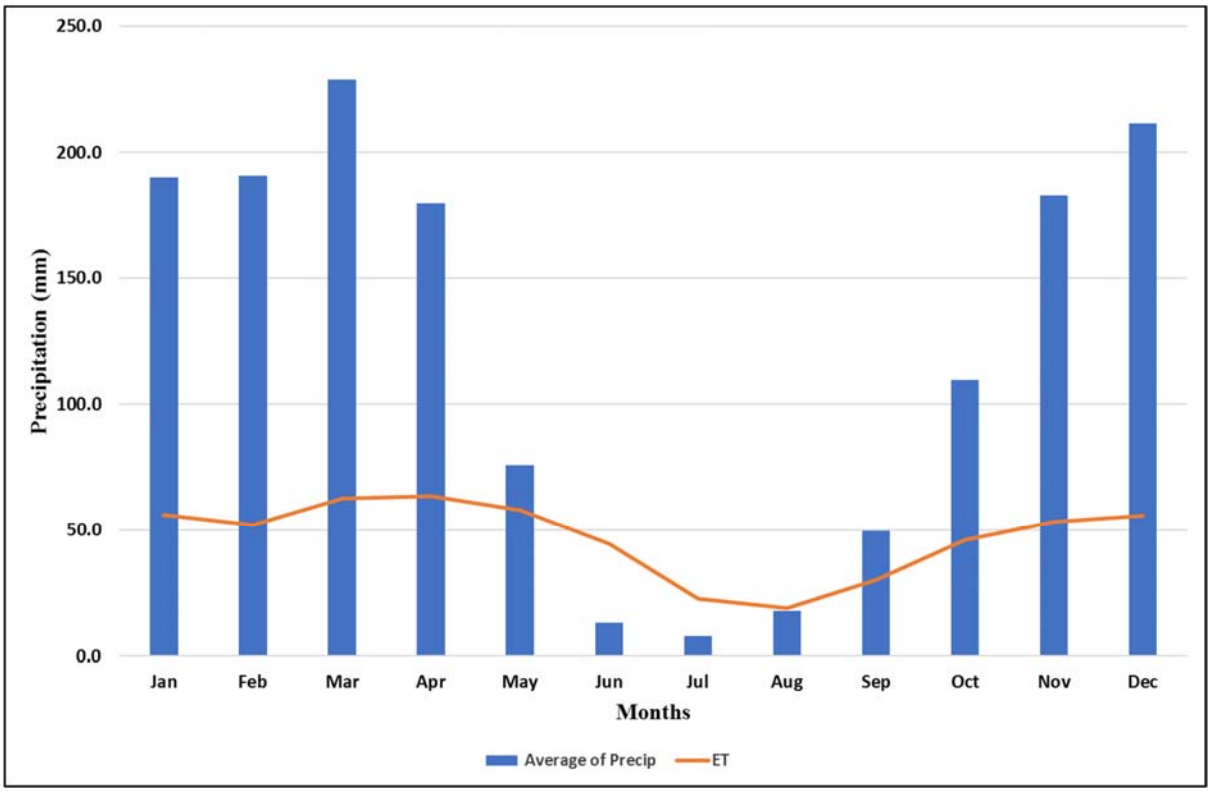


Figure 2-7: Average Precipitation and Evapotranspiration for the Highlands Part

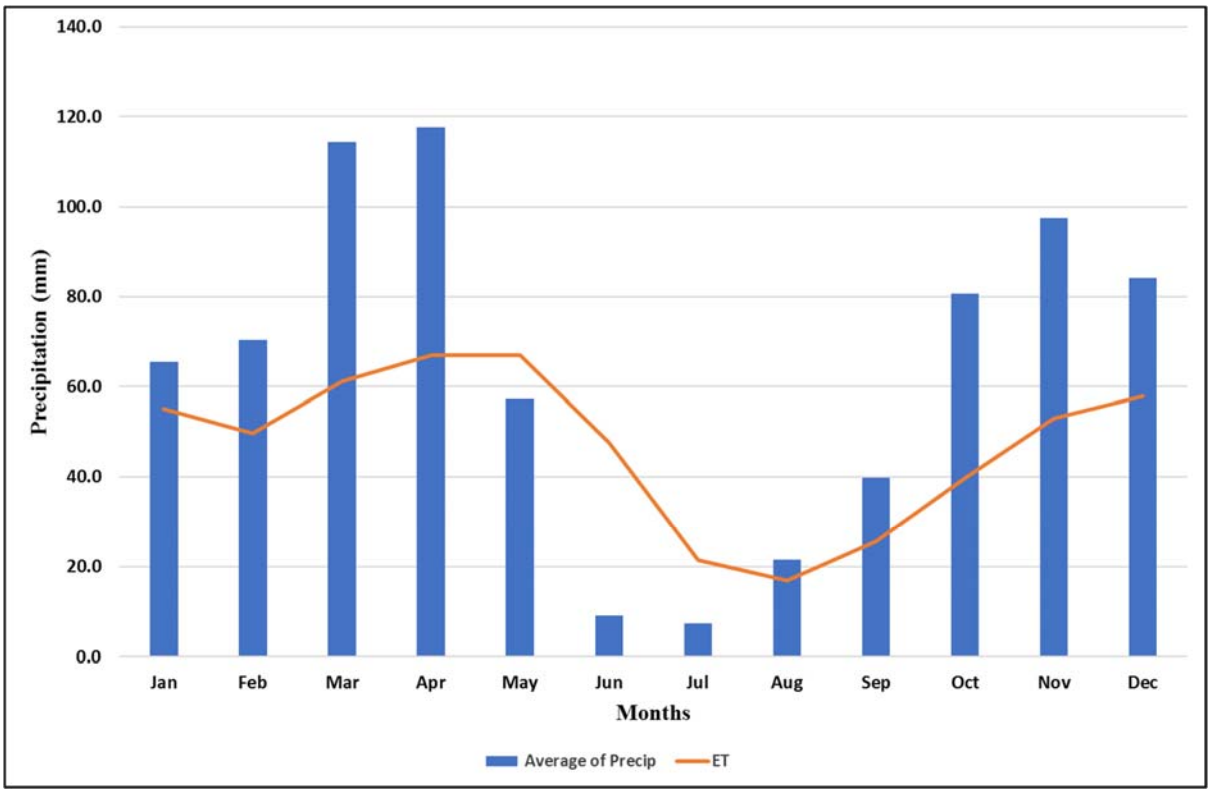


Figure 2-8: Average Precipitation and Evapotranspiration for the Plateau Part

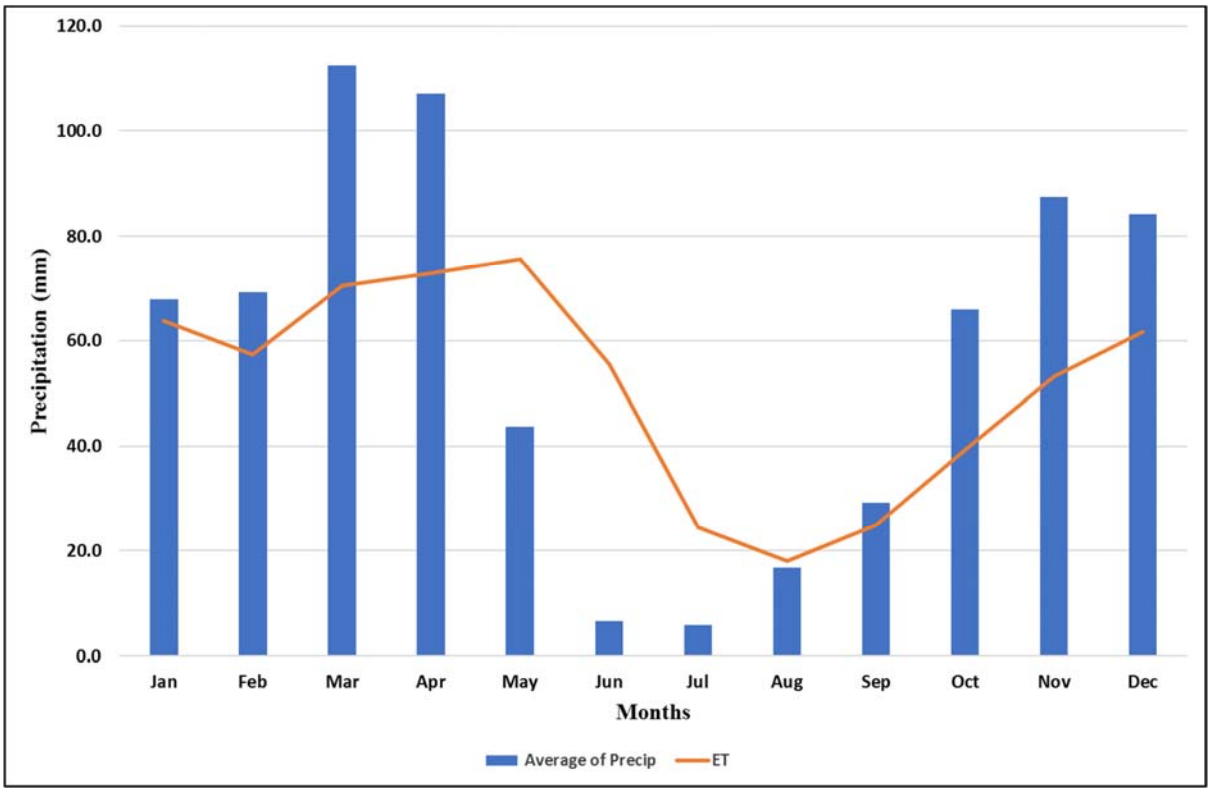


Figure 2-9: Average Precipitation and Evapotranspiration for the Low-lands Part

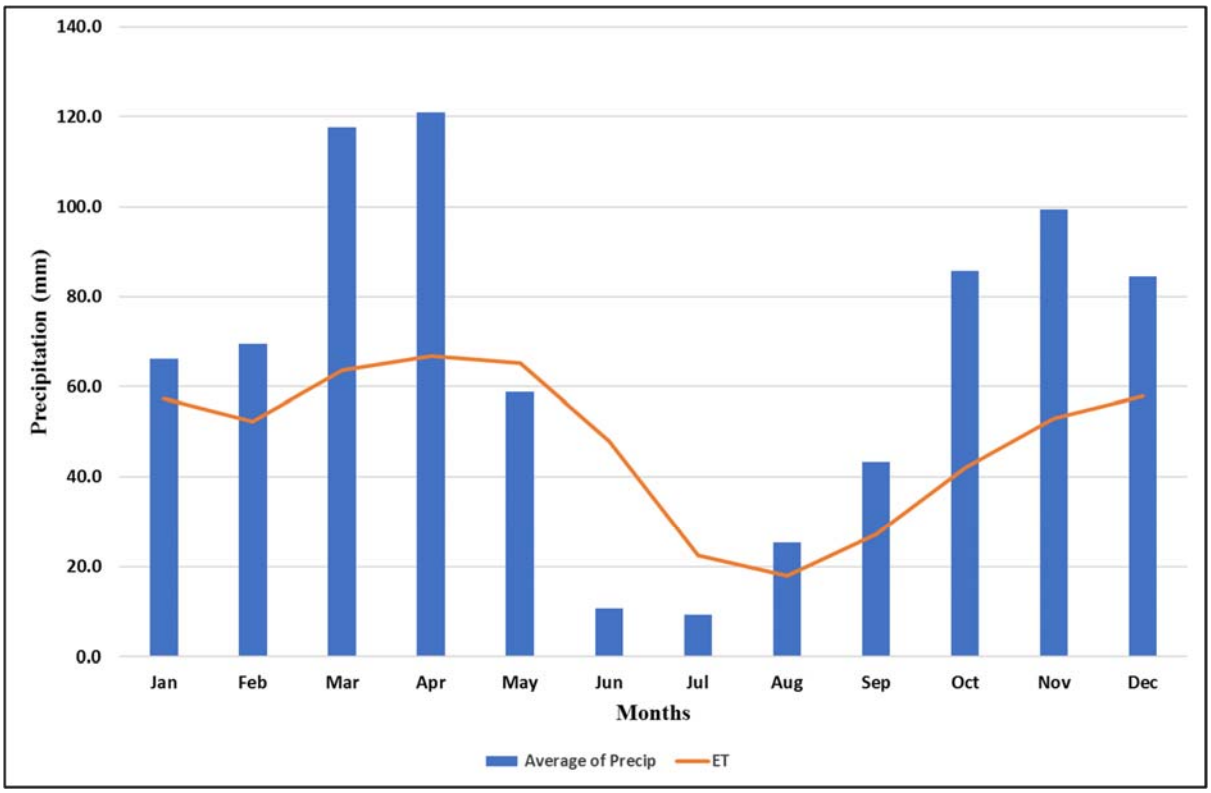


Figure 2-10: Average Precipitation and Evapotranspiration for study Area

2.4. Regional Geology

The simplified regional geological map of the Kagera Basin was established through the compilation of the national geological maps of the four countries (Burundi, Rwanda, Uganda and Tanzania). The geology of the basin can be itemized from younger to older into four main geological groups:

- Unconsolidated Deposits } Cenozoic (Late Pleistocene- Recent)
- Consolidated Sedimentary Deposits} Proterozoic (Neoproterozoic- Mesoproterozoic)
- Metasedimentary Basement } Proterozoic (Paleoproterozoic)
- Basement Complex } Archean

Basement Complex: (> 2500 Ma) The basement complex is the oldest rock unit in the area. They are highly deformed metamorphic rocks which consist of migmatites, granitic gneisses and gneisses with local intercalations of amphibolites and metaquartzites.

Metasediments: (1000-1800Ma) cover the largest part of portion of the Kagera Basin, these are Geologically, folded and slightly metamorphosed clastic sediments of the Mesoproterozoic Karagwe-Ankole Belt (formely known as Kibarana Belt) which underlie most of Burundi and extend through Rwanda into northwest Tanzania and Uganda in an east-northeast direction. They consist of quartzitic metasediments, other metasediments comprising micashists, schists psammites and psammoschists as well as magmatic intrusions represented mainly by granitoids and basic to ultrabasic rocks.

Consolidated Sedimentary Rocks: (635 – 1000 Ma) This unit is made up of consolidated sedimentary rocks, mainly consisting of sandstone, quartzite, schist, limestone, dolomite and local intercalations of volcanic rocks. The supergroup lies unconformity upon the older Burunidan Supergroup/Northeastern Kibaran Belt, its sedimentary succession may comprise two or three layers based on the degree of metamorphism of each layer. The Lower Series, comprises formations of quartzites and various undifferentiated rocks including argillaceous sandstones, basal conglomerates, and shales. The middle series comprises Silicified domomitic limestones and lava. The upper series which is mostly noted in north western Tanzania comprises Fine-grained sandstones, shales, conglomerates, limestones and dolomitic limestones.

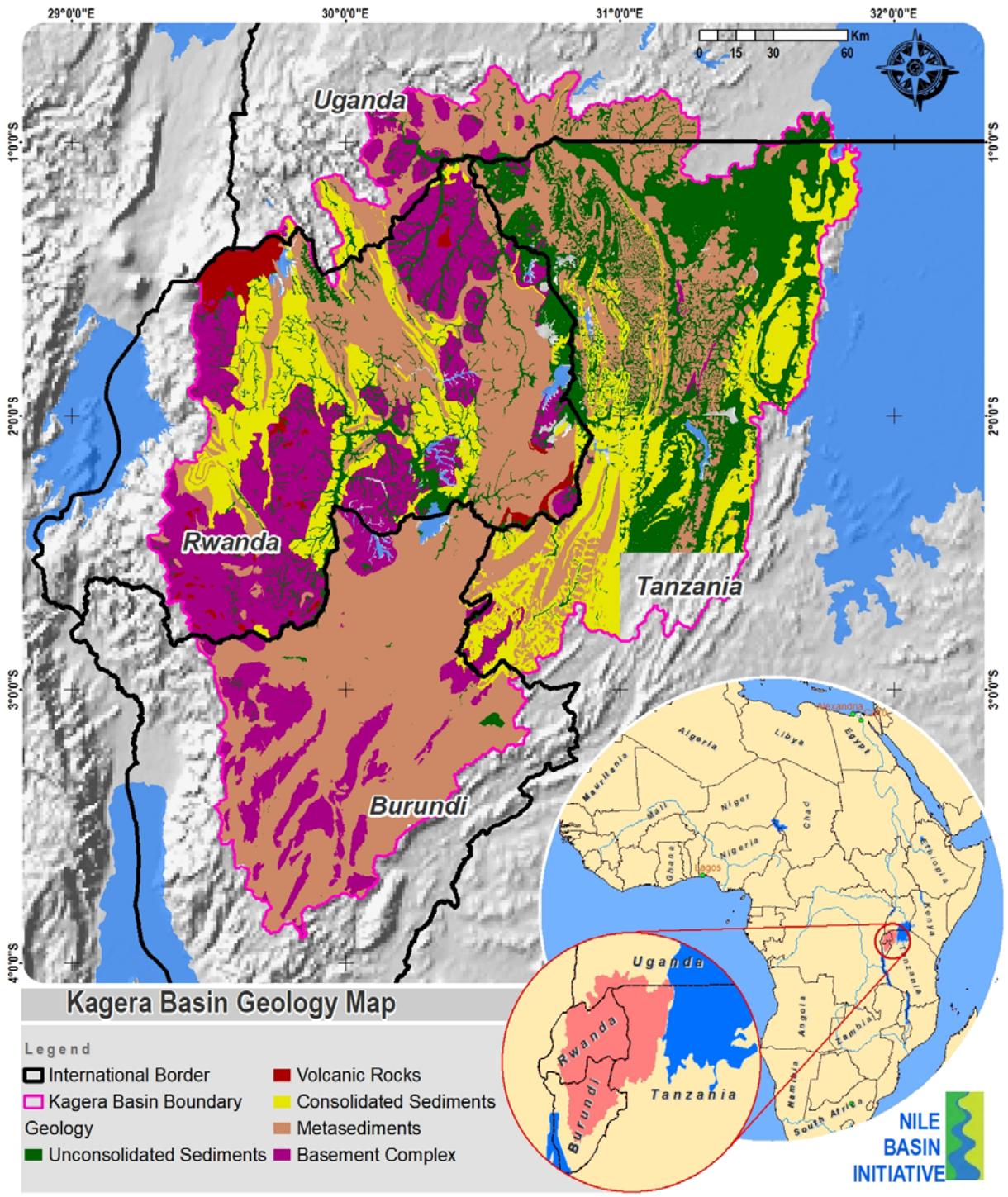


Figure 2-11: Regional Geology Map

Unconsolidated Sediments: These are Late Tertiary to Quaternary deposits: which comprise unconsolidated sediments of different soil types derived from the weathering of the various older formations including crystalline basement rocks. Deposits include the more recent Alluvium and fluvio-lacustrine sediments as well the older deposits of beach terrace gravel and sand

Structural Geology: the structural control of the Kagera Basin is related to the formation of the Eastern Africa Rift Valley, an active continental rift zone in East Africa, which began developing some 25 to 30 million years ago, (Miocene) for the eastern branch and some 10 to 15 million years ago, for the western branch in which the Kagera Basin is found. [other source 22 to 25 million years ago]. The major faulting trends are NE – SW and NW – SE

2.5. Hydrologic Conditions

The hydrology of the basin is defined by a number of physical conditions namely, its climatic conditions, topography and geology. The surface runoff generated by the significant precipitation which falls over the Kagera basin is drained by a number of Rivers which eventually join the Kagera River that drains into Lake Victoria.

The Kagera River starts at the confluences of Nyabarango and Kanyaru in Rwanda and is joined downstream by the Ruvubu which has its headwater in Burundi. The main tributaries of Ruvubu River are Ruvyironza, Mubarazi, Ndurumu, Nyabaha, and Kayongozi whereas the main tributaries of Kanyaru River are Kayave and Buyongwe and the tributaries of the Nyabarango are Mbirurume, Muhembe, Mukungwa, Rwondo and Satinsyi.

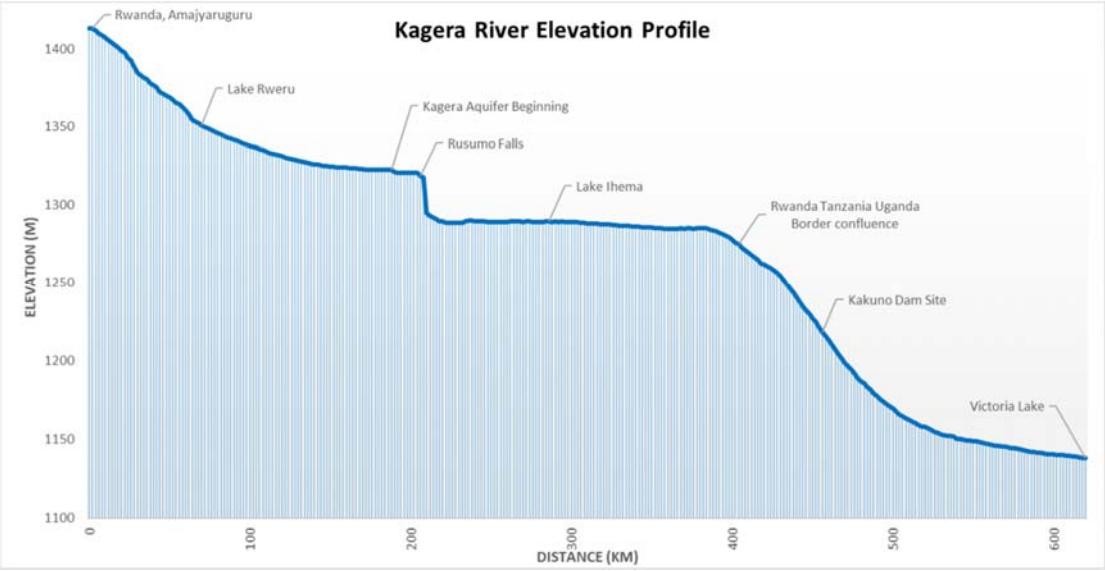


Figure 2-12: Kagera River Elevation Profile

Other tributaries that join the Kagera River before flowing into Lake Victoria include the Mwisa, Ngono, Kishanda and Rubare rivers in Tanzania and the Kagitumba which rises in Uganda. Precitation within the Kagera Subbasin is the source of water for the Kagera River and its tributaries.

The average annual discharge of the Kagera river at Kyaka (close to the River outlet in Victoria Lake) is 184 m^3/sec, which is equivalent to 3.15 km^3/year, with a low ratio of maximum, 540 m^3/sec to minimum of 101 m^3/sec flows caused by large swampy areas upstream, in Karagwe district (Tanzania). A representative sample of Kagera river hydrograph at Nyakanyasi station for 1971-1972 is given in Figure 2-14.

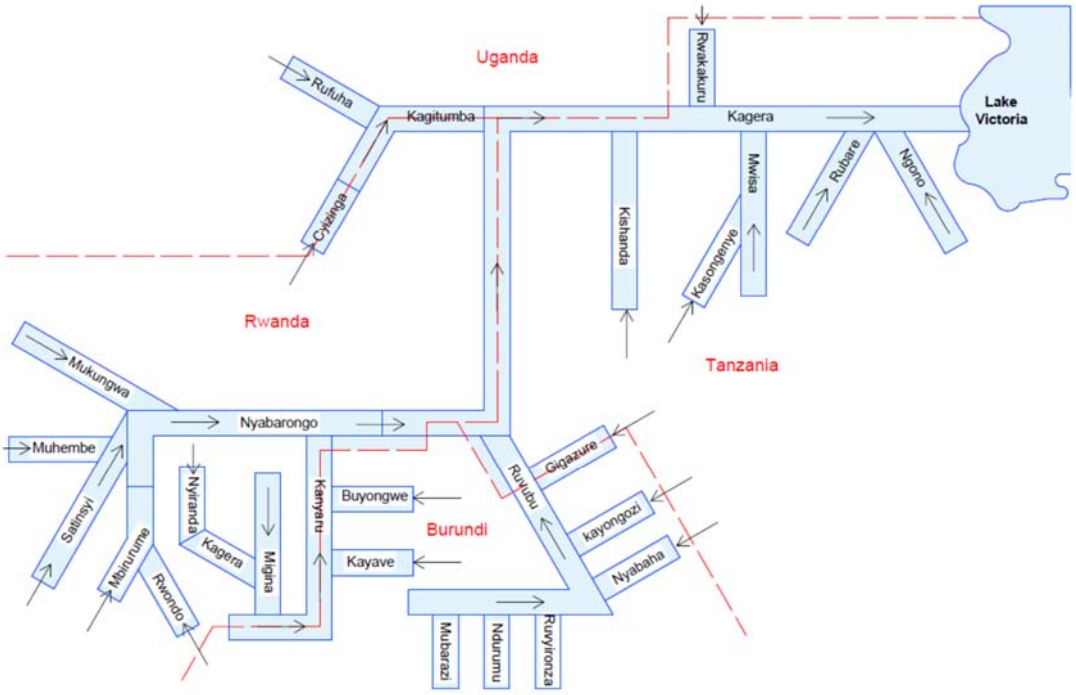


Figure 2-13: Layout of Kagera River Tributaries

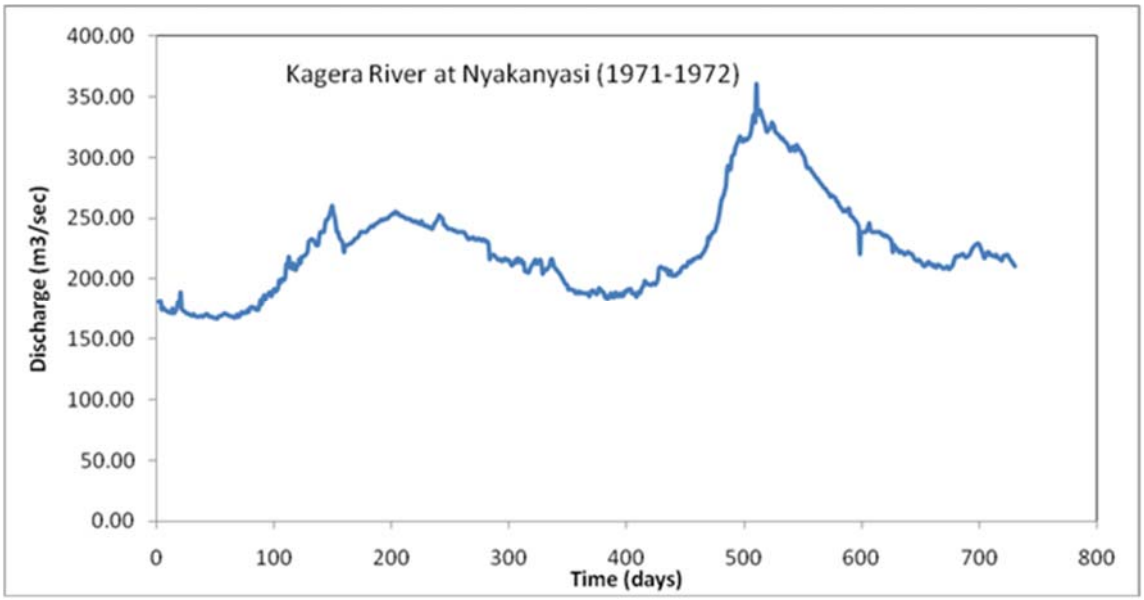


Figure 2-14: Hydrograph for Kagera River at Nyakanyasi station (Tanzania) for 1971-1972

2.6. Landuse

The land use/land cover map of the portion of the Kagera Basin was extracted from a ten-class global land use/land cover map for the year 2020 at ten-meter resolution released in July 2021 by Impact Observatory and Esri (Figure 2-15). It is a composite image of land use/land cover predictions for 10 classes built using European Space Agency (ESA) Sentinel-2 satellite imagery. Land use/land cover classes are described as follows (Karra, Kontgis, et al., 2021):

Water: Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.

Trees: Any significant clustering of tall (~15-m or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).

Grass: Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures.

Flooded Vegetation: Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves, emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.

Crops: Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.

Scrub/shrub: Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannahs with very sparse grasses, trees or other plants.

Built Area: Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.

Bare Ground: Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.

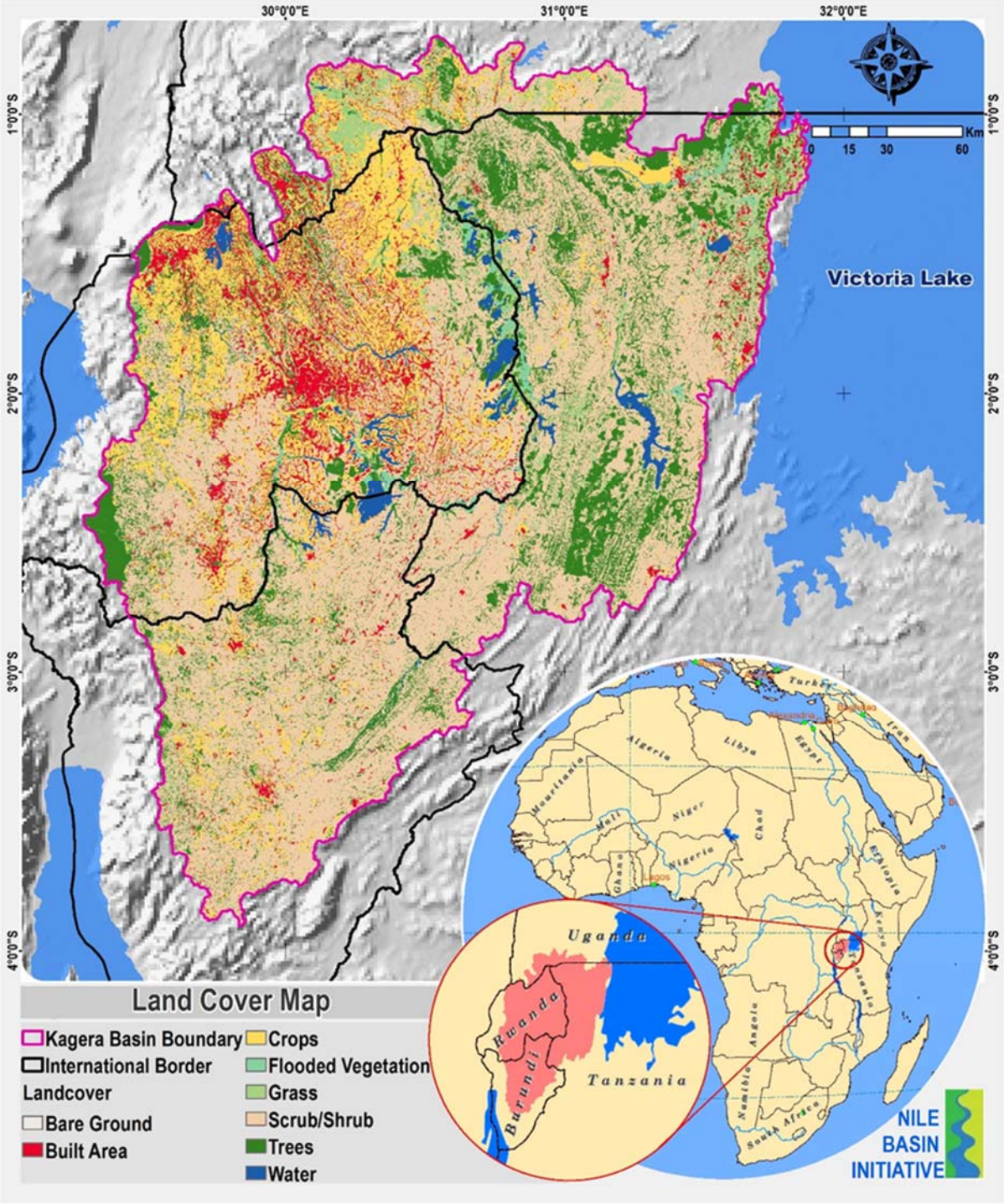


Figure 2-15: Land Cover Map

Table 2-2: The Area and Percentage of each Landcover Classes in the Study Area

Land Cover	Area Sq_km	%
Water	1,240	2.10
Trees	10,410	17.72
Grass	3,010	5.12
Flooded Vegetation	710	1.21
Crops	8,800	14.98
Scrub/Shrub	30,570	52.05
Built Area	3,980	6.78
Bare Ground	10	0.02

Land use/land cover in the Kagera subbasins dominated by scrub/shrub (52%) (**Error! Reference source not found.** and Figure 2-15), followed by trees cover areas (~18%) and cropland (15%). This shows that use of land for agricultural is the most dominant form of human landuse.

2.7. Population Density

The population density within the Kagera basin was ascertained from WorldPop site. The data shows that the total population living within the basin (2020) is about 21 million. The most highly populated part of the basin is the Rwandan part which is home to 52% of the basin's population and registered the highest population density in the basin 525 person/sq.-Km followed by Burundi (490 person/sqKm) while Tanzania had the least population density within the basin (115 person/sqKm)

Table 2-3: Population and Percentage of Total Population for each Country within Kagera Basin

COUNTRY	Population Adjusted (2020) from "WorldPOP" Site	Average Population Density (person/sqKm)	%
Burundi	6,477,949	490	31
Rwanda	10,820,638	525	52
Tanzania	2,326,551	115	11
Uganda	1,281,029	215	6

Total	20,906,167	

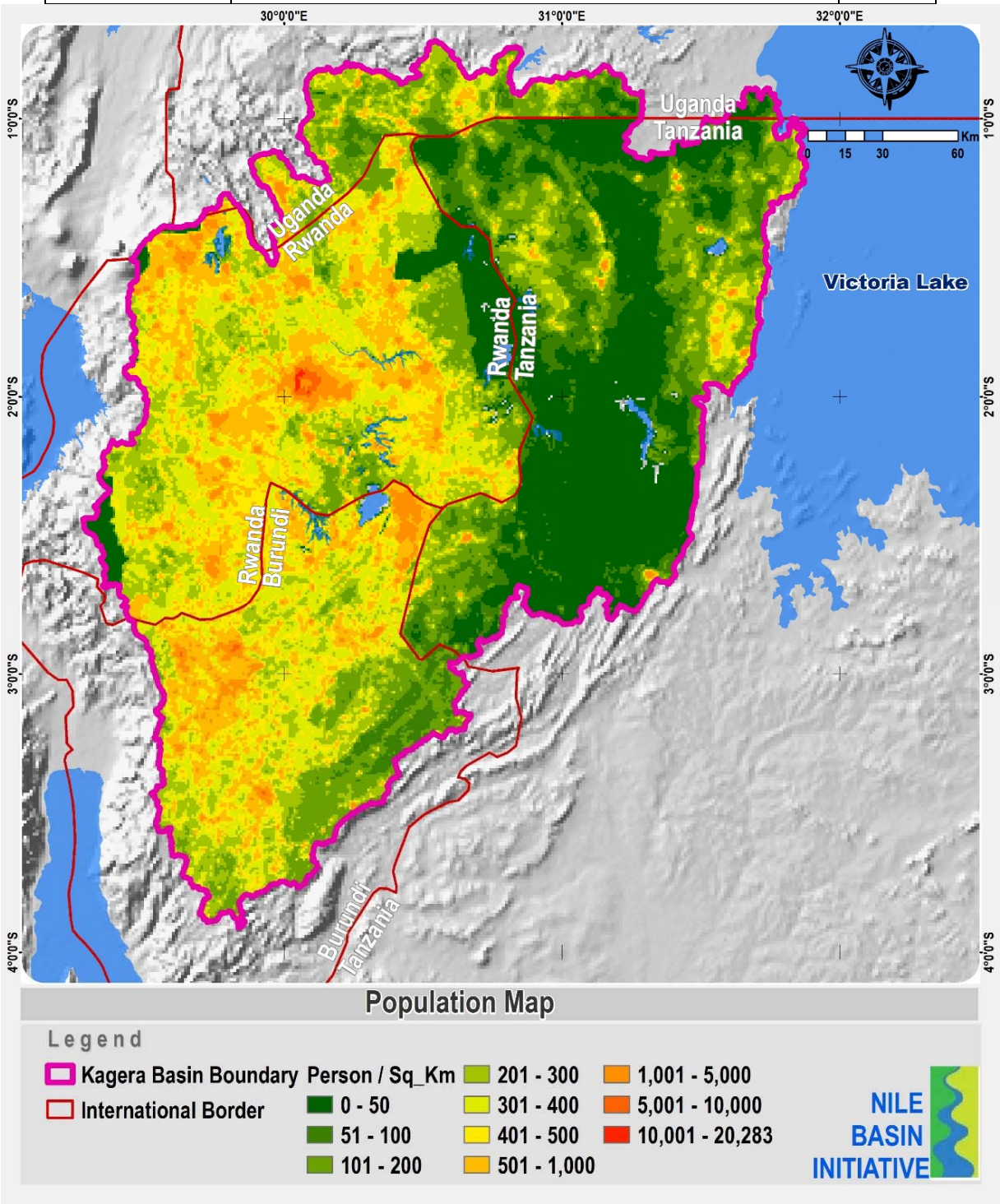


Figure2-16: Population Density Map

2.8. Kagera Aquifer Characteristics

2.8.1. Groundwater Occurrence in the Kagera Basin

The occurrence and movement of groundwater within the Kagera basin is controlled by the geology and the structure of the area. Areas of highest groundwater potential is found in unconsolidated alluvial sediments which occurs mainly within the rivers' valleys. However, these unconsolidated alluvial sediments have variable yield, mainly depending on lithology. Where the alluvium is dominated by coarse grained deposits such as gravel and coarse sand, storage capacity and transmissivity are high and this result in high yields. Groundwater occurrence in these formations is usually in unconfined conditions at depths that vary between 10 to 20 meters.

The second highest groundwater potential is located where consolidated sedimentary rocks. Groundwater occurs in this formation in confined or unconfined conditions depending on the geologic sequence and they give moderate to high yield reported to be in the range between 30 - 45m^3/hour. Rate of Transfer of water in this geologic formation is dependent on the effective porosity of the formation as well the fracture intensity generated by partial metamorphosis.

Groundwater can also be found within the fissures and fractures of the metasedimentary rocks covering most of the basin. These metamorphic rocks can store and transmit water in sizeable quantities and provide low to moderate yields sufficient for domestic supply of small communities.

The lowest groundwater potential is, in general, associated with the fractured/weathered basement. Groundwater potential in basement rock environments is attributed to a number of factors including weathering processes, tectonic activity, mineralogical composition and rock types. The productivity of basement aquifer is mainly controlled by the localised nature and extent of fracturing and weathering. In areas where a thick weathered overburden exists and where tectonic activity has caused an extended network of fractures and faults, the productivity of such aquifers may be moderate to high. However, most of boreholes in basement aquifers are likely to give yields ranging from <0.5 to 5 m^3/hour. Groundwater can be found in basement complex formations in confined to semi-confined conditions at depths ranging from few meters to 100 meters.

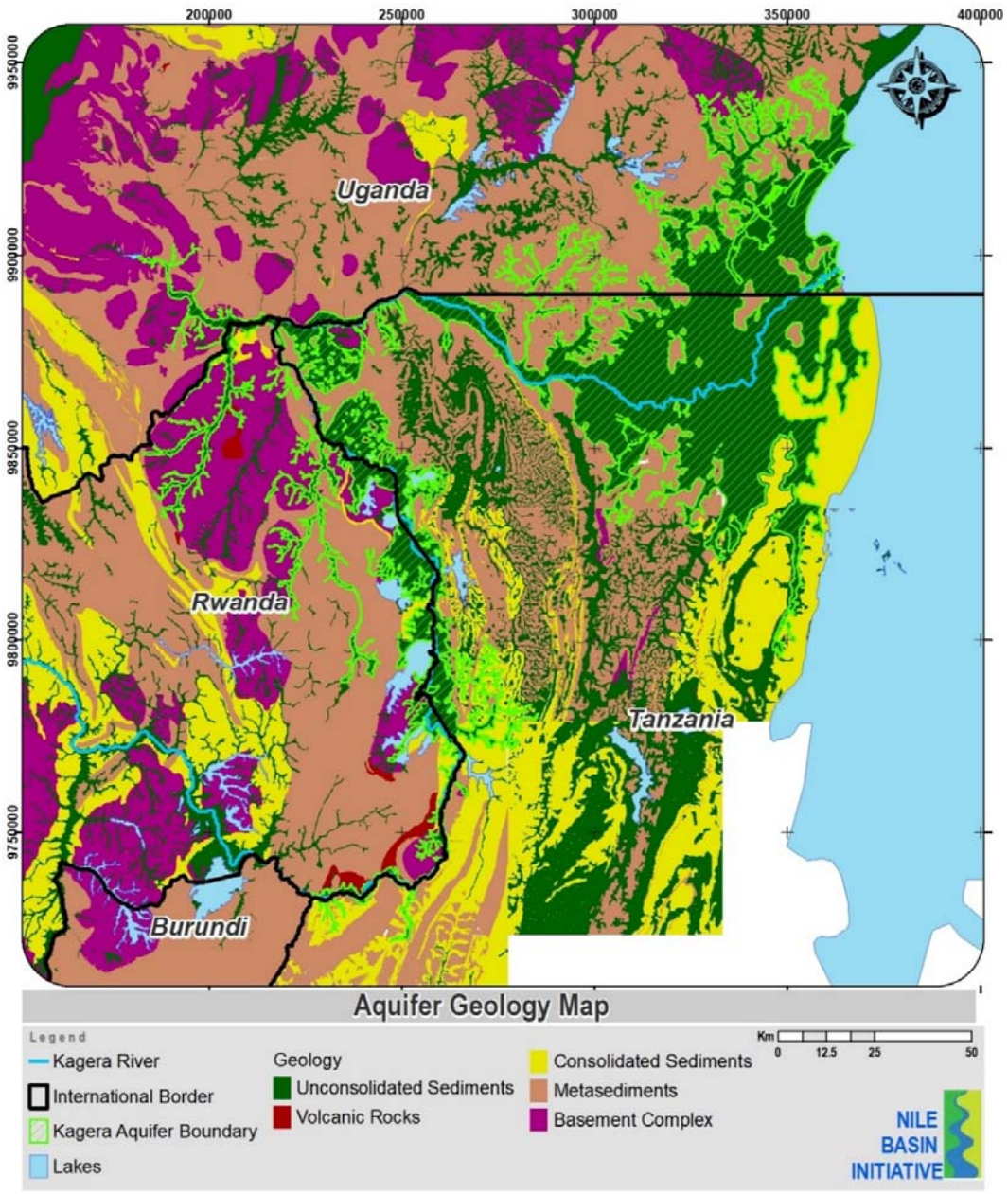
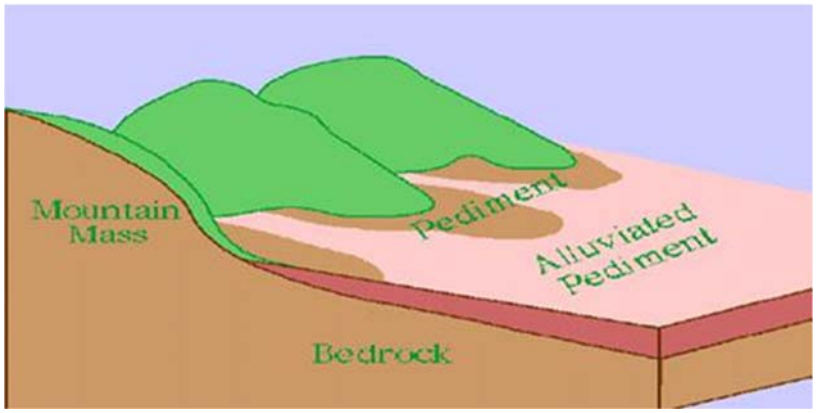


Figure 2-17: Detailed Aquifer Geology Map

2.8.2. Hydrogeological Conditions of Kagera Aquifer

The Kagera aquifer is for the most part defined as the low areas of alluvium deposits around the Kagera River. These shallow unconsolidated sediments were formed through the slow erosion and disintegration processes of the rock surfaces of the mountains by rain in the humid conditions of the basin area. These sediments were washed to the base of the mountains forming a series of pediments and these pediments gently slope outward, where they coalesce with each other to form one large pediplain. The pediplain is the basic formation of the Kagera Aquifer

its thickness is not known but is expected to be in the order of 50-80m based on drilled well depths. The alluvium layer, is underlain in either by a fractured basement complex / Metasedimentary rocks or by consolidated sedimentary formations. Interpretation of compiled data reveals that the source of recharge to the Kagera aquifer emanates from three sources



- Direct Recharge from the Kagera River: Aquifer replenishment apparently occurs when the river stage is higher than the groundwater level thus generating a hydraulic gradient where by the river loses to the aquifer. The process may be reversed when the river stage becomes lower than the groundwater level in which condition the river gains water from the aquifer
- Direct Recharge from Wetlands: The Kagera basin features a number of wetlands in its low elevation areas, a number of which around the depressions of the Kagera River. These wetlands are contact zone through which the aquifer may be recharged. Wetlands may also be points of groundwater discharge to the surface of the land, such as springs.
- Flow from the surrounding fractured basement complex: The heterogeneous mixture of crystalline rocks forming the basement complex around the Kagera River are highly fissured and thus have the ability to store and transmit rain water through these fissures. Water moves slowly through these fissures and often emerge in the study area in the form of spring in the side of the mountain, the flow may also emerge below the ground surface to latterly recharge the alluvium aquifer in the pediplain. The storage of the basement complex is finite and relatively small, however the large contact area of these hills along the boundaries of the aquifer means that significant volumes of recharge may be introduced to the aquifer with recharge sources as far west as the Congo-Nile Ridge.

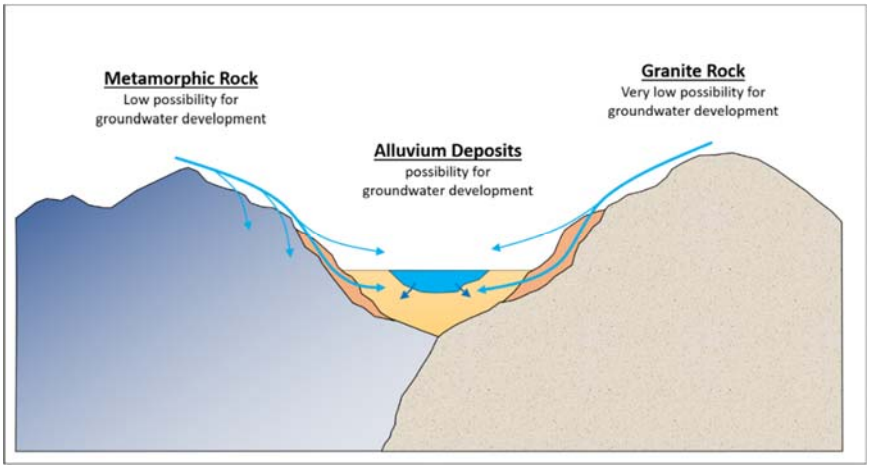


Figure 2-18: Schematic of the Conceptual Model of Kagera Aquifer

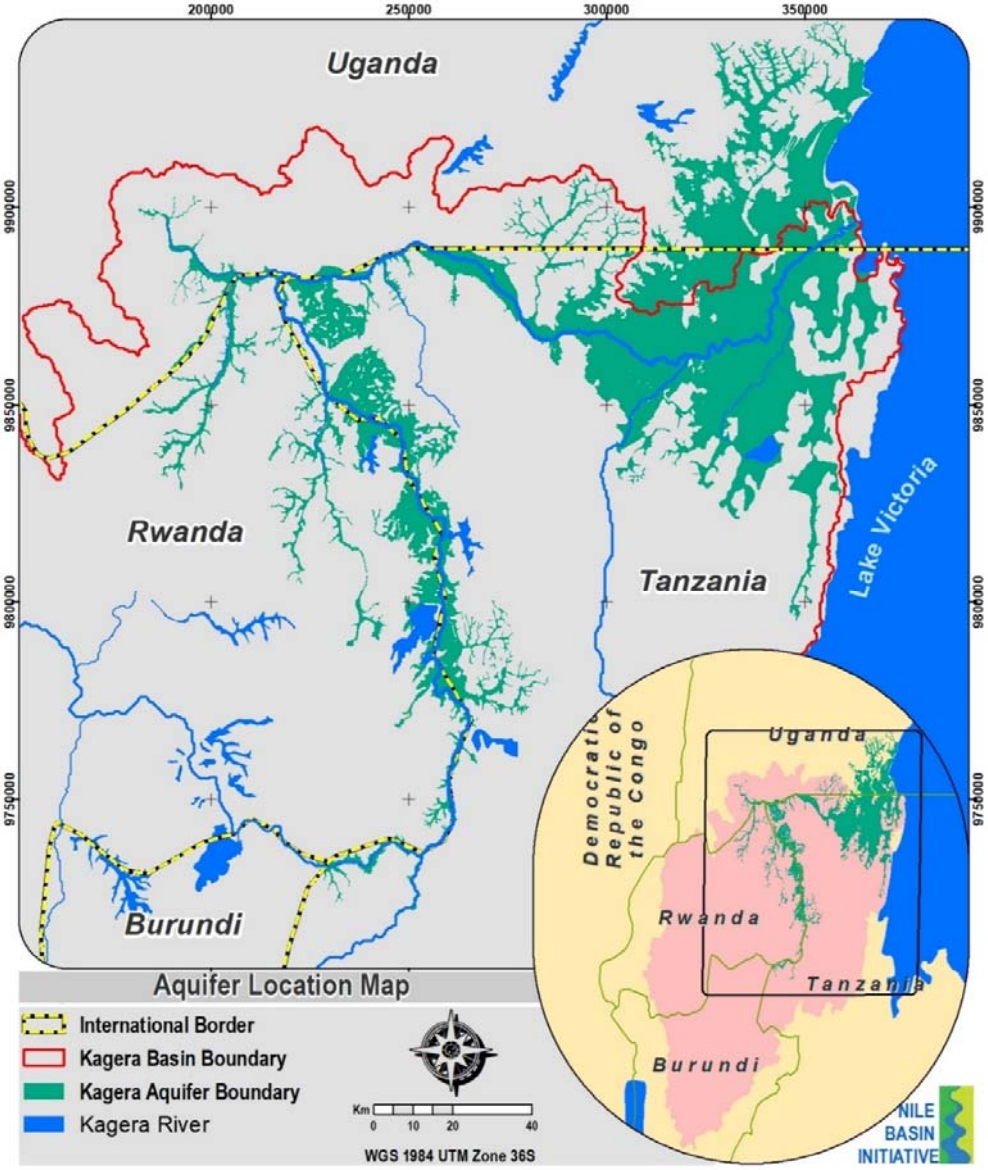


Figure 2-19: Kagera Aquifer Extent

The boundaries of the Kagera aquifer were ascertained from the geological maps of the four riparian countries as well as the topographic maps of the area. The area of the whole aquifer is estimated to be 6300 Km^2 with 1 % of it within Burundi, 13% within Rwanda, 22 % within Uganda and 64 % within Tanzania.

Groundwater occurs in Kagera aquifer in unconfined conditions and flow direction is expected to follow the Kagera River flow direction initially in a north trending direction and eventually eastwards towards Lake Victoria.

The Kagera aquifer in actuality is comprised of a series of alluvium deposit aquifers that are hydraulically or hydro-geologically connected. It can however be divided into three main sections. The lowland (delta) segment which is comprised of a contiguous alluvium deposit aquifer, constitute the most potential part of the aquifer as it forms about 70% of the total aquifer area and is expected to be the thickest part of the aquifer.

The Plateau (middle) segment is comprised of a series of discontinuous alluvium deposit aquifers that are hydraulically connected though the

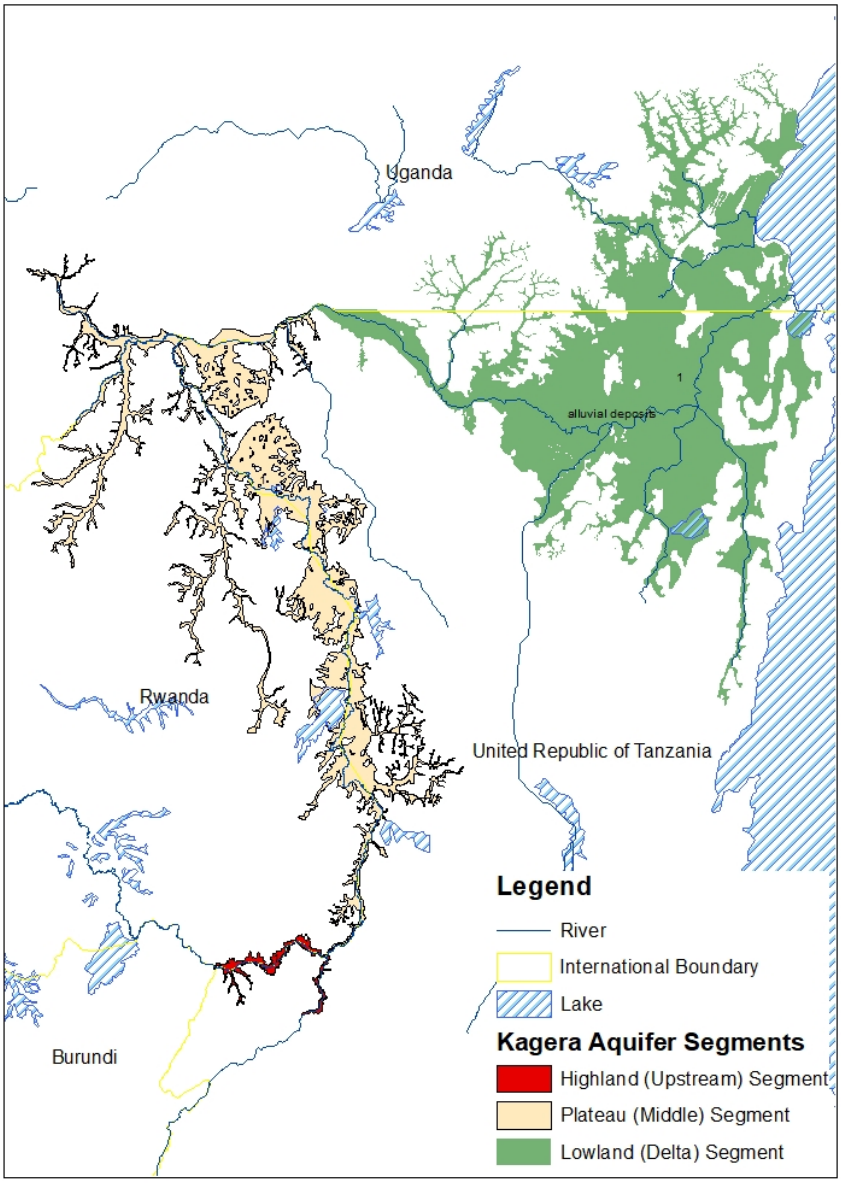


Figure 2-20: Kagera Aquifer Segments

Kagera River and hydrogeologically connected. The average width of the aquifer in this section is generally greater than 10 km and there are indications that metasedimentary and basement rocks containing these deposits are extensively fractured thus facilitating the hydrogeological connection between the alluvium subbasins. This segment extends upstream from the apex of the delta section to Rusumo falls and it constitutes about 28% of the total aera of the Kagera aquifer.

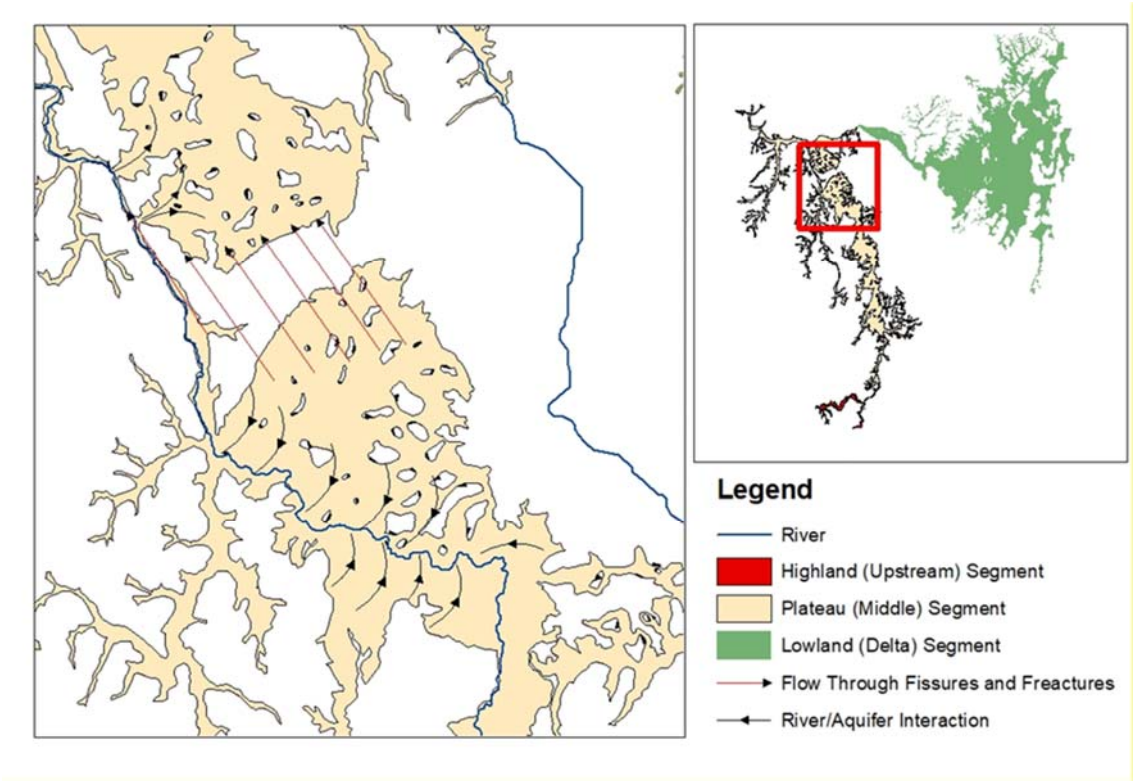


Figure 2-21: Hydraulic (River) and Hydrogeologic Connection of Sub-basins of the Middle Segment of Kagera Aquifer

The third (highland) segment is comprised of thin alluvium deposits along the Kagera river course. The aquifer width on both sides of the river is less than 1.5 Km in average indicating significantly lower potential than the other two downstream aquifer segments. Aquifer connectivity in this segment is expected to be mainly through interaction with the river due to the limited extent and storage capacity of the alluvium aquifer as well as the relatively low potential hydrogeological connectivity through the basement complex rocks containing the alluvium deposits. The upstream of extent of the highland segment in not well delineated, while it was currently extended to 30 kilometres upstream of Rusumo falls per available geological and topographic data, there are arguments that it could be extended upstream up to lake Rewru (approximately 60 Km upstream of Rusumo falls).

The hydraulic connectivity between the upstream and downstream segments of the aquifer is maintained through their interaction with the Kagera River. Hydrogeological connectivity between the plateau and delta segment is believed to be significant due to the extent of fractures in the basement rocks adjacent to the alluvium deposits. It is however deemed to be very weak and almost non-existent between the highland and the plateau segments across the Rusumo falls.

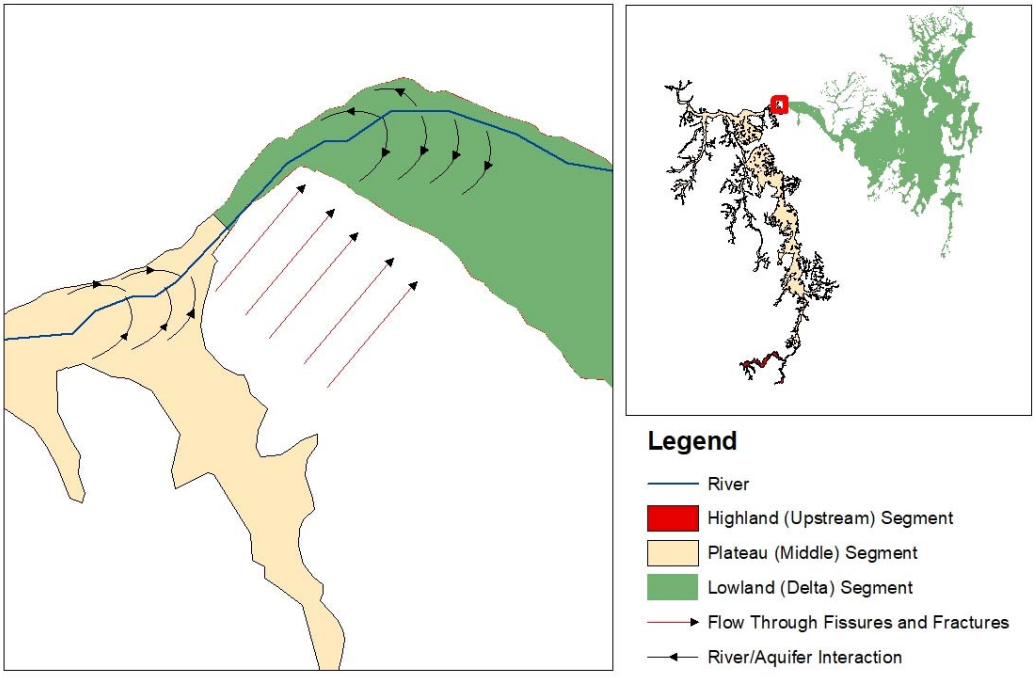


Figure 2-22: Hydraulic (River) and Hydrogeologic Connection of the Middle and Lowland Segments of Kagera Aquifer*

**Groundwater drains from the upstream Middle segment which has a relatively small storage capacity into the river which conveys these waters into the downstream Lowland segment (hence the term hydraulic connection) where it recharges the downstream segment of the aquifer. Significant subsurface flow also occurs through the fissures and fractures of the basement complex.*

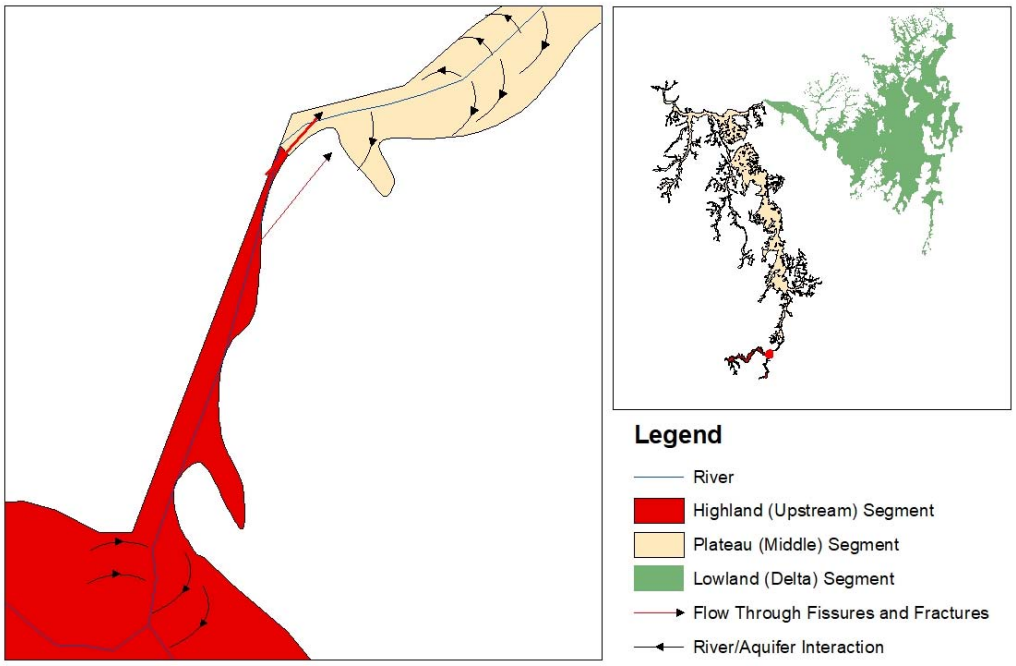


Figure 2-23: Hydraulic (River) and Hydrogeologic Connection of the Upstream and Middle Segments of Kagera Aquifer**

*** Groundwater drains from the upstream Highland segment which has a relatively small storage capacity into the river which conveys these waters into the downstream Middle segment where it recharges this segment of the aquifer. Limited subsurface flow occurs through the fractures of the basement complex*

The Kagera aquifer is isolated for the most part from Lake Victoria by the basement rocks of the crustal block which formed the lake. Zones of contact between the aquifer and the lake water occurs in small segments at the estuaries of the rivers flowing into the lake (Kagera and Kisomo). Groundwater water levels along the beaches of these contact zones is visibly high with full soil saturation conditions close to the lake shores. The length of contact zones with the lake is estimated to constitute about 15% of the total length of the aquifer alongside Lake Victoria. Figure 2-24

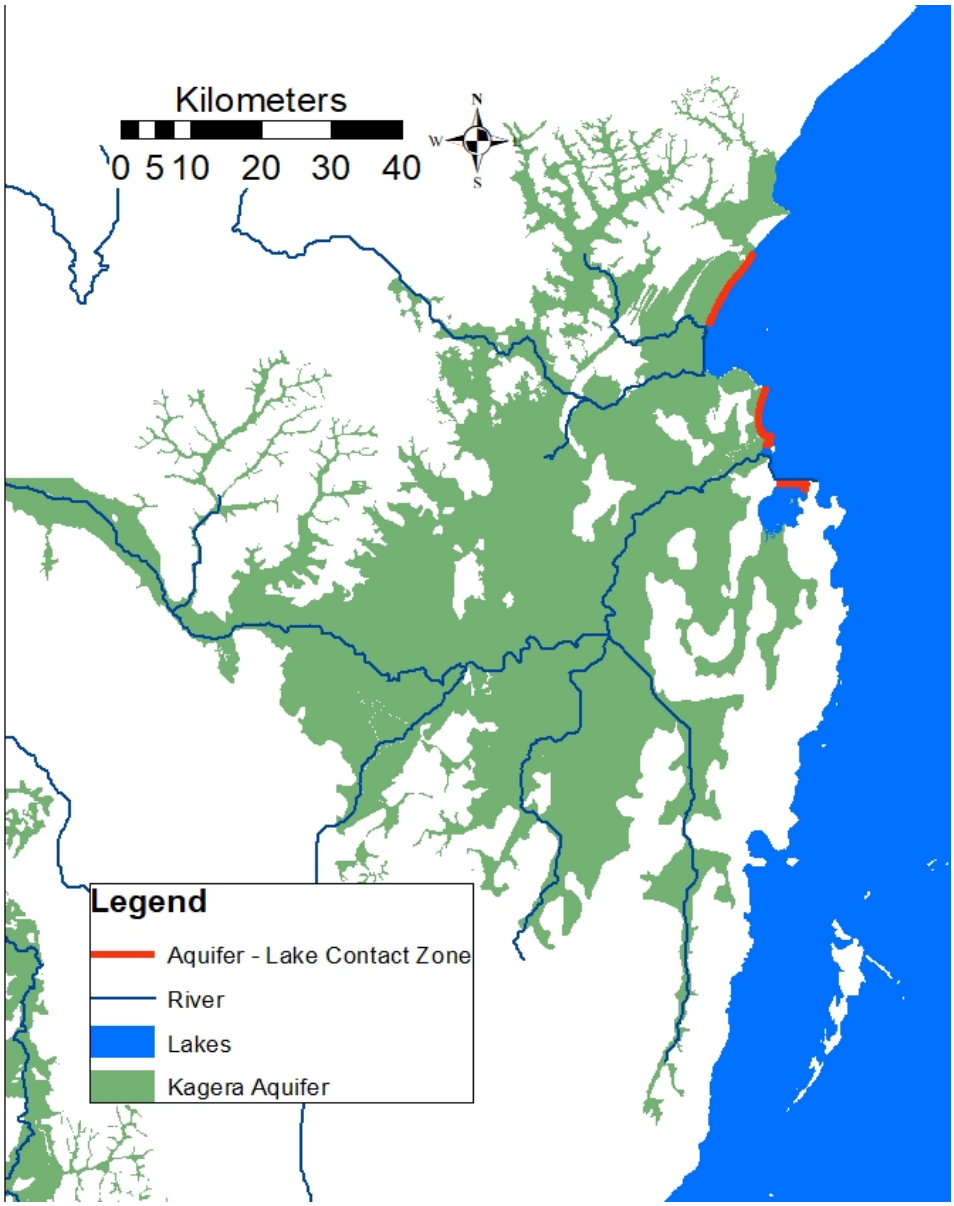


Figure 2-24: Kagera Aquifer/Lake Victoria Contact Zones

2.8.3. Groundwater Quality

Groundwater quality is controlled by several factors including the composition of different end-members (rainwater, leakage from surface water bodies, sea water intrusion…), the geological environment, the residence time, length of the flow path, different hydrogeochemical, biological and microbiological processes, climate and topography, and the groundwater flow regime. Groundwater in basement aquifers is generally of good chemical quality with generally a low mineralization which results from the low solubility of most of the aquifer-forming materials, particularly aluminosilicates. However, basement aquifers are complex in all aspects

and problems of groundwater quality may occur randomly due to particular geological settings and environmental issues.

Results of the chemical analysis of various groundwater and spring samples within the basin has revealed that all samples were slightly acidic (pH 5.5 – 6.5) as compared to water samples from the River and Wetlands. Analysis results of Kagera River shows that the pH values are between 7.0 to 7.6 with lower pH observed in the Ruvubu (6.40). The pH in lake Victoria is higher than 7.6. Shallow and deep groundwater has elevated values of EC indicating mineralization (groundwater that has dissolved minerals accumulated during its flow through rocks or sediments). Tritium dating of groundwater (shallow and deep groundwater and springs) conducted in the Kagera region of Tanzania gave values of residence time varying from 6 to 26 years, again confirming that groundwater in Kagera Basin is young, and recharge is recent and active.

Problems of high concentration of iron, manganese arsenic, mercury and even uranium were reported in some samples. While indications are that the source of these samples were most likely basement complex aquifers. Reliable information to ascertain the type of tapped formation from which these sample were extracted could not be obtained.

High levels of nitrate concentration were detected in a number of open shaft wells with strong indications that it is due to contamination from anthropogenic sources mainly poor sanitation practices as well as agricultural activities.

The slightly acidic aquifer water appears to indicate close proximity of the recharging carbon dioxide laden rainwater and active and fast recharge flow. This is confirmed by the very low to moderate values of EC, again close to normal values for rainwater. These results indicate the existence of recharge from the adjacent basement complex through fissures and possible existence of significant weathered layers between the recent alluvium deposits and the basement complex layer.

3. GOVERNANCE AND INSTITUTIONAL SETUP

3.1. Burundi

3.1.1. Institutional Setup of the Water Sector Governance System

Burundi is a constitutional republic whose main institutions are the Parliament with two chambers: low and high chambers, the Presidency of the Republic, the Vice-Presidency and the Prime Minister. The new constitution of Burundi adopted in 2018 provides 30% for women participation in all institutions. Several institutions are involved in the water sector, hygiene and sanitation. This situation creates an overlapping of mandates and a lack of clarity on the lead institution for management, governance and coordination of the sector.

In general, the Government leads the governance and management of the water sector. The Ministry of Environment, Agriculture and Livestock (MINEAGRIE) is entrusted with the management and governance of water. It has the mandate of defining the policy and to put in place regulation mechanisms, a role shared with at least three other relevant Ministries. These other Ministries include Ministry of Hydraulics, Energy and Mines (MHEM), Ministry of Public Health and fight against AIDs (MSPLS) and Ministry of Public works, Transport, Equipment and Land Use management.

Key national institutions involved in the water-related policy and regulation mechanisms include Directorate General for Environment, Water Resources and Sanitation (DGEREA); the newly formed Burundian Authority for the Protection of the Environment (OBPE) both under supervision of the MINEAGRIE. There is a Directorate for Promotion of Health, Hygiene and Sanitation (DPSHA) under the supervision of the Ministry of Public Health and Fight against AIDs. The Regulatory Authority for the Drinking Water and Energy Sectors (AREEN) is under the supervision of the Ministry of Hydraulics, Energy and Mines (MHEM). Although, a National Water Sector Coordination Committee (NSCC) was established as inter-ministerial body committee but it is reported to be non-operational at the time of preparation of this report.

National institutions offering water service include, the water supply company in urban areas, REGIDESO and the Agency for Hydraulics, in Rural under the supervision of the Ministry of Hydraulics, Energy and Mines. OBUHA (Burundi Authority for Habitat under the supervision of Ministry of the Public Works, Transport, Equipment and Urban Planning, which has been mandated to execute most of main public construction works including water infrastructure projects financed through government budget.

REGIDESO is the institution in charge of water and electricity services with the main objective of increasing the population's access to water in urban and semi-urban areas and improving the quality and reliability of water services in the main urban cities and other smaller urban centres.

AHAMR provides water and sanitation services aiming at increasing the access to water and sanitation for the rural populations and improving the quality and reliability of water services as well as awareness-raising and education of the population on hygiene in accordance with the policy of the government in matters pertaining to access to drinking water and basic sanitation in rural areas.

3.1.2. Organizational Structure of the Water Sector Governance System

In recent years, the institutional structure of Water and Sanitation services has been subject to recurring changes (changes of names and mandates of Ministries, merging and splitting of Ministries). The list of the water governance sector institutions at the national, provincial and regional levels and their organizational structure are shown in Table 3-1 and Figure 3-1 In general, National level agencies are responsible for responsible for policy making and finance, Provincial level institutions are in charge of regulation and project implementation, while local level institutions are responsible of direct management and operation of water facilities. The key regulatory body is AREEN (**Autorité de Régulation des secteurs de l'eau potable et de l'énergie),** its main missions are to ensure the orderly and profitable development of the drinking water and electricity sector in Burundi, the control, regulation and monitoring of related activities with a view to enforcing the implementation delegation contracts requirements and endorsements by operators; the implementation, monitoring and application of tariffs in compliance with the pricing principles set by regulation.

Table 3-1: Organizational Structure of the Water Sector Governance System for Burundi

Level of intervention	Institution	Roles and Responsibilities	Policy	Regulation	Financing	Service delivery	Production
National	The Ministry of Environment, Agriculture and Livestock (MINEAGRIE)	With responsibilities in water, environmental, land conservation and protection and the achievement of the SDGs through the Directorate General of Water Resources and Sanitation (DGREA) and ; Burundi Authority for the Protection of the Environment (OBPE).	✓	✓			
	Ministry of Hydraulics, Energy and Mines	With responsibilities in water, water infrastructures and sanitation management through Rural Hydraulics and Sanitation Agency (AHAMR); and the Water and Electricity Authority (REGIDESO), the public institution in charge of water and electricity supply in urban and semi-urban areas.				✓	✓
	Ministry of Public Health and AIDS control	With responsibilities in hygiene, sanitation and water quality through – Directorate for the Promotion of Health, Hygiene and Sanitation (DPSHA).	✓				
	Ministry of Public works, transport, equipment and Land Planning	In charge of supervision of municipalities and some technical services, including the Burundi Authority for Urban planning, Habitat and Construction which. is in charge of urban planning, sanitation and protection of Lake Tanganyika and water courses crossing cities				✓	
	Ministry of Finance, Budget and Development Cooperation.	Fiscal policy and budgeting			✓		
	Water and Electricity Authority (REGIDESO)	Charged with the production, distribution and the commercialization of water and electricity in urban and semi-urban areas				✓	✓

AHAMR: Rural Water Supply and Sanitation Agency	Its main missions are drinking water supply and basic sanitation projects as well as awareness-raising and education of the population on hygiene in accordance with the policy of the government in matters pertaining to access to drinking water and sanitation in rural areas.				✓	
Burundian Authority for the Protection of the Environment (OBPE)	Mandated in environmental protection and protected areas management. Ensures compliance with the Environment Code, the Water Code, the Forest Code, and other texts related to the protection of the environment; Establish and monitor mechanisms for international trade and exchange of flora and fauna species; Enforce environmental standards and propose all measures to protect and protect nature; Ensure monitoring and evaluation of development programs to enforce compliance with environmental standards in the planning and execution of all development projects, which may have a negative impact on the environment including water resources		✓			
Geographic Institute of Burundi (IGEBU)	Mandated to collect hydro-climatic data and water-related data including groundwater monitoring.		✓			
Directorate of Water Resources and Sanitation (DGREA);	Charged with the implementation of the national water and sanitation policies and fight against water resources pollution.	✓	✓			
Regulatory Authority for Water and Electricity Sectors (AREEN)	Assures the control, regulation and follow up of the activities pertaining to drinking water supply, basic sanitation and electric supply		✓			

	DGEREA (Directorate General for the Environment, Water Resources and Sanitation	Promote risk management policies linked to climate change in collaboration with IGEBU, OBPE and other services concerned, Design and monitor the implementation, in collaboration with the departments concerned, of national environmental policies while ensuring the protection and conservation of water resources, 3. Develop and enforce environmental protection and management regulations.	√	✓			
	Directorate for the Promotion of Health, Health Care Demand, Community and Environmental Health	Under the supervision of the Ministry of Public Health and Fight again HIV, this Directorate: Develops updates and disseminates the norms to be respected in all aspects pertaining to hygiene, basic sanitation, and traditional medicine. enforce the norms of hygiene, basic sanitation and environmental health in accordance with strategic documents participate in the management of waste water, including runoff, domestic, black waters, industrial effluents, domestic waste from rural areas and small communities					
Province	CPEA (Provincial Coordination for Water and Sanitation)	Responsibilities in water infrastructures and sanitation management				✓	
	Provincial Office for Environment, Agriculture et Livestock (BPEAE)	Coordinates and implements environmental, agriculture and livestock projects at the provincial level				✓	
Commune	Direction Communale de l'Environnement, de l' agriculture et de l'elevage	Ensure Technical advice to the commune in terms of project development and implementation in environmental, Agriculture and Livestock sector				✓	
	Local Authorities	Management and supervision of water infrastructures		✓		✓	
	Communal Water Authorities (RCEs)	In charge of rural drinking water services and infrastructures				✓	

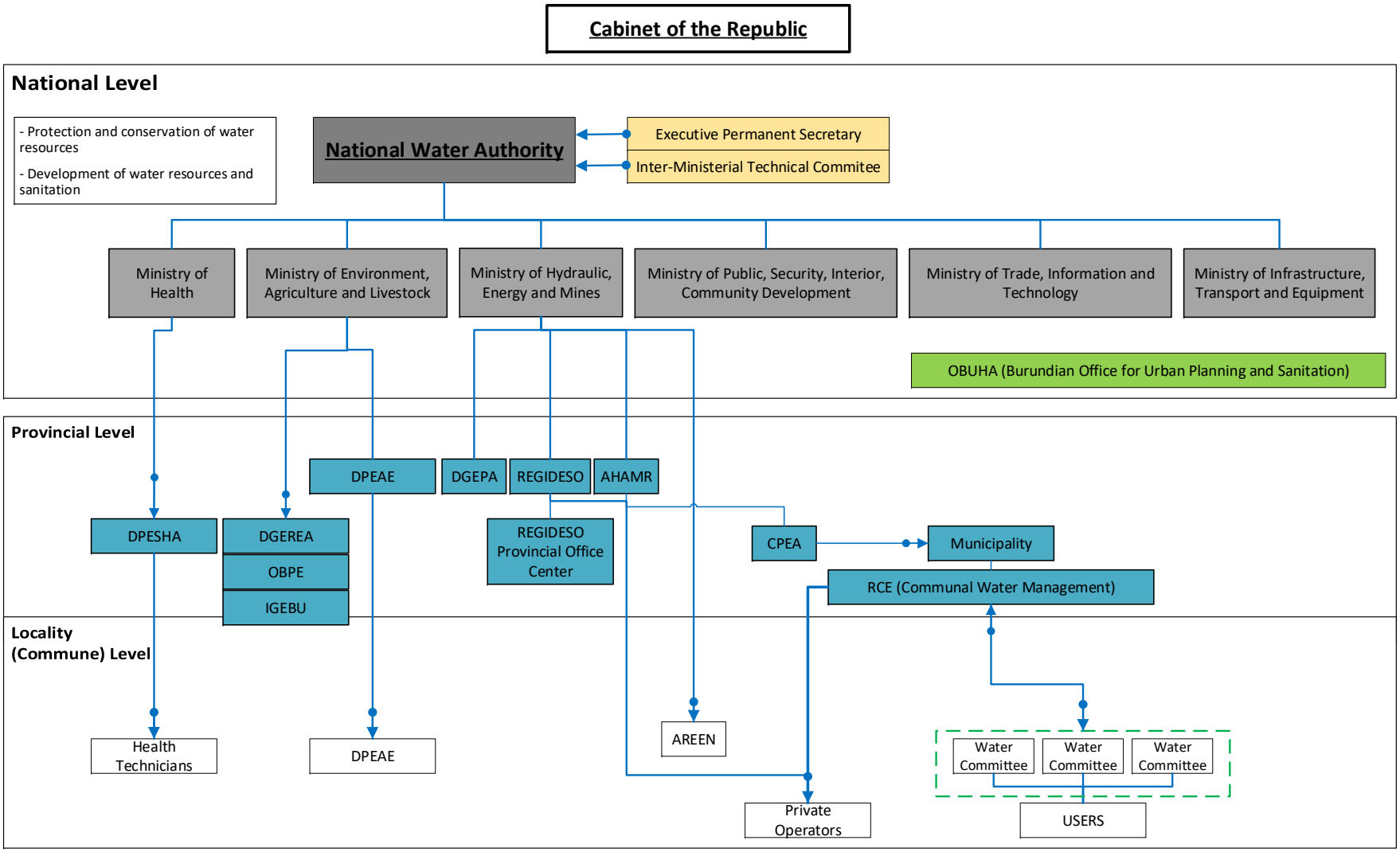


Figure 3-1: Organizational Structure of the Water Sector Governance System for Burundi

3.1.3. Water Management Policy

The water, sanitation and hygiene sector in Burundi has gained a new momentum owing to the priority it was given in the recently adopted 10-year National Development Plan (NDP 2018-2027). This priority stems from the continuous high-level advocacy stressing the importance of the water sector for the sustainable and integral development. More than 8% of the total budget of the NDP is allocated to the water and sanitation sector.

In order to ensure that no one is excluded from access to water and sanitation services and in accordance with the principle of solidarity expressed in the water law, the Ministry of Hydraulics, Energy and Mines adopted the pro-poor Strategy which aims at enabling the poorest households to have access to improved water and sanitation services

To strengthen the institutional structure and the legal framework, sectoral policies and strategies such as the National Water Master Plan (PDNE), the National Sanitation Policy (PNA), the National Water Policy (PNEau), the National Water Strategy, the National Sanitation Strategy and the National Community-led Total Sanitation (CLTS) implementation strategy and the Pro-poor strategy have been developed and adopted. Moreover, specialized agencies such as institutions in charge of regulating the sector and the principal inspector of water and sanitation Sector have been created.

The Government of Burundi is also struggling to achieve a better management of its watersheds in order to protect water sources and increase availability of water resources for the different uses through the implementation of the Integrated Water Resources Management (IWRM) plan. The main policy frameworks of Burundi that address the water resources sector include:

Country National Development Plan 2018 – 2027

Burundi National Development Plan is to transform the structure of the Burundian economy, for strong, sustainable, resilient, inclusive growth, creating decent jobs for all and inducing the improvement of social well-being.

Government policies will focus on four areas of intervention, namely: Area 9. Sustainable environmental management, Area 10. Water resources and global sanitation, Area 11. Climate change and risk management and Area 12. Territory Development. Thus, the actions of the Government of Burundi over the 2018-2027 decade will be oriented towards the implementation of reforms and measures aimed at achieving 6 objectives relating to the water sector, the area of hygiene and sanitation, as well as management of the environment and climate change.

Burundi Vision at the 2025 Horizon

The Burundi Vision 2025 expresses the wish to achieve economic and social developments for Burundi. Throughout the vision document, Burundians wish to achieve comprehensive and sustainable water resources management and development, in a manner that water sector plays a central role in Burundi's social and economic development process.

The National Water Policy, 2009

The overall objective of the water policy is to satisfy water needs to users through a harmonious and sustainable development of national water resources.

National Water Strategy 2011-2020

The National water Strategy aims to achieve the overall objective of the national water Policy which is to "ensure the coverage of the water needs of all users through a harmonious development of national water resources' in a sustainable manner.

National Sanitation Policy: operational strategy 2025

The National Sanitation Policy aims at promoting good hygienic practices and the use of adequate sanitation infrastructures in order to allow the protection of the environment and natural resources. It also aims at improving the sustainable the livelihood of the populations by curbing health due to the lack of basic sanitation. At page 28 and 29, the policy highlights the importance of public- private partnership and how the approach should be facilitated.

3.1.4. Burundi Water Legislations

Burundi's Constitution specifically stresses the need for a sustainable development of water resources and protection of natural resources in sustainable manner with a view to serving current as well as future generations' needs. Generally, key legislations governing the sub-sector in the country consists of an umbrella-law, i.e., the environment code, addressing a number of issues pertaining to environmental protection and management and specific legislations governing water hygiene and sanitation sub-sectors. Key water sector legislations include:

Hygiene and sanitation Code (2018): The provisions of the code set the fundamental principles and rules governing the organisation and functioning of the national system of hygiene and sanitation. The code is applicable to local communities, hygiene and sanitation professionals, state institutions, physical persons or corporation considered as stakeholder.

The Water code (2012): The provisions of this decree (law) are intended to protect the aquatic environment, preserve the common water resource and reconcile the interests of all different users.

Environmental Code of 2000: Constitutes a framework addressing all major aspects of environmental protection and management. Other laws and regulations complete the Environmental Code Burundi by governing specific sectors.

Public Health Code (1982): Article 2 of the code, provides that any water-related project should respect international standards of drinking water.

It should be noted that groundwater resources are not specifically addressed in the different legislations, but it referred as part of water resources in general.

3.1.5. Regulatory Framework

The general mode of tackling environmental impacts including those related to the water and sanitation sector is through enforcing the relevant codes which empowers the Authority in charge of environmental protection to oversee the compliance with the country's environmental standards and norms during the planning of development projects. To this effect, a number of implementing legislations stemming from the above codes have been developed by the Ministries in charge of governing and managing the water sector. In these implementing texts, groundwater is specifically addressed through two guideline documents, namely:

Guidelines of good practices for the drilling water boreholes (2013): It provide a guide to Good Practices for the realization of water boreholes. This guide deals specifically with water drilling, both in rural areas and urban environments

National guidelines for protection perimeters of water catchments for human consumption, 2014: The Guide aims to establish perimeters of protection for water catchment, to ensure a supply of good water quality to the population, as provided for in the Water Code.

3.2. Rwanda

3.2.1. Institutional Framework for the Water Sector

Rwanda is a constitutional republic with a presidential system and a bicameral parliament consisting of a senate and a chamber of deputies. The prime minister and the council of ministers is appointed by the president. The country is administratively subdivided into four Provinces, Kigali City, West, East, North and South. Provinces are subdivided in 30 Districts which are also subdivided in Sectors, then Cells and finally villages.

Rwanda has adopted the notion of Integrated Water Resources Management (IWRM) as the basic premise for the management of its national water resources. This a process which promotes the coordinated development and management of water, land and related resources,

in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Due to government focus and set priorities, the water sector in Rwanda is one that has been witnessing continuous restructuring and reform based on performance assessment. The implementation of policy and strategic plans for the sector is the joint responsibility of various government institutions –several ministries and national autonomous entities as well as local governments under the overall oversight of the Ministry of Infrastructure (MINIINFRA). MINIFRA is responsible of overseeing water use for domestic water supply and sanitation at the national level. Other key governance national level institutions include:

- The Ministry of Agriculture, Animal Resources (MINAGRI) and the Rwanda Agriculture Board responsible of the governance and management of Water for Agriculture use.
- The Ministry of Environment (MOE) and Rwanda Environment Management Authority. (REMA)

The principal institution in implementing the IWRM in Rwanda is the Rwanda Water Resources Board (RWB). RWB is a non-commercial public institution that has legal personality and enjoys administrative and financial autonomy and is managed by a seven-member board of directors and an executive organ. It has jurisdiction over water (including groundwater) allocation for different uses and is responsible of coordinating among various relevant institutions at the central level. IWRM is implemented at decentralized level using existing normal institutions of Districts, Sectors, Cells and Villages.

Water management functions (including planning, budgeting, resource allocation, community mobilization) at the regional and local levels are undertaken by local management entities (within districts and/or sectors). The direct operation of water resources facilities is undertaken by water users including professional organizations, NGOs and private entities. The national policy is to manage water supply systems through a public private partnership. (PPP).

3.2.2. Organizational Structure of the Water Sector Governance System

In recent years the institutional structure of water and sanitation services in Rwanda witnessed significant changes and reform. The main focus of these reforms is the provision of basic water services to the general population including the development and of a sustainable operation and maintenance O&M framework for water facilities. Groundwater plays a significant role in the water supply systems in Rwanda where 50% of the population in rural areas depend on point

water sources such as boreholes with hand-pumps and improved springs. Institutional roles can be categorized into three main levels:

National Level: Responsible for formulating national policies, oversight, budgeting, resource mobilization, regulating and overall performance monitoring.

Regional and Local Levels: Responsible for providing access to water to the population through development of infrastructure, planning of proper operation and management of existing water facilities. Private operators may be subcontracted by the districts to undertake specific water management roles.

Community Level: This may comprise individuals or water user committees whose role is to monitor service delivery and functionality, report problems and sensitize users to pay for water services. The two most common entities are the Water User Committees (WUC) and the Water User Associations.

Water Users Committee (WUC) is a group of individuals representing the water users in a certain area (water point). They are elected by water users (Community) to undertake activities related to the management of water points (borehole with hand pump, protected spring, public tap) for the mutual benefit of the community, operator and local authorities The currently established WUC are barely operational and are impacted by the lack of training

Surface water structure are managed at the community level by the water user associations (WUA) that manage water for irrigated farms. Members of these associations benefited from the training provided by districts and other stakeholders to provide effective management of crops irrigation in marshlands. Compared to the WUC, the WUA appears to be stronger, and better organized. They are registered Cooperatives, collect periodical fee from each farmer.

Table 3-2: Organizational Structure of the Water Sector Governance System for Rwanda

Level of intervention	Institution	Roles and responsibilities	Policy	Regulation	Financing	Service delivery	Production
National	Ministry of Environment (MOE)	Ensure that the WRM policy and strategy are passed by Cabinet and communicated to stakeholders; Present and defend the WRM strategy budget and proposed institutional reforms to cabinet; lead/ actively participate in resource mobilisation; provide policy oversight to water resource Policy and Strategy implementation including enforcement of accountability and continued alignment to high level political interests.	✓	✓			
	Ministry of Local Government (MINALOC)	Establishment, development and facilitation of the management of efficient and effective decentralized government systems capable of law enforcement and delivery of required services to the local communities including the management of boreholes		✓		✓	✓
	Ministry of Agriculture, Animal Resources (MINAGRI)	Integrate IWRM principles into agricultural policy priorities and budgets; is looking for more water for irrigation, report regularly on IWRM activities implemented in the agricultural, livestock and fisheries sectors.	✓	✓			
	Ministry of Infrastructure (MININFRA)	Development of institutional and legal frameworks, national policies, strategies and master plans relating to water supply and sanitation, energy and transport subsectors.	✓	✓			
	Ministry of Health (MINISANTE)	Policy formulation and promotion of hygiene and public health; Integrate health and hygiene aspects of domestic water supply from ground water.	✓	✓			

Level of intervention	Institution	Roles and responsibilities	Policy	Regulation	Financing	Service delivery	Production
	Ministry of Foreign Affairs and Cooperation (MINAFFET)	Foreign and diplomatic relations including regional and international cooperation over shared waters.	✓				
	Rwanda Environment Management Authority (REMA)	Develop regulations and ensure protection and conservation of the Environment and natural resources across the Country.		✓			
	Rwanda Utilities Regulatory Agency (RURA)	Integrate the IWRM targets for infrastructure and utilities within its regulatory framework and priorities. Will monitor enforcement of IWRM regulations and laws into water-related utilities' planning, financing and implementation to ensure compliance.		✓			
	Rwanda Bureau of Standards (RBS)	Provision of standards-based solutions for Consumer Protection and Trade promotion for socio-economic growth in a safe and stable environment.		✓			
	Rwanda Water Resources Board	As the overall institution responsible for execution of the WRM Strategy (as part of the wider NRM mandate), RWB will plan, budget and implement activities related to overall implementation of IWRM as monitor and report on the strategy implementation, including coordination of other WRM actors.		✓			

Level of intervention	Institution	Roles and responsibilities	Policy	Regulation	Financing	Service delivery	Production
	Rwanda Agricultural Board	Deals with water for irrigation, water user associations, and rain fed agriculture		✓			
	Water and Sanitation LTD (WASAC LTD)	Integrate the principles of IWRM in water supply, sanitation generation and supply infrastructure; promote water use efficiency by promoting appropriate technologies and providing information, knowledge and appropriate incentives to clients and stakeholders;				✓	✓
	Rwanda Development Board (RDB)	Support enforcement of IWRM regulations and laws by incorporating them into Investment regulation and monitoring instruments including incentives and information packages; Facilitate registration and operation of investors in water services programmes; and support services to investors.				✓	
Local	User Communities	Management of water resources in the course of their productive, consumptive and non-consumptive activities on a day-to-day basis				✓	✓
	Local Government Authorities	Plan, mobilise resources, supervise and monitor the implementation of WRM projects and activities in line with the overall GoR policies, laws and strategies related to WRM; Report regularly on WRM activities implemented.			✓	✓	

Level of intervention	Institution	Roles and responsibilities	Policy	Regulation	Financing	Service delivery	Production
	Private Sector	Provide water-related services including design, construction, operation and maintenance of water supply infrastructure; operation and maintenance of efficiency and safety of water-related infrastructure; provide training and advisory services to water users, Government and non-state personnel; Operate or provide other water-related services.				✓	✓

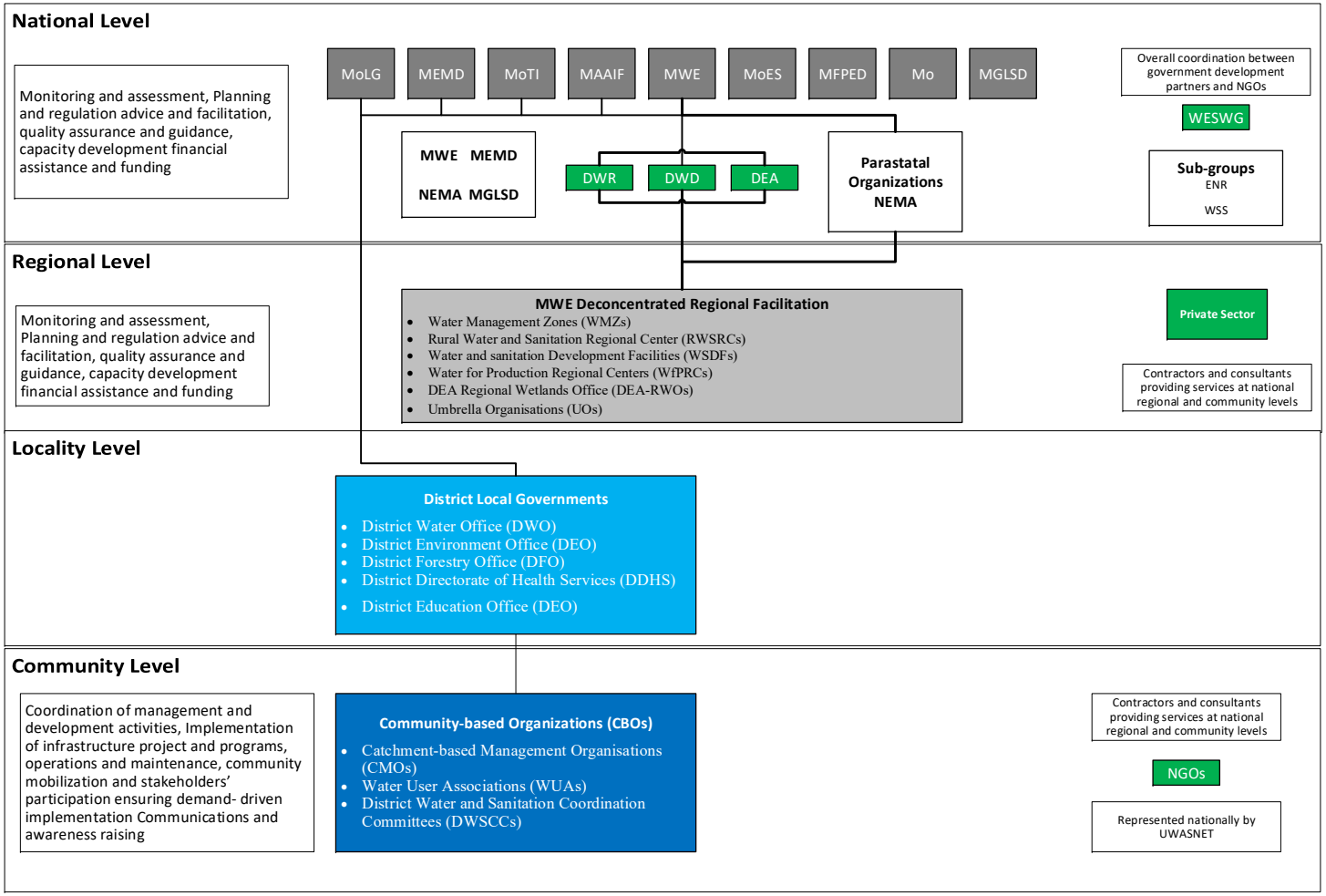


Figure 3-2: Organizational Structure of the Water Sector Governance System for Rwanda

3.2.3. Water Management Policy

3.2.3.1. Rwandan Vision 2050 key policy documents

The national policy of Rwanda is driven for the first 20 years of the third millennium by Rwanda vision 2020 which sought to transform the country from a poor to a knowledge-based-middle-income country thereby reducing poverty, health problems and improving access to daily amenities including safe clean water and adequate sanitation. Vision 2020 was converted into action by a series of medium-term strategic plans (four) which directed the water policy between 2002 and 2020. Following the achievement of all of the social and most of the economic targets[1] of the 2020 vision, the 2050 vision was developed.

Indeed, the Vision 2050 aspires to take Rwanda to high living standards by the middle of the 21st century and high-quality livelihoods. It adopts the United Nations Sustainable Development Goals (SDGs) and seeks to achieve universal access to a daily amenity, increase urbanization rates (from 17% in 2014 to 35% by 2024) and double irrigated land between 2017 and 2024, thus indicating a substantial increase in the utilization of water resources including groundwater. The National Strategy for Transformation (NST1) 2017-2024 was developed to be the implementation instrument that will provide the foundation and vehicle towards achieving Vision 2050. The NST1 proposes, under the transformative governance pillar, to increase citizens' participation and engagement in development of water resources including ground water. The key policies that guided that management and development of the water sector in Rwanda during 2020 vision implementation period include

National Policy for Water Resources Management, 2011

Water resources Policy for Rwanda was approved in 2011. The overall goal for the Water Policy ''to manage and develop the water resources of Rwanda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations with the full participation of all stakeholders in decisions affecting water resources management''

The Rwanda Water Policy is built on the following principles "Water is a finite resource, Human right to water, Water resource is an economic good, Water is a social good, management according to Integrated Water Resources Management (IWRM) approach with emphasis on

[1] GDP per capita increased to 820 USD from 290 USD instead of the expected 1,240 USD

Participatory management, Catchment-based water resources management, management of water taking into consideration impacts of climate change and consideration to the aspect of Internationally shared water resources.

The policy has eight statements that address water resources conservation, water allocation, building legal and institutional setups, cooperation for the sustainable management and equitable utilization of shared water resources, building climate change resilience, capacity building, financing arrangements, and cross-cutting issues.

Ground water in this policy is part of the key priorities in terms of water resources to be conserved, to be addressed legally, institutionally, in terms of transboundary sharing, in terms of climate change mitigation, in terms of sustainable management or use of ICT for a proper development.

Ground water is taken in a broad sense and is not well highlighted in the Water Policy as a specific resource that need high consideration. The Policy on Water resources developed in 2011 is still the guiding document in area of groundwater.

Water Resources Management Sub-Sector Strategic Plan (2011-2015), 2011

This strategic plan was developed to operationalize a National Policy for Water Resources Management formulated in 2011. In order to meet the increasing multiple water demand for internal use and trans-boundary needs. The strategic plan is to indicate the right directions in managing water sources to the concerned actors in five years. In the strategic plan, it is alerted that pollution of water sources and water losses significantly affect increase of O&M costs of water supply facilities. The systemic losses are partly driven by inadequate regulation of water supply and use. Public-Private Partnership on O&M of rural water supply facilities is expected to improve system maintenance, operational efficiency and reduce losses.

Rwanda National Water Resources Master Plan (2014)

The National Water Resources Master Plan is intended to develop the master plan for sustainable water resources development on the national level. The Masterplan shall be a blueprint for a process of sustainable water, land and related resources development and management with the aim to maximize economic and social welfare in an equitable manner while safeguarding the environment.

National Water Supply Policy and Implementation Strategy, 2016

This document constituted and important update to the 2011 National Policy and Strategy for Water Supply and Sanitation. It was a response to a number of emerging issues including primarily the need to align 2011 National Water Policy with the EDPRS 22 with due consideration of the following points.

- Decentralization of Water and Sanitation Services
- Sector financing mechanisms and access to funding for decentralized actors (District, Communities, Private Operators)
- Performance of Public Private Partnership arrangements
- Further sector harmonization towards Sector Wide Approach

National Sanitation Policy and Implementation Strategy, 2016

The National Sanitation Policy formulated in 2016 aims at promoting hygiene behaviour change of people and attaining 100% sanitary service coverage by 2017/18.

Water and Sanitation Sector Strategic Plan 2018 – 2024, 2017

This sector strategic plan guides the sector during 2017 to 2024 and is very consistent with the sector policy of 2016 which clearly set out the approach of the sector to reach the NST 1 and SDGs. This strategic plan formulates the specific objectives/priorities to ensure 100% sustainable functionality of rural water supply infrastructure by rehabilitating non-functional system and ensure sustainable operation and maintenance by 2024 while implementing effective management structures and well-regulated public-private partnership (PPP) arrangements.

3.2.4. Country Water Legislations

The Rwanda 2008 water legislation (Law No. 62/2008) define the applicable rules to the use, conservation and management of water resources including surface and groundwater. It defines the public water domain, the institutions in charge of these domains and how they should be planned and managed. The law also specifies the regime of water use and allocation and water protection rules with specific penal provisions for law violators. The law emphasizes the aspect of international cooperation in the management and exploitation of shared water resources

[2] The last of four successive strategies implemented to achieve the 2020 Vision

particularly allowing the exchange of information and data and the implementation of shared projects.

It appears that Groundwater is really not well understood and is confused with water spring or any other water flow from the ground. According to the letter of the law however, the provisions intended for the protection and preservation of surface water do apply to groundwater.

The Rwanda 2018 water legislation (Law No. 49/2018) determines use and management of water resources in the country. The law details the roles and responsibilities of the different segments of the government institutions at the different levels (central, local) and the public in water protection and management. The division of responsibilities include the different aspects of planning, monitoring, managing and protecting water resources.

The definitions and articles of the law reflects a better understanding of groundwater resources than that displayed in the law of 2008.

Specific efforts in the 2018 law are oriented to protection of area around groundwater perimeter and to notifying in case you find a water source nearby.

Article 27 talks on ground water protection area: “By a Ministerial Order, a Minister may designate any area within a catchment to be a groundwater protection area when it is proven there is a depletion of groundwater due to over extraction; 2º there is groundwater pollution or contamination; 3º groundwater exploitation caused a negative impact on the availability of surface water. Except activities related to the protection of groundwater protection areas, any other activity is subjected to prior authorization by the competent authority”

Article 28 calls for Notification of groundwater found incidentally. Any person who finds water sources or groundwater in the course of any kind of prospection, exploration or exploitation must immediately report the discovery to the competent authority

3.2.5. Regulatory Framework

There are a number of by-laws that regulates the water allocation and use in Rwanda. The regulations include water allocation, licensing of the provision of water services (production, transportation, protection, distribution and sale), licensing of waste disposal, conditions of use, revocation of water use licenses and sanctions for violators. Some of the relevant regulations include:

- Regulation No 007/R/SAN-EWS/RURA/2021 OF 04/05/2021 Governing Solid Waste Collection and Transportation Services
- Regulation N° 006/R/SAN-EWS/RURA/020 of 29/05/2020 Governing Cleaning Service Provision
- Regulation No 002/RB/WAT-EWS/RURA/015 OF 23/09/2015 Governing Water Supply Services in Rwanda
- Regulation N°004/R/SAN-EWS/RURA/2016 OF 10/11/2016 Governing Decentralized Waste Water Treatment Systems
- Official Gazette nº 10 of 22/03/2021 for Regulation No 002/R/SANEWATSAN/RURA/2017 OF 01/03/2017 Governing the Provision of Services of Hazardous Waste Management
- Regulations No 005/R/SAN-EWS/RURA/2016 Governing Liquid Waste Collection and Transportation
- Regulations no 002/ewastan/sw/rura/2015 of 24th/April/2015 governing solid wastes recycling in Rwanda
- Guidelines for annual report for cleaning service provision

There are apparently no specific regulations separately addressing the issue of groundwater development and use. It can be inferred however the existing regulations are applicable for both surface and groundwater. The enforcement of existing water use regulations falls within the Jurisdiction of Rwanda Utilities Regulatory Agency (RURA), while the allocation of water use is the responsibility of Rwanda Water Resources Board (RWB).

3.3. Uganda

3.3.1. Institutional Setup

Uganda is a presidential republic in which the President is the head of state and the prime minister is the head of government business. Legislation is undertaken by a unicameral national assembly or parliament and legislative Acts of Government are to be enacted with approval of and in conformity with the Constitution.

The Constitution of the Republic of Uganda sets a number of national guiding principles relating to, and supporting the principles of sustainable development and requires that the State adopts an integrated and coordinated planning approach. It further stipulates that the State ensures balanced development between different areas of Uganda and between the rural and

urban areas with special measures employed to favour of the development of the least developed areas.

Through the constitution, the State is entrusted to protect important natural resources including land, water, wetlands, minerals, oil, and fauna and flora on behalf of the people of Uganda. All possible measures must be taken to prevent or minimise damage to land, air, and water resources resulting from pollution or other causes. The Constitution entrusts the State to ensure the conservation of natural resources and promote the rational use of natural resources to safeguard and protect the biodiversity of Uganda. Through this, the Constitution sets the scene for Integrated Water Resources Management in Uganda.

3.3.2. Water Sector Governance System

3.3.2.1. National Level

The Ministry of Water and Environment (MWE) plans and coordinates all water and environmental sector activities and is the ultimate authority responsible for water resources and environmental management in Uganda. The MWE has the overall responsibility for setting national policies and standards related to water and the environment, managing and regulating all water resources and determining priorities for water development and management.

The MWE is divided into three directorates: Directorate of Water Resource Management (DWRM), the Directorate of Water Development (DWD), and the Directorate of Environmental Affairs (DEA).

The DWD has the responsibility for providing overall technical oversight for the planning, implementation, and supervision of the delivery of urban and rural water and sanitation services across the country including water for production. It is responsible for regulating the provision of water supply and sanitation and the provision of capacity development and other support services to Local Governments, Private Operators and other service providers.

The DEA is responsible for environmental policy, regulation, coordination, inspection, supervision and monitoring of the environment and natural resources as well as the restoration of degraded ecosystems and mitigating and adapting to climate change.

DWRM is responsible for managing and developing water resources of Uganda in an integrated and sustainable manner in order to provide water of adequate quantity and quality for all social and economic needs for the present and future generations. The Directorate comprises of four departments namely Water Resources Monitoring and Assessment Department (WRMAD),

Water Resources Planning and Regulation Department (WRPRD), Water Quality Management Department (WQMD) and the International Transboundary and Water Affairs Department (ITWAD).

The MWE further works closely with four semi-autonomous entities namely: the National Environment Management Authority (NEMA), which is mandated with the coordination, monitoring, regulation, and supervision of environmental management; the National Water and Sewerage Corporation (NWSC) — with the mandate to operate and provide water and sewerage services in the larger urban centres; the National Forest Authority (NFA), whose mandate is to manage Central Forest Reserves and to supply high quality forestry-related products and services; and the Uganda National Meteorological Authority (UNMA), slated to return to the ministry as a department under the new restructuring of government MDAs. UNMA is mandated with weather and climate services (UNMA Act. 2012) and a is focal institution to Inter-Governmental Panel on Climate Change (IPCC), an international body mandated to carryout scientific research on climate change

Other national entities significantly impacted by technical water management issues are the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF); the Ministry of Tourism and Industry (MTI); and the Ministry of Energy and Mineral Development (MEMD). The Ministry of Education and Sports (MoES) is responsible for the implementation of Water and Sanitation in schools, and the Ministry of Health (MOH) is responsible for sanitation via the environmental health department.

The Ministry of Local Government (MLG) oversees the implementation of Local Government Development Plans, which include water supply and programmes for the improvement of hygiene and sanitation in institutions and public places. There are a number of development partners, private sector, and NGOs that also act in the water sector providing services, advice, and facilitation. A number of NGOs active in the water sector are coordinated at the national level through the Uganda Water and Sanitation NGO Network (UWASNET), an umbrella organisation largely funded by development partners and the MWE. An outline of the focal organisations involved in water management is indicated in Figure 3-3.

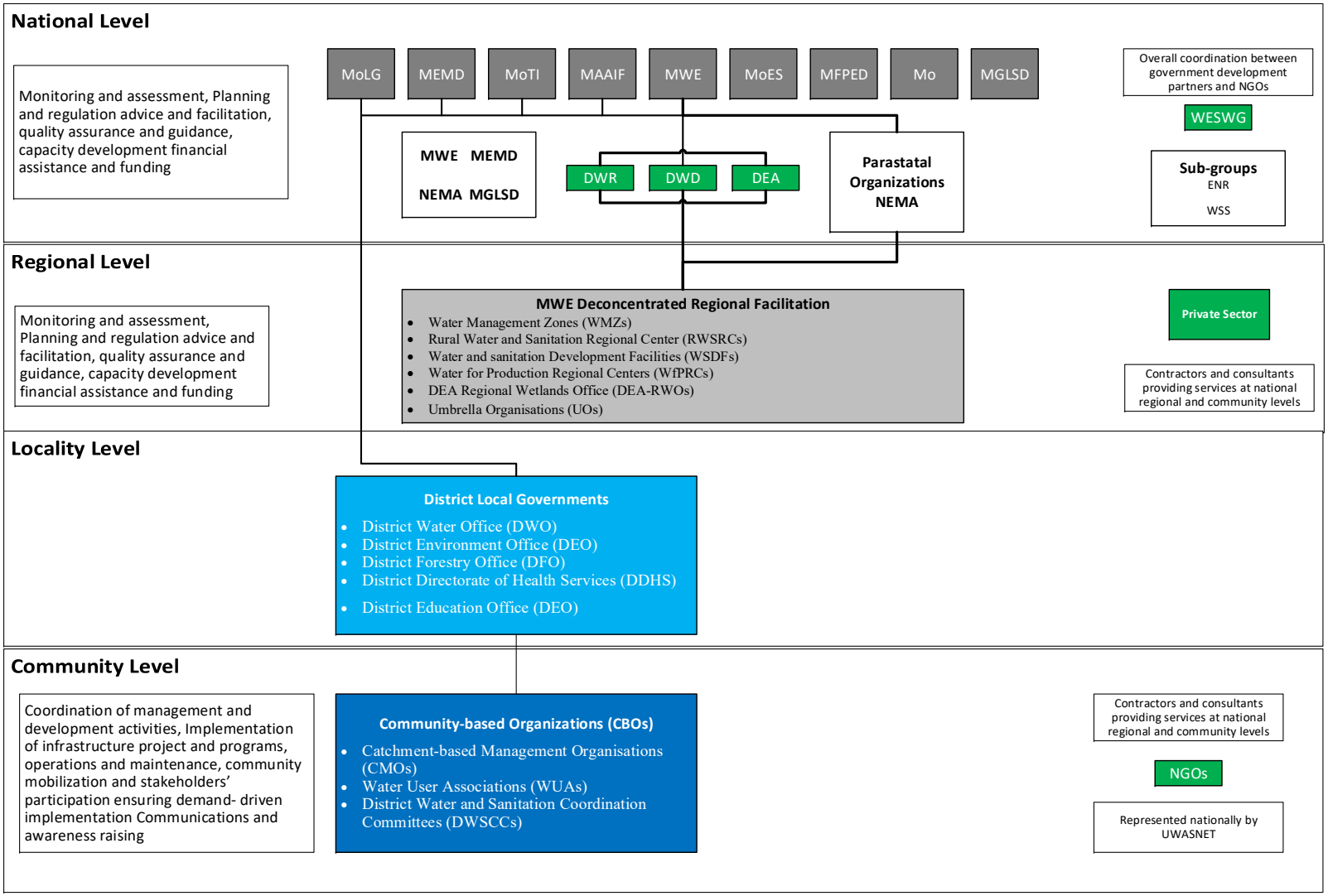


Figure 3-3: Institutional Setup at a National Level (MWE, 2015) for Uganda

3.3.2.2. Catchment Regional and Local Levels

As a result of the deconcentration of the management of water resources, DWRM created four Water Management Zones (WMZ) following hydrological boundaries. This in effect created the need for an institutional framework which brings the stakeholders within each WMZ together to present and exchange their views. Hence, came the establishment of the Catchment Management Organisations (CMOs), which builds on and utilises to the maximum practicable extent, existing structures and relationships. The CMOs consists of several bodies Figure 3-4.

- The Catchment Stakeholder Forum (CSF) brings together all actors on catchment management. The CSF defines key issues related to water resources in the catchment
- The Catchment Management Committee (CMC) is composed of representatives of all relevant stakeholder groups and collaborates with the WMZ during the formulation of a Catchment Management Plan and plays a steering role during its implementation.
- The Catchment Management Secretariat (CMS) provides support to the Catchment Management Committee in coordinating the planning and implementation of activities in the catchment as well as following up of recommended actions by the stakeholders.
- The Catchment Technical Committee (CTC) forms the technical arm of the CMO and supports the CMC in their tasks.

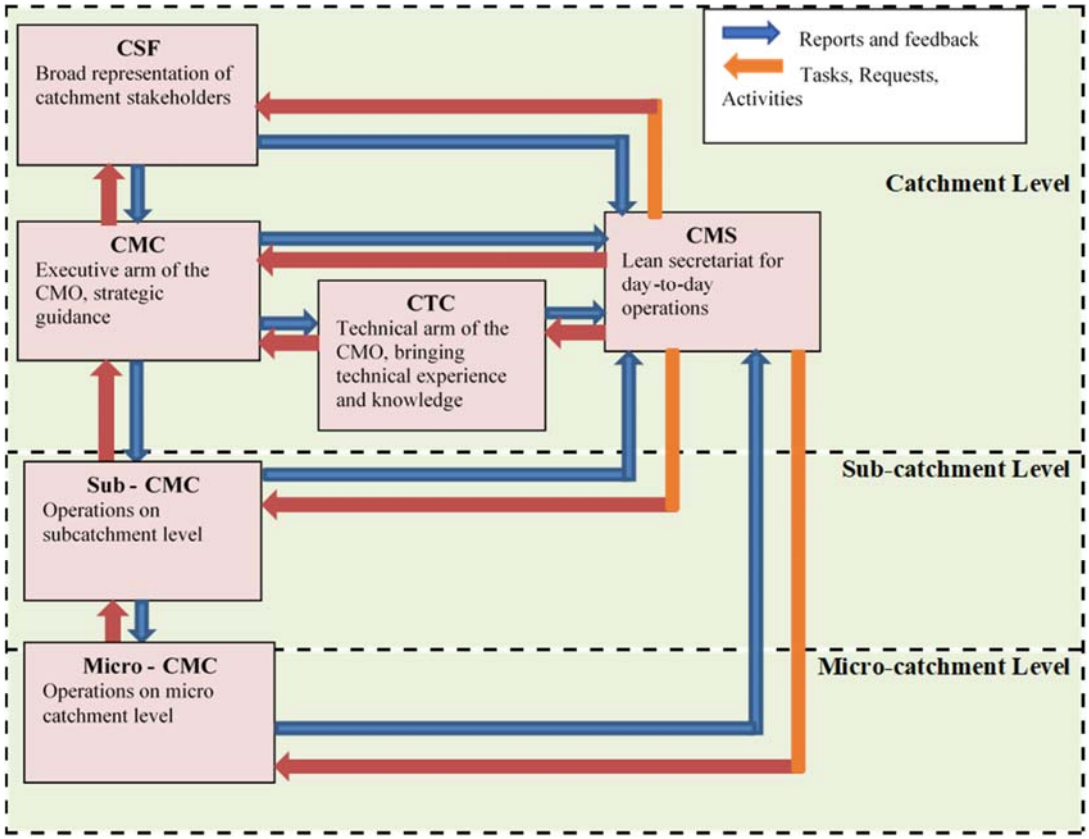


Figure 3-4 Catchment Management Organisation Structure (DWRM)

MWE institutions and mechanisms were established on regional level with the objective of improving cooperation and integration among water governing the national and regional levels and bring the central services closer to the stakeholders at the local level.

Their primary role is to facilitate sustainable development of the water resources for the economic and social benefit of the people in the catchment and to implement the water management measures needed to protect and conserve the catchment and its water resources, ensure sustainability, and reduce or resolve conflicts over resource use. They include:

- Technical Support Units (TSU) established by DWD at the regional level which have the mandate to support capacity building of district-based structures. This involves training, technical advice and support supervision of districts to enable them to effectively implement their roles in the rural sub-sector. The mandate also covers water for production undertaken by DWD staff deployed to the regions. The DEA is another department of the DWE which has established offices for its Wetlands Department on regional level.
- Sanitation Development Facility (WSDF) is a DWD mechanism for supporting water supply and sanitation facilities for rural growth centers and small towns, intended to promote a demand responsive approach where Water Authorities/Town Councils or Town Boards apply for funding. The successful applicant is assisted by the WSDF to develop piped water supply systems.
- Umbrella Organizations (UO) are regional organizations constituted as associations of the local Water Supply and Sanitation Boards (WSSBs) with the principle objective of providing operation and maintenance (O&M) back-up support (training, technical, legal and organizational support, supervision of rehabilitation, and extension works as well as water quality monitoring).

These deconcentrated units in the regions are based together for improved cooperation and integration and represent the MWE on regional level. Specialized departments or district offices (e.g., District Natural Resources Department District Works or Engineering, District Agricultural Office) are responsible for the implementation of the district development plans emanating from the sector and national levels. Additionally, there are a number of private sector and NGOs, which also act in the water sector, providing services, advice and facilitation. They work at catchment and regional level or sometimes combine the two. Many of these NGOs are coordinated at the national level through the Uganda Water and Sanitation NGO Network (UWASNET), an umbrella organisation largely funded by development partners and the MWE

3.3.3. Water Management Policy

The Uganda Vision 2025 provided a strategic framework for the national development of the country since the beginning of the third millennium. The translation of the national vision into action plans began in May 1997 including various sectors. The plans of governance and management of the water sector were greatly influenced by the African Water Vision (AWV) 2025. The AWV 2025 states its goal as "an Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, regional cooperation, and the environment". One of the results of the adoption of the Ugandan Vision 2025 was thus effectively the adoption of a water policy reform initiative aimed at realising the vision for water management in the country within the IWRM framework. This required the establishment of the legislative and policy mandates needed to promote the approach to IWRM and to ensure that the best economic, social and environmental development were enshrined in the relevant national policies. The result was the adoption of number of national policies which include:

The National Policy for the Conservation and Management of Wetland Resources (1995)

The National Policy for the Conservation and Management of Wetland Resources **predated** the adoption of the 2025 vision it aimed at restricting the continued loss of wetlands and their associated resources and aims to ensure that benefits derived from wetlands are sustainably and equitably distributed to all people of Uganda.

The Wetlands Policy was strengthened by a supplementary law specifically addressing wetland concerns. Wetland resources are regarded as forming an integral part of the environment and is recognised that present attitudes and perceptions of Ugandans regarding wetlands be changed.

National Water Policy (1999)

The 1999 National Water Policy provides an overall policy framework that defines the Government's policy objective as managing and developing water resources of Uganda in an integrated and sustainable manner, to secure and provide water of adequate quantity and quality for all social and economic needs sustainably, with the full participation of all stakeholders (DWRM, MWE, 2012).

Uganda National Land Policy

The Uganda National Land policy provides a framework for articulating the role of land in national development, land ownership, distribution, utilisation, alienability, management, and control of land. The Land Policy has a specific objective that seeks to ensure sustainable utilisation, protection and management of environmental, natural and cultural resources on land for national socio-economic development.

National Forestry Policy

The National Forestry policy provides for the establishment, rehabilitation and conservation of watershed protection forests. It aims at promoting the rehabilitation and conservation of forests that protect the soil and water in Uganda's key watersheds and river systems.

Coordination is a key process for Integrated Water Resources Management (IWRM), which involves multiple stakeholders from different sectors, on different scales, and with different structures and interests. At the national level, the following committees are relevant to integrated water resources management:

- The Policy Committee on Environment: chaired by the Prime Minister, at the highest level of political decision-making
- The Water Policy Committee, which is composed of directors, and enables high-level and strategic dialogue specifically in the water sector,
- The IWRM Working group, which is an informal working group enabling technicians to coordinate
- The Water and Environment Sector Working Group (WESWG)
- The Inter-Ministerial Technical Committee regarding Water for Production, comprising members from the MWE, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Office of the Prime Minister, National Planning Authority, and Ministry of Finance. It meets on a quarterly basis to coordinate investments and works regarding water for production
- The Wetlands Advisory Group (WAG), which is a technical group dedicated to wetlands. The WAG improves coordination on wetlands issues, particularly on the issue of dry land rice
- The MWE-DWRM has created Water Net, a network for building capacities of stakeholders connected to the water sector.

3.3.4. Country Water Legislations

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.

According to the National Water Policy (1999) and the Water Act Cap 152, the responsibilities to provide water services and to maintain facilities are devolved to local councils in districts and urban centres, with full mandates to construct, acquire or alter any water supply work. The role of the Central Government's Agencies is that of guiding and supporting as required. The Act thus emphasises the shared responsibilities in development and management of water resources among stakeholders (including the Private Sector and NGOs) to regulate human activities that can pose risks to water resources. It also provides for pollution control measures with associated penalties and fines. Other Water Sector related policies form synergies with the Water Policy include:

- The National Gender Policy of 1999, which recognizes women and children as the key stakeholders of water
- The Local Government Act of 1997, which underscores the role of Local Government in provision and management of water and sanitation, empowering the local authorities to plan and to implement development interventions according to local needs

The existing policy and legal framework promote wise use of water resources from the lowest possible level, while considering roles to be played by different stakeholders at different levels. This offers an opportunity to ensure communities actively participate in development and maintenance of water sources.

National Environment Act (1995)

The National Environmental Act provides for "sustainable management of the environment; to establish an authority as a coordinating, monitoring, and supervisory body for that purpose; and for other matters incidental to or connected with the foregoing."

The Act makes provision for a tiered approach to environmental planning, commencing with a National Environmental Management Plan to be prepared and reviewed every five years. Each district is required to compile a district environmental action plan every three years that compliments the National Environmental Management Plan. Both of these plans are made available to the public. At a project scale, the Act stipulates that developments of a certain

nature are required to undertake detailed Environmental Impact Assessment process in a prescribed manner.

The Act also makes provision for the monitoring of air and water quality and makes provision for the establishment and implementation of minimum standards pertaining to emissions and e The Act goes on to make specific provisions for the protection of river banks and lake shores as well as the protection and management of wetland systems

Hilly and mountainous areas have also been identified as areas requiring special attention and protection by the Act. The Act however does not appear to directly address the protection of groundwater

Transboundary considerations

The trans-boundary nature of Uganda's water resources is such that there are a number of international conventions relating to management of water resources with which Uganda must comply. Currently, the key conventions/organisations to which Uganda is party are; the Protocol for Sustainable Development of Lake Victoria Basin and Nile Basin Initiative.

- Legal Framework for the Sustainable Management of the Nile Waters
- Agreed Curve for the Lake Victoria Release:
- Nile Basin Cooperative Framework Agreement
- The Lake Victoria Basin Commission
- Ramsar Convention (1971)
- UN Framework Convention on Climate Change (UNFCCC) and related Kyoto Protocol
- UN Convention on Biological Diversity

The key international conventions related to shared water resources to which Uganda is party are related to the sharing, protection and sustainable use of transboundary surface water and their protection.

3.3.5. Regulatory Framework

Regulations are delegated or subordinate legislation intended to enforce specific policies. The use of groundwater is organized by the Water Resources Regulations act (1998) which ordains the receipt of government (DWRM committee) authorization for the use of groundwater and specifies the conditions that must be maintained to maintain such permits. Other relevant regulations in place include Waste Discharge Regulations (1998), Water Supply Regulations

(1999), Sewerage Regulations (1999), Environmental Impact Assessment Regulations (1998), National Environment Standards for Discharge of Effluent into Water or on Land Regulations (1999), National Environment Waste Management Regulations (1999), National Environment Hilly and Mountainous Area Management Regulations (2000), National Environment Wetlands, River Banks and Lake Shores Management Regulations (2000).

The successful implementation of a regulatory framework hinges upon the attainment effective enforcement and monitoring bodies. Enforcement of regulations pertaining to water use and protection in Uganda (including groundwater) is undertaken by the DWRM, DEA and other regulatory agencies such as NEMA. The mechanism apparently suffers from underfunding and staff shortages. To enforce pertaining regulations an Environmental Police has been formed at NEMA, comprising 25 officers. Only five regional Environmental Police officers (liaison officers) have been designated, effectively designating enforcement in one quarter of the country to one single officer. The liaison officers belong to the regular police but are specifically trained in environmental issues. They are under the command of the territorial police (Regional Police Commander/District Police Commander). Their functions include sensitisation, demarcation, control, issuing warnings, following up of cases, eviction, and prosecution.

Within each district, there are offices that are in charge of the environment, forestry, wetlands, agriculture, fisheries, planning among others. However, the structure varies within districts.

3.4. Tanzania

3.4.1. Country Government System:

The Tanzania Government System is a two-tier system where the Central Government is responsible for matters of State, such as Executive power. There is an independent Judiciary and the National Assembly. The country is divided into 26 administrative regions and these are made up of several districts. Each region and district is headed by a Regional commissioner and District commissioner respectively, who is assisted by a Regional and District Administrative Secretary heading a secretariat of technical personnel.

The other tier of Government is the Local Government responsible for most of social services such as water supply, primary and secondary education, health, from the district, division, ward, village level down to the lowest, street. Each district has a District council headed by a chairman with the respective number of Councillors. The district council secretariat is headed by a District Council Director assisted by technical personnel in several departments, of which Water and Environment are some. Some specialized services such as urban water supply,

regional and referral health services, electricity, regional and trunk roads, railway, ferry, shipping and air travel are handled by specialized agencies.

3.4.2. Water Sector Governance System

The ministry of water of Tanzania through its different departments is responsible for the formulation of water policies and regulation and the coordination of water resources management (including groundwater) within the country. The ministry has three main divisions (Water Resources Division, Water Supply and Sanitation Division and Water Quality Services Division) as well as advisory boards, regulatory bodies and agencies. It is at the level of the ministry of water that different water basins, sub-basins and aquifers of Tanzania are designated for water resources management purposes. Tanzania is divided into nine river/lake basins that do not follow administrative boundaries. In addition to the national level, the: management of each basin is conducted through four additional levels namely; (ii)Basin level, (iii)Catchment level, (iv) District (Local Government) Level and (v) Community or Water User Association level.

National Water Board: It is an advisory Board to the Minister of Water on matters related to multi-sectoral coordination in integrated water resources planning and management, strategic water investments, inter-basin transfers as well as resolution of national and international conflicts. It is composed of a chairperson and ten other Members from among water related sectors of agriculture, energy, industry, forestry, environment, livestock, wildlife, lands, mining, irrigation, fisheries and infrastructure and one representative from local government authorities, Basin Water Boards and Non-Government Organizations. **At least one third of the members are Women.**

- **Basin Water Board:** The powers and functions of the Basin Water Board are exercised and performed under the direction of the Board. Main functions of the Basin Water Board are data collection, processing and analysis for monitoring and assessments, water allocation, pollution control, preparation of water utilization plans, collection of the various fees and charges, and resolution of various water related conflicts. Membership to the Basin Water Board is by appointment by the Minister and composed of ten members including the Chairperson, from among the water related sectors of private sector water users in the Basin (industries or mining or agriculture or energy), three representatives from Catchment Water Committees, two representatives from key water related sectors important in the Basin (agriculture, energy, minerals, trade and industry, forestry, environment, natural resources, lands, livestock, fisheries and

infrastructure), one representative from local government authorities, one representative from water supply and sanitation authorities and one representative from the Ministry. **At least one third of Members of the Basin Water Boards are Women.**

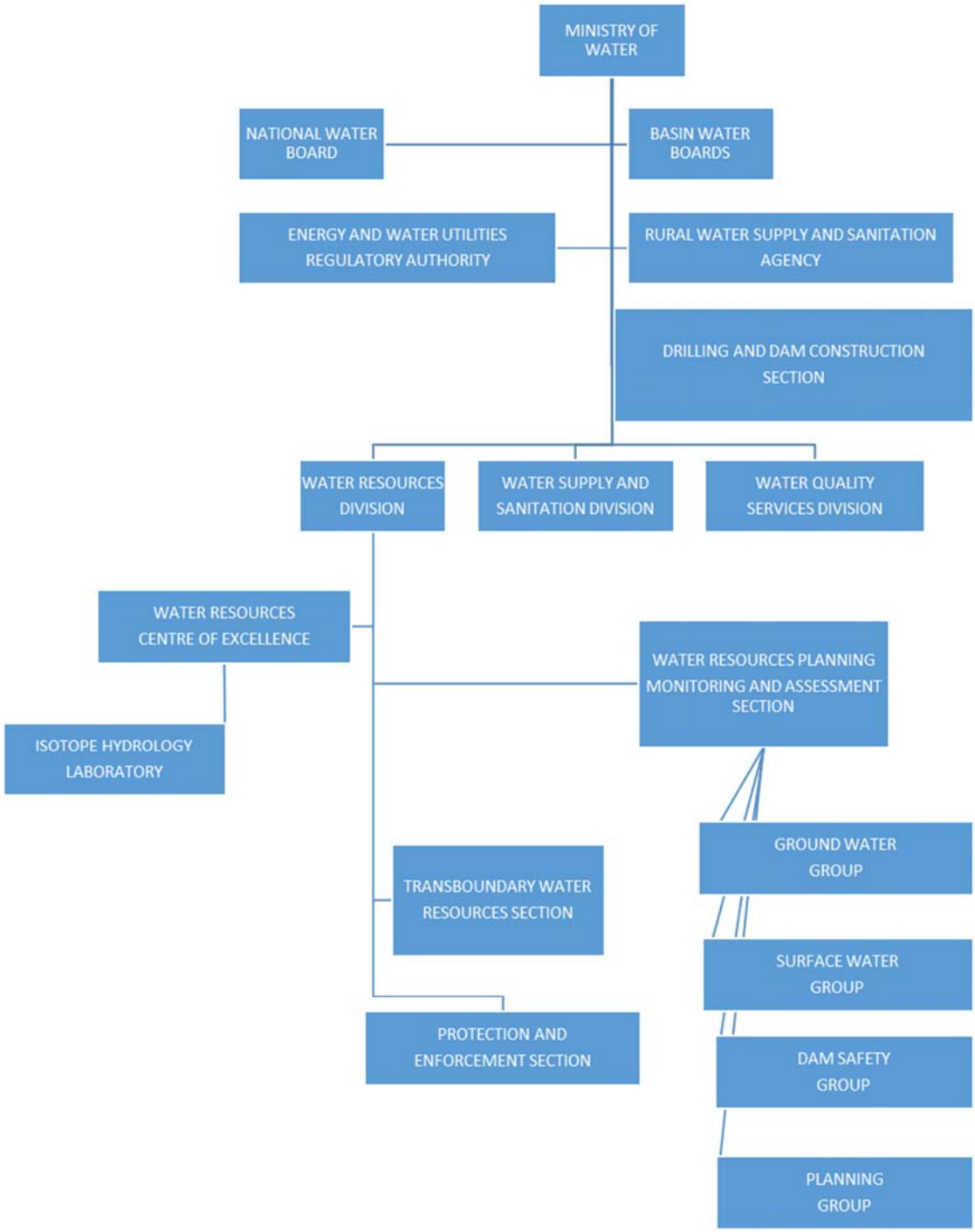


Figure 3-5: Organisational Structure of The Ministry of Water for Tanzania

- **Catchment and Sub-Catchment Water committees:** Due to the large size of Basins making administration and water management difficult since the Basin Office could be distant from the water users, provision has been made for the establishment of Catchment and Sub-Catchment Committees. Main functions of the Committees include preparation of and implementation of catchment plans and resolution of water conflicts arising within the catchment/sub-catchment. Membership of the committees, appointed by the respective Basin Board are composed of a chairperson and not less than and not more than five members comprising of one representative from major private sector water users from the catchment/sub-catchment, two representatives from the Water User Associations in the catchment/sub-catchment and one representative from the local government authorities in the catchment/sub-catchment. **At least one third of the members of the committees are Women.**
- **District Level:** District Councils fully participate in water resources management by way of membership in Basin Water boards and Catchment/Sub-catchment Committees. Districts are responsible for planning and development of water resources in accordance with Basin plans, protection and conservation of natural resources in villages and wards, enactment of bye-laws on the management of water resources, conflict resolution in accordance with established laws and regulations. In addition, the District Councils are responsible for assessing water demands of their respective districts, and participate fully in the conception and preparation of Basin Plans. **This is an ideal level for multi-sectoral planning and implementation, sectoral collaboration and coordination, where IWRM can be practiced. It has no legal status, unlike all the other levels.**
- **Water User Associations:** This is the lowest level for water resources management. The WU Associations are responsible for local level management of allocated water resources, mediation of water disputes among water users and between water groups within their respective areas of jurisdiction, collection of various data and information, collection of various fees on behalf of the Basin Water Boards, participate in the preparation of water utilization plans, conservation and protection of water sources, and catchment areas, efficient and effective water use and ensuring return flows, enforcement of the law, and implementation of conditions of water permits, and control of pollution. They participate in water resources management by providing legitimate representatives in the Basin Boards and Catchment/Sub-catchment Committees. Membership to the Association comprise of villagers, institutions, companies, committees and authorities or any person natural or legal, as may be users of water from sources within the area of responsibility of the Association.

- **Other Relevant Institutions:** Besides the above institutions, water resources management is also complemented by other relevant institutions including; Fisheries, Forests and Beekeeping and Tourism Divisions and District Councils.

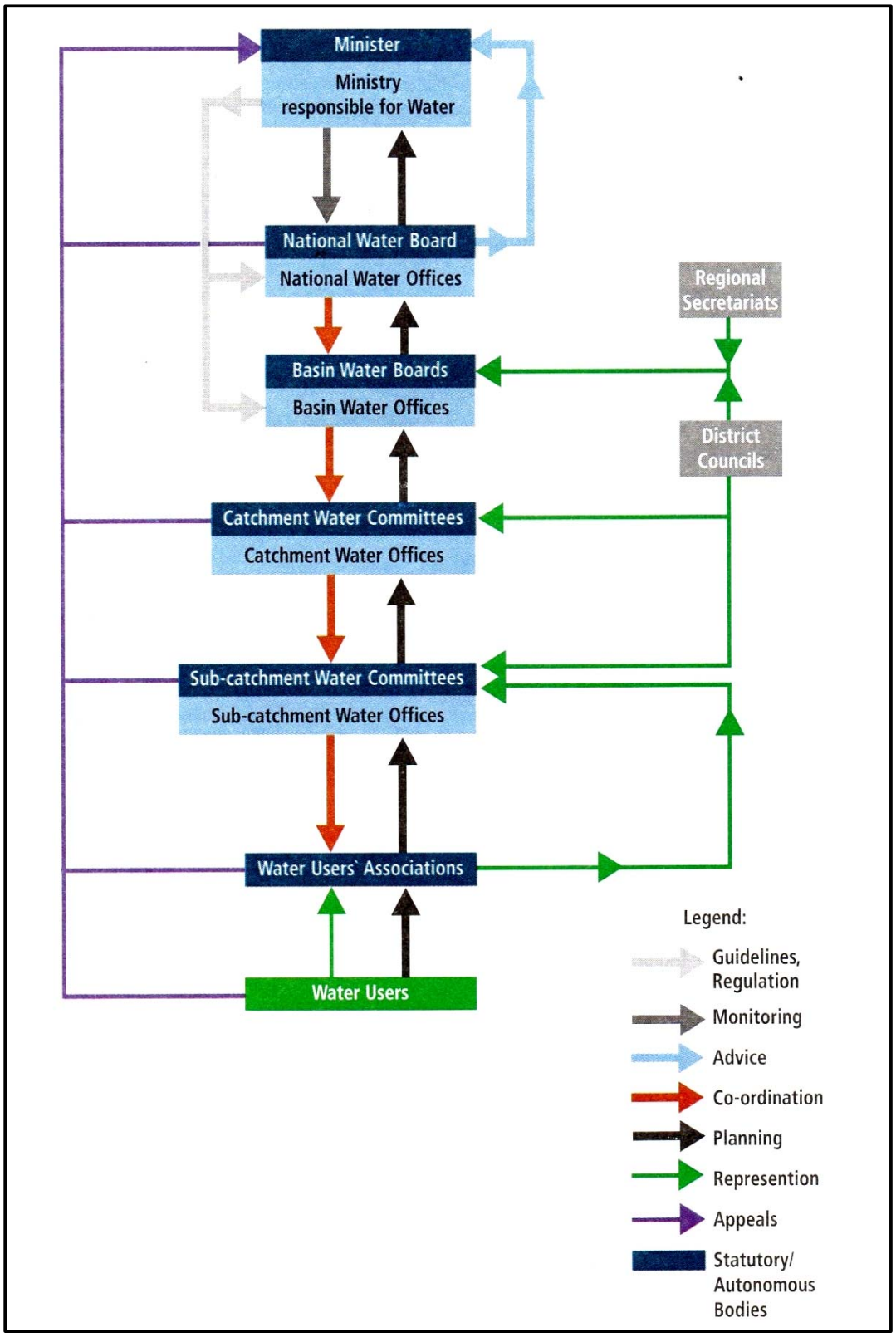
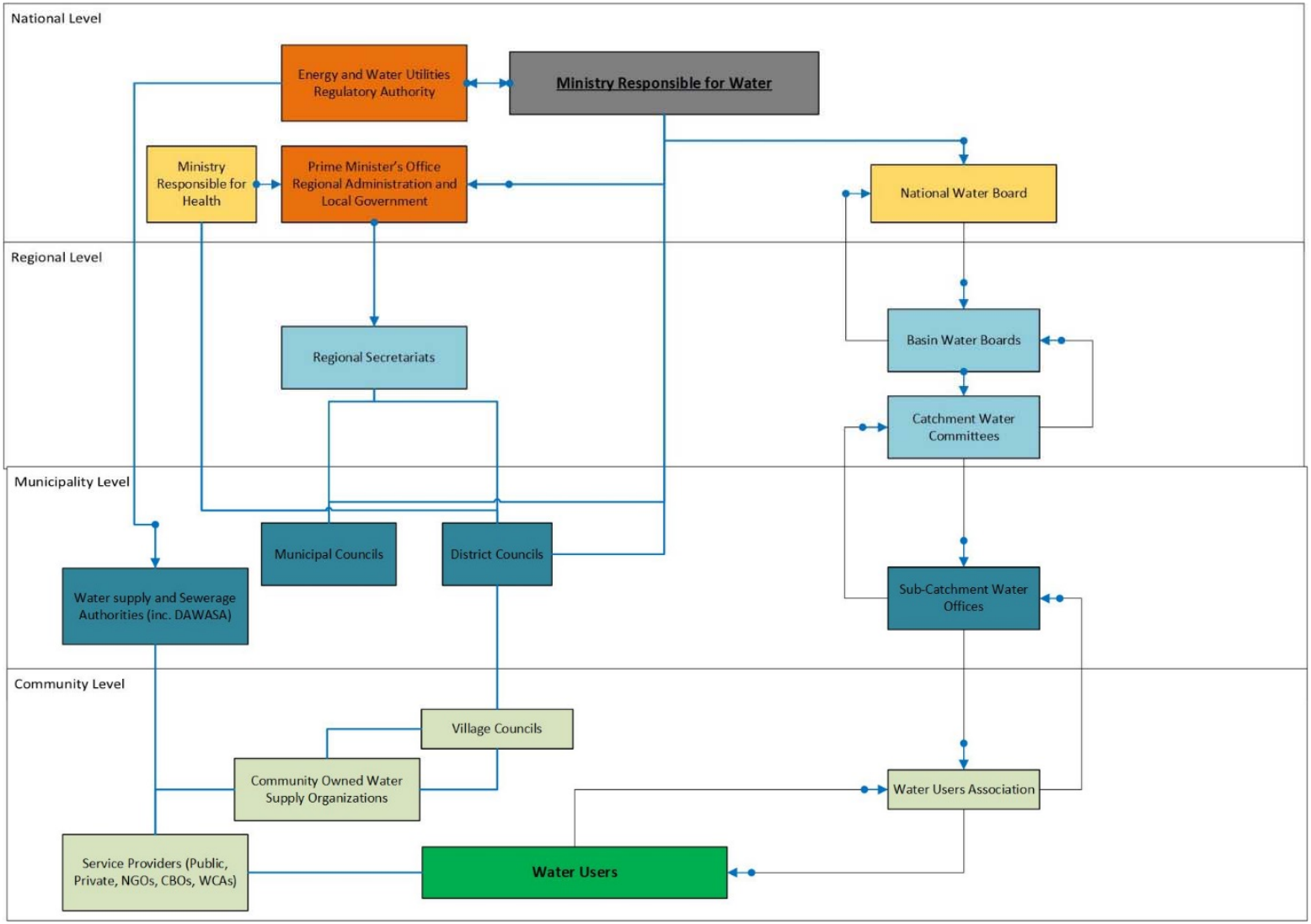


Figure 3-6: Institutional Framework for Water Resources Management in Tanzania



Organisational Structure of the Water Governance Sector for Tanzania

3.4.3. Water Management Policy:

The current policy governing water resources development and management in Tanzania is the National Water policy of 2002 (NAWAPO). The preparation and subsequent adoption of the National Water Policy of 2001 arose out of emergent challenges; inadequacies in the 1991 National Water Policy such as unmet goals for provision of water to both the rural and urban population, growing water demands from different socio-economic sectors, weak policy and legal and institutional frameworks such as unregulated groundwater development, invasion, destruction and pollution of water sources as well as fragmented uncoordinated planning, implemented following sectoral. Regional or district interests, greatly aggravating the situation even further.

Main Objective of the 2002 National Water Policy: To develop a comprehensive framework for sustainable development and management of the Nation's water resources, in which an effective legal and institutional framework for its implementation will be put in place.

Policy Aim: Ensuring that beneficiaries participate fully in planning, construction, operation, maintenance and management of community based domestic water supply schemes. It seeks to address cross-sectoral interests in water, watershed management and integrated and participatory approaches for water resources planning, development and management. It also lays a foundation for sustainable development and management of water resources in the changing roles of Government from service provider to that of coordination, policy and guidelines formulation, and regulation.

The Policy is structured into three sections addressing three water sub-sectors namely:

i. Water Resources Management: The management of water resources is guided by the following principles:
   a. Separation of service delivery and water resources management.
   b. Management responsibility is devolved to river basins, catchments, and water user groups.
   c. Planning is an inter-sectoral process involving all stakeholders.
   d. The value of water is recognised through charges for water use and pollution discharge.
   e. Environmental water allocations are needed to ensure river health.
   f. Trans-boundary waters are managed through a cooperative approach.

ii. Rural Water Supply: The management of which is guided by the following principles:
   a. Human consumption is the highest priority water use.
   b. Water-scarce areas receive priority.
   c. Water is an economic good requiring financing by water users at full cost recovery for Operation and Maintenance costs.
   d. Water resources need to be protected for the benefit of rural water users.
   e. Beneficiaries of rural water schemes will own and manage their schemes.
   f. Technology and the level of service will be commensurate with the economic capacity of users

iii. Urban Water Supply and Sewerage: The management of which is guided by the following principles:
   a. Access to water and sanitation is the right of all citizens, including the poor.
   b. Cost recovery is vital to ensure quality.
   c. Service delivery is to be decentralised and accompanied by institutional reforms.
   d. Wastewater treatment must be paid for by water users.
   e. Private sector participation is encouraged.
   f. The regulatory framework will be independent and transparent.

Other Relevant National Policies: Besides the National Water Policy, other National Policies with relevance to water resources include; National Environmental Policy of 1997, National Land Policy, 1995, Wildlife Policy of 2007, Agriculture and Livestock Policy of 1997, National Irrigation Policy and National Tourism Policy of 1999.

3.4.4. Legal Framework Governing Water Resources Management in Tanzania

Water resources development and management in Tanzania is governed and controlled by The Water Resources Management Act No; 11 of 2009 (WARMA) which was prepared based on the National Water Policy of 2002.

Water Resources Management Act (WRMA), 2009: The Water Resources Management Act (WRMA) provides the legal framework for the management of water resources within the integrated water resources management (IWRM) framework. The Act provides for pollution control and issues discharge permits of effluents to water bodies, including the underground

strata. The Act also provides measures for flood mitigation and control to prevent or minimize the risk of flooding, flood damage and water pollution. Moreover, it was for providing for the participation of stakeholders and the general public in implementation of the National Water Policy, and the relevant water control and regulation acts.

Part XII of the Water Resources Management Act No 11, 2009, provides for management of trans-boundary waters. It gives the direction on recognition and formulation of policies, strategies and legislation in respect to trans-boundary waters. That part gives the Minister responsible for Water the power to develop policies and strategies for the purpose of ensuring sustainable, equitable utilization and management of trans-boundary waters. It also imposes to the Director of Water Resources the responsibility of keeping a register of all International and Regional Agreements concerning the utilization and management of trans-boundary water to which the United Republic of Tanzania is a party. As regards to groundwater resources, the following have been provided for:

PART VI: PROTECTION OF RESOURCES

Section (c) Protected Zones: Section 37 sub-section 1 (a) Empowers the Minister responsible for Water to limit or prohibit Human activities altogether for purposes of protection of water sources from pollution, erosion or any other adverse effects.

Section (d) Groundwater Controlled Areas: Sub-Section 38 (1) to (5) provides for the Minister to declare any area of Mainland Tanzania to be a Groundwater Controlled Area.

Section (e) Prevention of Pollution: This Section provides for the Basin Water Board to prevent pollution of water sources from human activities; take measures to remedy effects of pollution to water sources from human activities; Control of emergency pollution incidents; and Duty and emergency powers of Basin Water Boards during such emergency incidents. In this Section, the general term water source is taken to include groundwater.

PART VII: WATER ABSTRACTION AND USE:

Section 43, Sub-Sections (a) to (f), provides for the respective Basin Water Board to do the following in regard to water abstraction and use:

a. Grant Water Use Permits
b. Recording of Unregistered rights
c. Grant of Groundwater Permit

d. Grant of Discharge Permits

e. General Provisions Relating to Water Use, Groundwater and Discharge Permits

f. Keeping and Maintenance of a Water Register

WARMA contains clauses that levies penalties for offences such as

- Use of water in excess of what is specified in the water use permit (46)
- Failure to obtain permits prior to the construction or enlargement of wells (55)
- Pollution of water sources by waste or effluent (64)
- Assault, threaten, resist, hinder or delay an authorized officer under the act from exercising his/her duties. (101)
- Make false statements to procure water use permits. (102)
- Pollution of water sources (103)

Besides the Principal Act, the Ministry of Water prepared and issued Groundwater Regulations (Exploration and Drilling) Licensing of 2013 in order for the Basin Water Boards to monitor, control and regulate, the private sector engaged in groundwater surveys/exploration and water wells drilling in the country. However, experience has shown that most private firms do not follow best practices required in groundwater resources development, mainly due to lack of professional norms, ethics and guidance.

Besides the Water Resources Management Act, water resources are also governed by other complementary legislations relevant to water resources. These include;

Water Supply and Sanitation Act 2019: The act repeals the 2009 Act (WASSA) which bears the same title and it makes provision with respect to water sustainable supply and sanitation in Tanzania and establishes the Rural Water Supply and Sanitation Agency (RUWASA) and the National Water Fund. The Act provide for sustainable management and adequate operation and transparent regulation of water supply and sanitation services;

Other Relevant Legislations: The Environmental Management Act of 2004, Forest Act of 2002, Land Act of 1999, Wildlife Conservation Act Mo: 5 of 2009 and Fisheries Act No: 22 of 2003. These acts provide for the conservation, protection of the environment as well as the sustainable management of land and other natural resources.

3.5. Status of Institutional Setup

The beginning of the third millennium witnessed the development of national visions within the four riparian countries that share the Kagera aquifer to reduce poverty, and health problems and improve access safe clean water and adequate sanitation within 20 to 25 years. National policies to achieve the set targets were subsequently developed. At the core of these policies were the water policies which embraced the UN sustainable development goals for water and sanitation to achieve the equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, and the protection of the environment.

The policies adopted by the four counties were similar in that they followed the same principles which regarded water as human resource which is to be used for the public good, emphasized the human right of access to water, and adopted the concepts of Integrated Water Resources Management (IWRM) for water management with emphasis on participatory approach. The policies embraced the concepts of catchment-based water resources management, management of water taking into consideration conservation of water sources, environmental impacts and consideration to the aspect of internationally shared water resources. If not specifically cited in these policies groundwater is addressed as in the case of Burundi as part of the water resources to be conserved and sustainably managed. The water policies of the four countries have in essence the same core set of guiding principles and goals and do provide a coherent set of strategies to guide the sector and allows for the establishment of joint legal framework for joint management of transboundary water resources.

The evolution of the legal frameworks for the governance of water resources was influenced in each of the four riparian countries by the adopted water policies, history, socio-cultural structures and practices as well as the existing political climate. In spite of the existence of differences in focus and structure the legal frame works governing water resources management in the four countries have similar perspective elements. They provide binding set of rules that govern the vision established in the country's policy and establish the institutional setup responsible for water resources management within the country. Furthermore, they provide aligned legal frameworks that address the use and management of water resources including its protection from pollution. Existing legislations also allows for cooperation and sharing of data with riparian countries for the management of transboundary water resources. Legislations however are more centred towards the use and management of surface water and address groundwater with different levels of emphasis. Groundwater management regulations are more

developed in the four countries in the following order Tanzania, Uganda, Rwanda and Burundi which apparently reflect the order of prevalence of use of groundwater within the four countries.

Legislations and regulations pertaining to groundwater management in the legislative frameworks of the four riparian countries include:

Water Allocation: Development of groundwater resources requires the attainment of water permits and the legislations specifies the level of government from which the water allocation permits can be obtained. The amount of water that can be allocated and time for which water rights are granted are subject to the discretions of the authorizing agency. It is bound to be different within the four countries as it is most likely influenced by local legal traditions. Water allocation for human consumption is considered as basic right and can apparently be readily obtained. The issue groundwater allocation for irrigation or other industrial purposes may be a source of controversy in establishing joint management efforts of the transboundary aquifer.

Water Tariffs: The concept of payment of tariffs for used Groundwater is enshrined in the water resources legislative frameworks of the four riparian countries. The basis for the fee determination is not set and may differ in different areas within the same country. Water tariff may be specified based on cost recovery principles, market value principle or as a conducive element for the efficient use of water. Agreement on the basis of water tariff specification will be conducive to efforts of developing transboundary aquifer management systems.

Environmental Considerations: Environmental legislations are similar within the four countries in that they take into consideration water quality when issuing groundwater allocation, require environmental impact processes for proposed interventions and put controls on discharge to water sources.

The water management structure practiced in the four riparian countries is a state-centred or technocratic system of management. This system is based on the notion that the state, through its administrative and political institutions can and should allocate and plan the nation's water resources in the interest of the common good.

Water resources management is sought in the riparian countries within the framework of the river basin adopting IWRM principles. Planning management and conflict resolution is undertaken by the government with emphasis on decentralization through governing boards and regional and local authorities/agencies with the involvement of Primary stakeholders (local communities, farmers, water users).

The water governance institutional setup in the four countries can be divided into four levels (i) the National level responsible for formulating national policies, oversight, budgeting, resource mobilization, regulating and overall performance monitoring. (ii) The regional level (or Basin/Catchment Level) which is responsible for the development, management of water facilities. (iii)The local level (subbasin/subcatchment level), responsible for the direct operation of water facilities, monitoring, conflict resolution, regulation enforcement. (iv) Community Level: This may comprise individuals or water user committees whose role is to monitor service delivery and functionality, report problems and sensitize users to pay for water services.

The implementation of existing water resources regulations requires the establishment of a range of mechanisms aiming to ensure compliance with existing regulations. These mechanisms, situation monitoring, issuing warnings, imposing fines, revoking water licenses or suspending operations. There is an apparent weakness in the performance of the enforcement mechanisms within the four countries which attributed to number of factors:

- Lack of funding for monitoring activities
- Shortage of trained enforcement officers
- Weak involvement of primary stakeholders due to lack of awareness and/or poor communication with stakeholders at the local level.
- Poor coordination between stakeholders at the national, regional, and local levels

The development of an enabling environment for attaining the effective joint management of the Kagera Aquifer requires the alignment of the water resources policies and legislations, the establishment of effective regulatory agencies, and monitoring systems and the full engagement of the primary stakeholders in the decision-making process.

4. SOCIAL AND ECONOMIC ASPECTS IN KAGERA AQUIFER

4.1. Burundi

4.1.1. Socio-economic Background of Burundi

(West), Rwanda (North), Tanzania (East and South). It covers an area of 27,830 Km2 which straddles the crest of the Nile-Congo water shed draining into the Kagera (Nile) system to the east and lake Tanjanika (Congo) to the west. The country is administratively divided into 18 Provinces which are subdivided into Communes (129) which are further subdivided into Collines.

Burundi is a low-income economy where 80% of the population is employed in the subsistence agriculture. It is one of the most densely populated countries in Sub-Saharan Africa with 11.6 million people, of which 50.4% (2019) are women. According to the UNICEF, the infant mortality was estimated at 39.15 ‰ in 2020 while the mortality rate of infants below five years is estimated at 56.5‰.

With nearly 65% of its population living below the poverty line, Burundi ranks 185th out of 189 countries according to the Human Development Index (HDI). Unemployment is also endemic, especially among young citizens, although according to the World Bank the unemployment rate was 0.8% of the total labor force in 2020. With a GDP per capita of 267 dollars, Burundi is ranked as the poorest country in the World as of 2021.

Life expectancy at birth is low, at about 61 years old (World Bank). In addition, one in 15 adults is HIV positive and medical supplies are insufficient. According to the World Health Organization, 8.2 million Burundians (73% of the population) were affected by malaria in 2016; more than 3,800 died, prompting the government to declare it an epidemic. Severe and moderate malnutrition affects 50% of the population.

Table 4- 1: Burundi Economic Indicators

GDP growth Indicators	2019	2020
GDP (Billions USD)	3.01	3.04
GDP annual growth rate (%)	1.8	-1.0
GDP per capita (USD)	261	256
Inflation rate (%)	-0.7	7.3
Active Population	4,987,390	5,134,416[3]

[3] International Labour Organization, ILOSTAT database

4.1.2. Social Policy Trends of Burundi

The government of Burundi is placing great emphasis and efforts on improving the quality and access to education and access to safe drinking water and sanitation. Free primary education was introduced in 2005 with the intention to increase the gross enrolment rate in primary education nationwide. Plans to improve water points in public facilities and improve access to water to local communities were invoked with heavy reliance on foreign funding which constituted more than 50% (≈ 74% in average) of the WASH sector funding in Burundi. These efforts and plans were however in recent years due to a significant drop in foreign aid since 2016 in response to internal political discord, fiscal problems, high national debt and weak economic growth. The funding of the WASH sector in 2021 depended almost entirely on internal sources (91%)

The Current government constitution of Burundi, has dedicated at least more than 30% of women participation in administrative and development structure. Adequate national legislation and good institutional framework take account gender issues and active participation of women is promoted by the government. All municipalities in the Kagera Region have a Communal community development plan giving a good attention to empower women and promote their participation in productive activities. By law, each municipal administrative structure has a minimum percentage of women representative (at least 30%). As a result of this policy, the presence or participation of women in the different levels of government and local administration has increased in recent years; and is proclaimed to have reached 30% in all sector.

The right to water is explicitly recognized in the Burundi National Development Plan 2018-2027, in Sustainable Development Goal 6 relating to drinking water and sanitation and in the Convention on the Rights of the Child. The drinking water coverage rate increased from 51% to 61% between 2010 and 2017 (UNICEF / WHO, JMP 2019) and varies according to the environment. Indeed, in urban areas, this rate improved significantly, from 82% to 90% between 2010 and 2017. Likewise, in rural areas, this rate increased from 48% to 57% over the same period.

4.1.3. Demography of Burundi

According to the 2008 census, Burundi has 8,053,574 inhabitants and is expected to have an estimated population of 13,375,400 in 2030 (10,705,036 in 2020), of which approximately 51% are women. This estimate explicitly takes into account the effects of the rate of increase of 2.4% /year, which has a significant effect on the demographics of the country. The population density

of about 316 people per square kilometer in 2008 is the second highest in sub-Saharan Africa. About 85% of the population is Hutu ethnicity group; most of the remaining population is Tutsi, with a small minority being Batwa (Pygmies) and a few thousand foreign residents. According to the UNIPROBA assessment report in 2009, the total population of the Batwa community was estimated at 78,071 people (~1% of the population). The Batwa are believed to be the original inhabitants of the region, others arriving in the 1300s and 1400s period.

4.1.4. Description of Socio-economic Conditions of Kagera Aquifer in Burundi

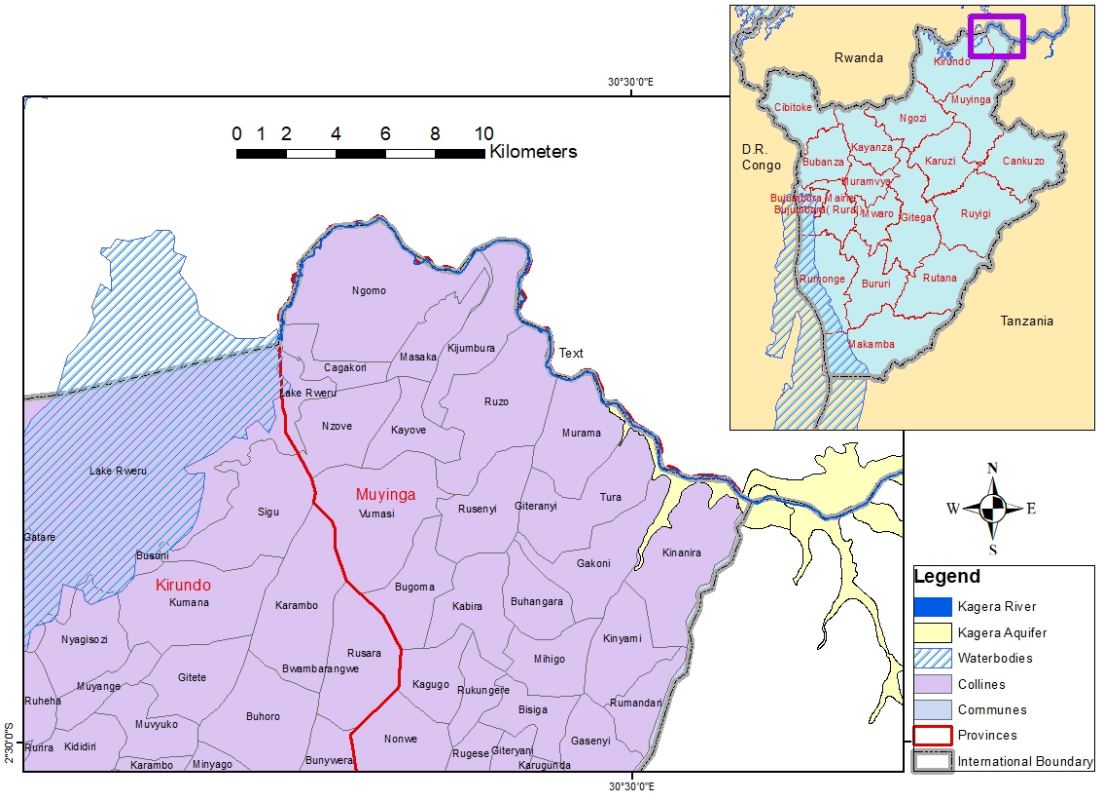


Figure 4- 1: Kagera Aquifer Extent in Burundi

The Kagera Aquifer extends over a narrow strip along the right bank of the Kagera River in the northern part of Muyinga Province, within the Giteranyi Commune (Figure 4-1). Based on the population density data the number of people living within the Kagera Aquifer limits is estimated to be about 28,000[4].

The social structures within the project study area are heterogeneous. Very few people would be classified as financially secure, indicating a high poverty rate, with the groups of landless communities being the poorest. Due to limited access to land and poor production, many of

[4] Using population projections in 2020 for Muyinga province and the resulting population density

these families depend on support from government social programs and / or partners. It can be seen that adults play a very important role in household income and have a high position at the community level. They are the ones who contribute financially to the livelihoods of their families. Young people often migrate from the countryside in search of work in urban towns. Most of families practice subsistence agriculture largely dependent on rainwater, while irrigation is seldom done depending on the availability of water in the marshes in some areas. Thus, the success of agricultural production largely depends on climatic conditions and the availability of water for irrigation in the marshes. Climate variability, combined with a poor understanding of the availability and sustainable use of water resources, leads to both reluctances to invest in agriculture for fear of poor harvests and consequently loss of income. Irrigated agriculture is practiced on a relatively small total area of the study areas (mainly in Marshlands), while rainfed agriculture and livestock rearing occupies a much larger area, notably in rural communities.

Water access present a contrast between urban and rural areas in service levels. While 87 per cent of urban residents benefit from piped water on their premises, only 25 per cent of rural areas benefit from such services (JMP, 2017). However, urban piped water services are affected by service interruptions, which can last for several days (up to one week in some peri-urban areas). In rural areas the main sources of water are protected springs, but anecdotal evidence indicates that no service provider tests water quality. Water management for public water point (spring or public fountain) is managed is being done through user associations (RCE), Communal water committees in all municipalities of the study area.

The domestic water supply of Burundi is mainly based on some 25,000 springs that provide water through gravity systems. These systems have their natural limitation and cannot respond to current and future domestic water needs caused by the enormous annual population growth. They may also be are subjected to dry up due to climate change and land cover degradation.

The data of the Joint Monitoring Program for Water Supply, Sanitation and Hygiene (JMP) show that 80% of households nationwide have access to a water source for drinking, but only 61% of them benefit from improved safe drinking water source within working distance less than 30 minutes' roundtrip from their home. Most of the work to fetch water rely on women (80%) and usually takes more than one hour per day. Members of the Batwa communities in the project area who were interviewed during the SADA study stated that lack of water access is one of the main causes of school drop for children in the communities who have poor financial capacity to pay for water even if it is nearby their localities.

The Batwa communities who are estimated to constitute 6% of the population Muyinga province raised a number of key areas that they wanted to be addressed urgently. The main priority fluently cited by the communities was the need to obtain, through either government compensation or other means of purchase, **land**, which for most Batwa is seen as the base from which they will be able to obtain new or, at the very least, more secure livelihoods. Education was also ranked high amongst communities as it was seen as reason for backwardness in the communities, making them vulnerable to trickery. There was also a call for functional adult literacy classes that Batwa felt would enable them to operate more effectively in the wider community and have better interaction with majority communities. Adults, especially women, were very interested in developing their skills in activities that would enable them to generate income. The communities that were approached called on increasing their access to the forests to enable them to practice their culture, and secure materials for making craft items such as baskets and clay pots. Lack of potable water near by the communities were highlighted.

It was estimated from the observations of the social survey conducted during the course of the SADA study that boreholes provide only about 2% of the drinking water with most of the boreholes utilizing the basement complex aquifers. The use of this technology had been historically hampered by a number of factors including (a) a lack of existing knowledge about the location and size of groundwater resources particularly in the basement complex. (b) Lack of technical knowhow about groundwater exploration techniques, as well as borehole drilling and development technologies, (c)High cost of boreholes operation and/or maintenance (c) lack of finances to meet the high capital cost for borehole drilling and installation.

4.2. Rwanda

4.2.1. Socio-economic Background of Rwanda

4.2.1.1. Background

Rwanda is a landlocked country situated in Central and Eastern Africa, in the Great Lakes region. Surrounded by the Democratic Republic of Congo (West), Uganda (North), Tanzania and Burundi (South). It covers 26,338 Km2 of a very diverse landscape, ranging from dense equatorial forest on the volcanic slopes of the north-west of the country to tropical savannah in the East, along the Akagera river.

With an estimated population of about 12 million people (NISR, 2019), 52% of which are women, Rwanda has one of the highest population densities in Africa (458.75/km2). Rwanda has one of the most youthful population on the continent, with over 40% of the population under

the age of 30 (RPHC, 2012). The total number of households is 2,708, 000 of which 677,000 are headed by women (25%) and 2,031,000 are headed by men. The country is divided administratively into four provinces (Northern Province, Southern Province, Eastern Province, Western Province) and the City of Kigali, which are also further divided into 30 districts. Moreover, the districts are further divided into 416 Sectors.

Rwanda aspires to reach middle income country status by 2035. Rwanda experienced robust economic and social performances in the past decade prior to the COVID-19 pandemic, where growth averaged 7.2% (MINECOFIN, 2019). Rwanda's firm commitment to economic and social transformation will be carried out through a series of National strategies for Transformation (NST1) from 2018.

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Table 4- 2: Rwanda National Economic Indicators

Indicator	Description
GDP Growth rate	9.4 percent (2019, World Bank)
GDP per capita	$818 (2019, NISR)
GDP composition per sector	**Agriculture:** 30.9% (2017 est.), **industry**: 17.6% (2017 est.), **services**: 51.5% (2017 est.)
Total Labour force	6296625 in 2020
Agriculture labour force	61.68% in 2020
Industries	cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles,
Main Agriculture products	Coffee, pyrethrum, tea, flowers, beans, cassava banana, Irish potatoes, rice, wheat, sugarcane

Source: RDB, 2021; MINECOFIN, 2021

Rwanda's economy is mostly agrarian, followed by the service sector. The agriculture sector employs over 70% of the workforce. Coffee/Tea are the major export crop. The irrigation is practiced on both large scale in valleys and marshlands and in small scale, the latter is practiced at hill side for season C production (horticulture, maize, soy, etc).

4.2.1.2. Social Policy Framework for Water, Land, and Other Resources

The Government of Rwanda has expressed its continued commitment to promote social inclusion through enactment of laws, development of policies and strategies, as well as ratification and domestication of international commitments that promote human rights through

social inclusion strategies to integrate the needs of all disadvantaged groups in water and sanitation sector, but also in the equal right and access to other natural resources by all. The realized social achievements in the water sector were as a result of the following key frameworks:

• Law Governing Land in Rwanda (2013): Guarantees equal rights on land access for men and women. Land Ownership by Categories Only by Women Only by Men Both Spouses. Women's access to land tremendously contributed to their control over productive resources and access to loans using land as collateral.

- Law Governing Matrimonial Regimes, Donations and Successions (2016): Provides for equal rights and responsibilities over the management of familial properties and also allows both boys and girls to inherit their parent properties.
- National Water Supply Policy 2016 and the Water and Sanitation Sector Strategic Plan 2013/14 - 2017/18 commit to ensure equal participation and representation of women and men in the design and implementation of sector activities.
- National Policy and Strategy for Water Supply and Sanitation Services (2010) affirms that women's meaningful participation in WatSan tends to be beneficial for the sustainability of the infrastructure, given women's immediate interest in reliable functioning facilities. The implementation manual will also include guidance on environmental, social and gender issues to be taken into account during all stages of planning and execution, and on measures to ensure that local residents are not deprived of their right to access the existing natural sources of water

4.2.1.3. Poverty Context

Rwanda's strong focus on homegrown policies and initiatives has contributed to significant improvement in living standards. The poverty has declined from 77% in 2001 to 55% in 2017.

The life expectancy at birth improved from 29 in the mid-1990s to 69 in 2019. The maternal mortality has fallen from 1,270 per 100,000 live births in the 1990s to 290 in 2019. (WB, 2019). The cause or mortality and morbidity in Rwanda from water quality related diseases include bacterial diarrhea, hepatitis A, and typhoid fever (Check updates DHS, 2020).

Rwanda's social protection policies defines the vulnerable categories and these benefit from government support (Village Umurenge Program) that allow them to gradually retrieve from poverty. In total 4.4% of households in Rwanda are VUP beneficiaries. They include women

headed households, needy genocide survivors, elderly, disabled peoples, the historically marginalized peoples (indigenous peoples), and other vulnerable groups landless, children headed HH.

Girinka also known as "One cow per Poor Family" program initiated as a strategy to fight poverty with nutrition benefits has boosted the livestock count and the milk value chain in the country. The Agriculture Household Survey recorded 1,856,490 total cattle headcount (AHS, 2017). The cows are predominantly in zero grazing with exception of the large cattle ranch found mostly in the Eastern province.

Table 4- 3: National Water Access Indicators

Indicator	Male	Female	Total	Source
% of households with access to 'improved' water source	87.7	86.6	87.4	EICV5
Percentage of households with access to 'improved' sanitation facility	88	80.6	86.2	EICV5
Water demand/consumption for domestic use in Rwanda	-	-	38.61%	http://www.fao.org/rwanda/news/detail-events/en/c/1378711/
Water consumption for agriculture (Water use for agriculture (farming activities)	-	-	59.75%	http://www.fao.org/rwanda/news/detail-events/en/c/1378711/
Total livestock headcount (cattle)	-	-	1,856,490	(AHS)Agriculture household Survey 2017, NISR
Total livestock headcount (goats)	-	-	2,283,445	(AHS) 2017, NISR
Total livestock headcount (sheep)	-	-	499,316	(AHS)2017, NISR
Water consumption for animal watering	-	-	-	http://www.fao.org/rwanda/news/detail-events/en/c/1378711/
% of total irrigated land (National level)	-	-	6%	EICV5_ Thematic Report _Environment and Natural Resources
% of people participating in irrigation	-	-	10.10%	(AHS)Agriculture household Survey 2017, NISR

Access to improved water sources by male and female headed households is almost equal with 84.4% and 85.9% respectively. Interestingly, regarding the users of protected wells and springs, female headed households make the highest proportion than men.

Table 4- 4: Distribution (%) of Households by Main Source of Water

Main/ Improved source of water	Rwanda		Urban		Rural	
	Sex of Household Head					
	Female	Male	Female	Male	Female	Male
Internal pipe-born water	0.3	0.5	1.8	2.3	0.1	0.1
Pipe-born water in the compound	4.8	7.9	28.3	36.0	1.0	1.6
Public tap out of the compound	26.7	28.0	46.4	43.3	23.5	24.5
Protected spring/ Well	39.9	36.0	13.8	10.2	44.2	41.7

Source: 4th Rwanda Population and Housing Census, 2012.

4.2.2. Description of Socio-economic Conditions of Kagera Aquifer

Kagera aquifer boundaries stretches over parts of the eastern province. The surveyed aquifer crosses parts of five districts, Akagera River where Rwanda share its borders with Uganda, Tanzania and Burundi. The surface comprised in the aquifer area and the administrative boundaries at sector level, are shown in **Error! Reference source not found.**and **Error! Reference source not found.**. The Kagera aquifer lies in the eastern province of Rwanda, it traverses four of its 30 districts namely Nyagatare, Gatsibo, Kayonza and Kirehe covering between 10% to 16% of their areas and crossing over 29 sectors.

Table 4- 5: Administrative boundaries of the aquifer (excluding recharge zone)

District	Sectors	Land Area (Km^2)	Aquifer area within the District (Km^2)	% of the District Area underlain by the Aquifer
Nyagatare	Gatunda, Karama, Karangazi, Katabagemu, Matimba, Mimuli, Mukama, Musheri, Nyagatare, Rukomo, Rwempasha, Rwimiyaga, Tabagwe	1920.1	305.0	15.9
Gatsibo	Kabarore, Ngarama, Nyagihanga, Rwimbogo	1,582.3	155.4	9.8
Kayonza	Murundi, Mwiri, Ndego, Rwinkwavu	1,935.0	237.5	12.3

Kirehe	Gahara, Gatore, Kigarama, Mahama, Mpanga, Musaza, Nasho, Nyamugali	1,184.9	129.6	10.9

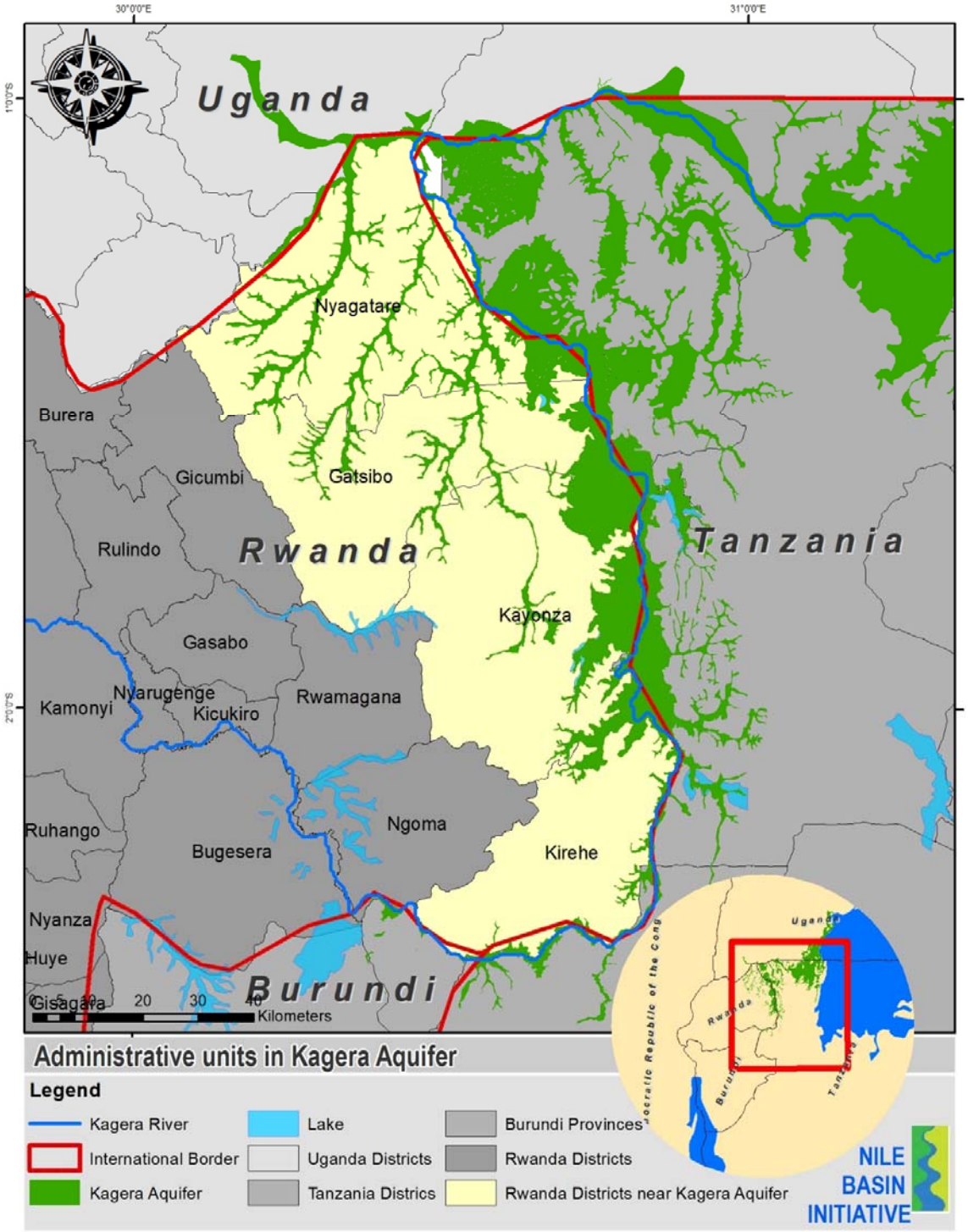

Figure 4- 2: Districts of Rwanda Crossed by Kagera Aquifer

4.2.2.1. Demographic Data and Population Settlements in the Area

The total population in the sectors crossed by the aquifer is 937,396, of which 456,645 are males, females account for 480,751 (51.3%). According to the RPHC, NISR, 2012, the total population in the province is 2,998,000, and country population is 11.8 million). It was estimated that population within the aquifer area within Rwanda was 124,161 in 2012 and 147,902 in 2020. The table 4-6 shows the population within the aquifer only per geographical location (district level). About 65% of the Kagera aquifer area within Rwanda is within Kyanzo and Nyagatare districts.

Table 4- 6: Total population structure in the aquifer districts

District	Total area in aquifer (km^2)	Total population			Pop. Density (Pop/Sq km)
		Female	Male	Total	
GATSIBO	155.4	5,489	5,142	10,631	68
KAYONZA	237.5	7,555	7,302	14,857	63
KIREHE	129.6	15,369	14,291	29,660	229
NYAGATARE	305.0	35,116	33,898	69,014	226
TOTAL	827.5	63,529	60,633	124,161	150

Source: (District Development Strategies, NISR data 2012, Pop.and housing census)

Considering the data from the National population census of 2012, number of HH per administrative entity the estimate total number of households in the aquifer area is 499,667. The national average annual population growth rate during (2002-2012) was 2.6%, it was 4.3 in the Eastern Province (aquifer area). The majority of the population in the aquifer are the youth between 15 and 34 years.

4.2.2.2. Population Settlements per Geographical Location

The population living in the aquifer area is settled in the main districts cities, business centres but also newly established planned settlements. The program of settlements is still at starting point, but with the consultative meeting with the district engineers of One Stop Centres, revealed that in 9 Sectors of Kirehe, counts 20 settlements, located in 20 cells in 30 villages, (see the annex 1).

Table 4- 7: Key population settlements location in the aquifer

Population settlements in the aquifer	Gatsibo	Kayonza	Kirehe	Nyagatare
Main urban city		Kayonza city	Kigina sector	Nyagatare secondary city
Other population settlements				Matimba, Karangazi, Rwimiyaga
HH with rainwater harvesting system			10%	
IDP Model Villages		Rugeyo 243 inhabitants (52 HH)	MPANGA IDP MV 80 inhabitants (20 HH); BUKORA IDP MV 16 inhabitants (4 HH); CYAMBWE IDP MV: 144 inhabitants (36 HH)	

Migration status: According to the desk review, only 41% of the households in the settlements of the aquifer area had been living in their actual village for more than 10 years. (Nelsap, 2013). After 1994, large numbers of returning families, especially from Tanzania and Uganda, settled in Eastern Province. Besides, internal migration has brought inhabitants from other provinces, in pursuit of farm employments and farm land scarcity in their districts.

4.2.2.3. Livelihood Conditions

The desk review showed that farming activities are the most dominant livelihood activity in the area. The main livelihoods structure in the aquifer are dominated by agriculture (maize, beans, rice, banana, and vegetables); livestock (cows, goats, pigs) and small business (boutique, restaurants, Man power. The consultations held at district level revealed other livelihoods activities namely: small scale fish farming that is practiced near East Rusumo and in Kigarama sector supplement the livelihood of farmers. According to the community consultations, the primary goal of fish production is to earn money. Brick making is another activity identified in at least two sectors of all districts comprised in the aquifer area namely Kayonza and Gatsibo. Handcrafts cooperatives (baskets made in papyrus) are a source of income particularly for women in the study zone. They are sold in local markets or handcraft shops in Kigali. The historically marginalized people are not fully integrated in other development activities, they make the main community of potters. Their products are sold locally and sometime these people are resettled in new IDP model villages given to the marginal and the poorest.

4.2.2.4. Poverty Status

Poverty status in the aquifer varies from one location to another depending on existing opportunities for economic activities. The Rwanda Labour force Survey, 2018 showed that the labour force participation rate is found to be more intense for males than females, and in urban area than rural area. The data per district is depicted in **Error! Reference source not found.**.

Table 4- 8: Poverty status in the aquifer area

Indicator	Gatsibo	Kayonza	Kirehe	Nyagatare
Poverty incidence rate	42.1%	26.7%	44.6%	44.8%
Extreme poverty	18.8%	8.5%	18.5%	20.1%
Labour force participation rate	49%	54.4%	53.7%	59.3

The assessment revealed that the project area is generally composed of various categories of vulnerable people comprised of women headed households, young people who don't have land or unemployed, people with disability, elderly people, people attended with chronically illness, and children headed household. Majority of these are included in the Village Umurenge Program (VUP), and are priority for resettlement in new model villages.

Table 4- 9: Vulnerable People (VUP) Screening - Beneficiaries of Social Safeguard Schemes

Vulnerable group category	**Description**	**Male**	**Female**	**Total**
VUP Beneficiaries				
Direct Support beneficiaries	Most vulnerable households without labour capacity elderly, disabled, widow)	3,159	5,187	8,246
Public works beneficiaries	Vulnerable households able laborers with very limited income in category 3.	6,749	4,385	11,134
Financial services beneficiaries	Beneficiaries of small credit schemes for business start up	-	-	
Total		9,908	9,572	19,380

These population makes the majority of the population living below the national poverty line (38.2%), and in extreme poverty (16%).

The vulnerability of HH is defined according to ubudehe categorization and three main vulnerable categories are identified to benefit social protection scheme named Village Umurenge Program. These are: Direct Support, Public works and financial services schemes.

4.2.3. Water demand and utilization in the aquifer

4.2.3.1. Water Utilization for Domestic Use

The aquifer area is predominantly located in the Eastern Province. According to EICV5, 84.4 % of the population in Eastern Province have access to safe drinking water. The distance walked to the source of safe drinking water ranges between 8.6-40 minutes. Most EICV5 data RPHS was collected in 2012, therefore it is not surprising that since then district have increased the number of HH connections to clean water, and new boreholes have been established in the last 5 years.

The aquifer area is located in the tropical savanna of the eastern province. In the East, the Kagera National Park is located around 1,300/1,400 meters (4,200/4,600 feet) above sea level. The Eastern Province is the driest region with the least precipitation records along the year (1,000 to 1,400 millimetres).

Figure 4-1: Young people fetching water at the local borehole, in Gatsibo District (Photo)

The findings from Focus group discussions revealed that ground water was mostly used for domestic use and animal watering.

The level of satisfaction by ground water users in the aquifer area was positive, the population in the aquifer use it as drinking water despite the reported salinity content in some boreholes. Access to water for domestic use is reflected by the data in the table below.

Information obtained through interviews with the local population revealed that in the circumstances where the households have no water on the premises, women and children (Young people of 8-17 years) are mostly responsible for the collection of water. The average time spent to collect the water ranges between 20-30 minutes, it was revealed to be higher (30-40 min) in Kayonza district and lowest in Gatsibo.

Rain water harvesting is a practice by many households to adapt to the early dry season in early dry season, however as revealed by the visited IDP village inhabitants in Mwili sector in Kayonza, they stay empty for months during the long dry season from July-September. Table 10 show the data of the number of HH that have access to water and sanitation facilities in the aquifer.

Table 4- 10: Water Access Indicators in the Aquifer Area

Indicator	Gatsibo	Kayonza	Kirehe	Nyagatare
% of HH using an improved water source	79.1%	88.1%	84.3%	80.4%
% of HH with access to improved sanitation	82.2%	83.9%	95.3%	94.7%
HH with rainwater harvesting system	7.2%	-	10%	6.2%
Average time to reach a water point (minutes)	15-20min	30-40 min	20-30 min	15-30min
Average total quantity of water used per HH/day (litters)	40	100	100	80

Source: NISR, EICV5

Access to water in Ngoma is 91% according to District survey 2021, from 84.4 % of EICV 4 report. Access to sanitation facilities in Ngoma was 77.1% (Source DDS 2018-2024). Access to water in Nyagatare is 80.4%, and access to sanitation facilities 94.7% (Source DDS 2018-2024). However, district consultation revealed that the access to water stands at 60%. (District Report 2021). This drop can be attributed to non-operational boreholes. District consultations in Kirehe conducted during the SADA study revealed that the access to water stands at 68%. (District Report 2021). A few districts were able to share the number and location of boreholes established in the Aquifer. It was found that an estimate of 120-400 HH are served by one borehole in the aquifer area.

Table 4- 11: Water Sources in the Aquifer

District	Piped water system	Public well/borehole (manual or motorized)	Improved/Unimproved spring	River	Lake/dam	Estimate No. of users/ 1borehole (HH)
Gatsibo	X	X		X	X	60
Kayonza	X	X		X	X	120
Kirehe	X	X	X	X	X	120
Nyagatare	X	X		X		200

Source: Field consultations at District and community level

Error! Reference source not found. shows that the aquifer counts about 414 boreholes , of which 75 were new (established in the last 5 years).

Table 4- 12: Survey findings on boreholes establishment trend in the aquifer

District	Number of total boreholes in the area	New boreholes established in past 3 years	Year of establishment of new BH	Involved partners/sponsors of boreholes
Gatsibo	29	6	2020-2021	China Aid
Kayonza	55	9	2021	MINAGRI/RAB KIIMP
Kirehe	120	-	2019-2020	JICA, China Aid
Nyagatare	240	60	Before 2015	China Aid, Water Aid, MINAGRI/RDDP, World Vision, Rwanda for Water

Source: District reports 2021

District consultations revealed that stakeholders or sponsoring organizations have contributed to establish boreholes in the district. These stakeholders include the national water utility WASAC, but also government projects, international and bilateral organizations, i.e.: JICA and Chinese aid in Kirehe Districts.

The aquifer zone of Nyagatare district has the highest number of boreholes (240), Kayonza District has 55 total boreholes, 14 (Afridev), 24 (Indian Mark), 5 use solar pump. Besides, there

are additional 9 boreholes under construction powered by solar in 3 selected sectors closed to Akagera River implemented by of MINAGRI/RAB/KIIWP. Rwimbogo counts 29 boreholes but most of them are very old and damaged only 6 are operational and were established in 2020-2021. While this information underlines the spreading use of groundwater to meet domestic water need in the project area. It should be noted that the cited groundwater development is not limited to the Kagera Aquifer and some wells are drilled in the fractured basement complex.

Figure 4-2: Ongoing boreholes drilling works in Ndego Sector, Kayonza (Photo)

In general water price in the aquifer varies according to type of water source. The average cost of drinking water from the borehole in the aquifer is 20 Frw per 20 liters (1Rwf/1 liter). In Gatsibo, Rwimbogo, 100 Rwf/ 20L jerrican was reported.

Community management was practiced whereby each household (HH) pays a monthly subscription of 1000 Frws per household for solar powered borehole, 200 Frws per cow per month and for piped water. The price of borehole water is 500/month/HH, 25/jerrycan in District pipe where they use diesel pump, 20F/jerrican where electricity is used.

4.2.3.2. Water demand and utilization for Agriculture

The land use in the aquifer is predominantly agrarian system, salvo-pastoralism with a significant occupation of Akagera National Park in the savanna. The irrigated lands in valleys

and marshlands use surface water, for rice and seasonal crop production that use small scale irrigation. Many actors have contributed to the construction of water dams: i.e.: KWAMP Project.

Table 4- 13: Water Demand for Agriculture/Irrigation

Indicator	Gatsibo	Kayonza	Kirehe	Ngoma	Nyagatare
% of land under land consolidation	16.8	10.1%	33%	-	7.9%
% of irrigated land	3.7%	14.9%	5.8%	-	4.1%
Irrigated land in (Ha)	1,630	-	3,432	1,722	5,250

Source: EICV 5, NISR, 2012

According to District development strategies, and confirmed by district consultations, all irrigated lands in the aquifer represent more than 12,034 Ha. Irrigation use surface water and valley dams allow continued production (season C) along the year. The district consultations and the focus group discussions revealed that few case of ground water use for irrigation in Kayonza and Nyagatare. The main irrigated crops in the area dominated by rice, vegetables, maize, beans, and soybeans. Other crops produced include ground nuts, cassava, banana, and coffee.

Figure 4-3: Marshland Irrigation: Sagate Dam, constructed to facilitate the farmers for the irrigation of Rice in Musaza and Gatore Sectors/ Kirehe District (Photo)

Figure 4-4: Hillside irrigation system: Kinoni 2 dam constructed to facilitate hillside irrigation in Kigara Sector (Photo)

4.2.3.3. Water demand and use for Livestock

Animal watering comes as one of the main utilizations of ground water in the aquifer. An estimate of 80-100 Liters is used per day per day per cow. In addition to the ground water, livestock owners also use piped water from WASAC, water from the rivers and irrigation dams, and rainwater harvesting. Table: Livestock and water consumption

As everywhere else in the Eastern province, agriculture and livestock constitute the spinal column of the economy in the aquifer area, where more than 70% of the inhabitants depends on agriculture sector and have some type of livestock. The table below consolidate the number of livestock in the aquifer dis-aggregated by of cattle head count, and small ruminants.

Figure 4-5: Use of ground water for animal watering in Murundi Sector, Buhabwa cell, Gakoma village. Kayonza. (Photo)

Table 4- 14: Number of livestock in the aquifer area

Livestock	Gatsibo	Kayonza	Kirehe	Nyagatare	Water consumption for watering animal per day (L/day)
Cattle headcount in the aquifer	14,131	33,144	28,558	53,030	40 l/day local breeds 70-80l improved breeds
Small ruminants: Goats, pigs in the aquifer	1,285	28,927	73,902	44,927	4-5 litters/day
Source of water for livestock	boreholes or spring water	Rivers, groundwater, rain water harvesting		Ground water, river, WASAC, RWH	

(Source: District Reports, 2021)

Water scarcity is the main challenge for animal watering and domestic use in the aquifer. Water from dams, and lakes is also used in the absence of proximity wells and surface water sources are almost always jointly used by people and cattle. Although women and children are in charge of fetching water, young men use bicycles for water transportation in case long distance is required to reach the water source. This water is sold to livestock owners and can sometimes reach 100 Rwf depending on the distance.

Figure 4-6: (Left) Rwakigeli Lake, Ndego Sector, Karambi Cell, Kumunini village; (Right) Farmers and cattle sharing the water on the same basin (Photos)

Wild life and national park occupation in the aquifer: Akagera National Park is an ecotourism activity in the aquifer that contribute to the economic development and poverty reduction projects for the local inhabitants. Its revenues from Rwanda development Board (RDB) help the inhabitants of Akagera. Besides Akagera National Park. Other tourism attractions include Lake Muhazi, Urutare rwa Ngarama, Utubindi twa Ruganzu twa Rubona & Kibondo.

4.2.3.4. Water User Industries in the Area

This study revealed other unconventional use of water in the area, namely: mining, brick making, industries and factories, coffee washing stations. The mining activities however predominately utilize surface water. The mining activities are found in Kayonza Murundi Sector.

Table 4- 15: Water Utilization per Industry and Administrative Location

Activity /industry	District	Sector	Cell	Village
Mining	Kayonza	Mwiri	Nyamugali	Gasarabwayi
		Murundi	Buhwa	Mucucu
		Murundi	Karambi	Nyagashanga
	Kirehe	Kigina	Rugarama	Buhwaga
Brick making	Kayonza	Kigarama	Nyankurazo	Rusumo
		Murundi	Karambi	Nyagashanga
	Gatsibo	Rwimbogo	Nyamatete Kiburara	Rwimbogo Isangano
	Kirehe	Gatore	Curazo	Nyarwogo
Industry/factory	Kirehe	Kigina	Rwanteru	Rwanteru 2
	Gatsibo	Rwimbogo	Kiburana	Isangano
	Nyagatare	Kabarondo		
Coffee washing stations	Kirehe	Gahara	Butezi	Kijumbura
		Musaza	Musaza	Musaza
		Kigarama	Kigarama	Kigarama
		Gatore	Curazo	Gatega
Others				

Source: (District Development Strategies 2018-2023)

4.2.4. Water Governance Structures

4.2.4.1. Catchment committees

The water Law Nº48/2018 of 13/08/2018 has determines the organization and functioning of Catchment Committees. The Ministerial Order determining the establishment and functioning of these Catchment Committees is not yet released. The catchment committee that will be mandated to coordinate water management in the catchments were not yet established in

surveyed aquifer area. These Catchment committees once established will coordinate the management of all water resources in the catchment, including the existing water user committees/ associations.

Prior to the establishment of Catchment committees, the Ministerial Order Nº005/16.01 OF 24/05/2013 determining the organization and functioning of hydrographic basin committees was enacted. Currently, hydrographic basin committees have been established at sector level in the whole country.

4.2.4.2. Water User Committees

Local structures that manage ground water are named Water User committees (WUC). These are established at each borehole level, Data collection through district consultations in Nyagatare explained that Water User Committees (WUC) are established from the water point (wells or boreholes), WUC are also established at sector level. The cells and sectors staff make monitoring while at District level there is WASH Board composed of Vice Mayor in charge of Economy, WASAC Representative, JADF staff, Watsan officer who is secretary of the body, the Hygiene officer, and the Sanitation Engineer.

The most challenging factor identified for water governance in general is the lack of coordination of established community water management structures. Moreover, majority of water user committees established at the boreholes are not operational. Which impact on the maintenance of wells and the harmony in water pricing.

4.2.4.3. Water User Associations

The surface water governance structure is the water user associations that manage water for irrigated farms. Water user associations (WUA) members informed that they benefit sufficient training from districts and stakeholders to help their effective management of irrigation water in marshlands. Compared to the WUC, the WUA revealed to be stronger, well organized in registered Cooperatives despite the presence of non-farmers members in these committees. The annex 10 show WUA Cooperatives established in the aquifer per each crop farming cooperative.

The knowledge gap: Discussions with WASH Officers regarding the training needs identified for the water user committees: Operation and maintenance of water infrastructures, administrative and financial management, and sustainable management of boreholes. Basic

water testing, irrigation techniques, and water harvesting techniques, water treatment and storage techniques.

4.2.5. Groundwater challenges and Impact on Vulnerable Groups

4.2.5.1. Groundwater impact, Economic and Social Benefits

The use of Groundwater contributes to the reduction of the risks of waterborne diseases, as it is generally less susceptible to contamination when compared to surface water sources. It is generally of better quality than other alternative water sources used by the community during dry season. (Water from marshland, rainwater storage in traditional RWH).

As a perennial source of water, groundwater may be a source of conjunctive irrigation for small scale farms to avoid crop stress thus increasing crop productivity. Use of groundwater for livestock watering shall improve milk productivity and animal health.

4.2.5.2. Vulnerable people's rights to the land, water and other resources

The development of groundwater resources may affect the rights of traditional land owners and impede their access to natural resources. Compensation of vulnerable groups whose access land or natural resources is caused by groundwater developments are entitled to compensation. Lack of access to clean water on the other hand also comes at a cost to communities as people who cannot access safe water are forced to rely on unclean stagnant surface water for their domestic use. This can lead to increased health diseases at the community level. The lives of the most vulnerable becomes exposed to water borne diseases from unsafe water in the swamps (bilharzia) as they lack sufficient household labour to help carry, manage and clean water before use.

Women and children in particular suffer as they travel long distances to fetch water from the neighbouring areas. The result is usually an increased number of drop out children or missing classes at the community level. Water scarcity also hinder some livelihood activities such as pottery.

The community perceptions of the quality of groundwater from local borehole/pumped well was found to be positive in general, the water pumped is clean compared to other alternatives such as stagnant water from marshlands. Water salinity have been reported by local communities but this did not sway them from using the resource.

The local population affirmed that they use methods of boiling, filtering, storing, covering the water for cleaning water safe for use and/or consumption. Despite that, (intestinal worms, bilharzia disease prevalence were reported in the study area. According to the District Development Strategies, the prevalence of water borne diseases is significant. i.e.: Kirehe district has 11% and 4% prevalence of diarrhea among children under five years.

4.2.5.3. Role of women in the use, management of groundwater resource

Women makes the main agriculture workforce (86%), with lowest levels of schooling and highest level of illiteracy (23%). As a result, women remain in subsistence agriculture and are less involved in irrigation than the men, and feel the impact of water scarcity compared to the men. Women from disadvantaged groups lack the capacity and literacy to participate in best earning activities including agri-business, as the majority are employed in low paid positions in secondary agriculture (NELSAP, 2013).

Although the women are members of water users' committees, community consultations revealed that they occupy tasks like secretary, treasury and in some of WUAs and WUC women are vice chairs. However, the illiteracy and limited training cannot allow a significant negotiation skills and decision making to advocate for their strategic gender needs. There is usually a skill gap in managing water at community and HH level. This is attributed to the limited training provided to WUC members..

Women occupy roles and responsibilities that expose them to face water shortage shocks in case of climate change. They are in charge of catering for the livestock in zero grazing, while men are responsible for watering the cattle in farm ranching. The impact to most of them is a vicious cycle of poverty that transcend generations;

In the water and sanitation sector a gender-conscious approach is needed due to the fact that women are in charge of providing water in the household, hygiene and healthcare according to the traditional division of labour. Women are therefore most affected when water supplies fail and sanitation is poor. On the other hand, women are typically under-represented in decision making, in the management of water and sanitation infrastructure and in training and educational activities.

In general water supply and sanitation interventions are known to have a positive impact on women, by improving living conditions, reducing the work load (time to fetch water, caring of the sick), improving the hygienic conditions at schools and potentially enhancing women's participation and empowerment. On the other hand, a strong involvement of women tends to be

beneficial for the sustainability of water and sanitation infrastructure since for the cited reasons women have a strong and immediate interest in reliably functioning facilities.

Global experience and the SDGs also suggest that gender equality must go beyond addressing equal access to domestic water and sanitation services only. It is important that policies and strategies should target economic equality through water for productive uses, equality in decision-making, equality in contracts, employment opportunities in senior positions of water institutions, opportunities for consultancy and the general business opportunities around water and sanitation infrastructure development as a whole.

However, the findings from desk review shows that previous water related projects do not always integrate gender dimension and women empowerment, and it was found that no specific project outcome for diversifying income sources for women and other vulnerable categories. Therefore, further projects in water sector should undertakes measures to ensure by appropriate guidelines and indicators that:

- Women are adequately represented in decision making processes as well as in training programs;
- Participation of women in committees and in the management of water schemes, including in high-level positions, is promoted;
- The needs, priorities and interests of women are taken into account in all planning processes, implementation strategies, training materials, etc.;
- Local implementation partners are sensitized and trained on gender issues;
- The water and sanitation approach considers menstrual requirements for woman and adolescent girls with emphasis on educational premises.

4.3. Uganda

4.3.1. Country Socio-economic Background

4.3.1.1. Location, Size, and Administration

Uganda is located in East Africa and lies across the equator, about 800 kilometres inland from the Indian Ocean. It lies between 10° 29′ South and 40° 12′ North latitude, 29° 34′ East and 35° 00′ East longitude. The country is landlocked, bordered by Kenya in the East; South Sudan in the North; Democratic Republic of Congo in the West; Tanzania in the South; and Rwanda in South West. It has a total area of 241,551 square kilometres, of which the land area covers 200,523 square kilometres. As of July 2020, Uganda was divided into 135 districts and the

capital city of Kampala, which are grouped into four administrative regions (GoU, 2017; Ministry of Local Government Fact Sheet, 2017). Since 2005, the Ugandan government has been in the process of dividing districts into smaller units. This decentralization is intended to prevent resources from being distributed primarily to chief towns and leaving the remainder of each district neglected (Ocwich, 2005). The districts are further subdivided into Counties, Sub counties and Parishes. The role of these local governments is to implement and monitor government programmes at the respective levels. Overtime, the administrative units have been sub-divided with the aim of easing administration and improving the delivery of services. The head of elected official in a district is the chairperson Local Council Five (LCV). In 2020, Parliament approved 15 new cities for Uganda (The Independent, April 28, 2020).

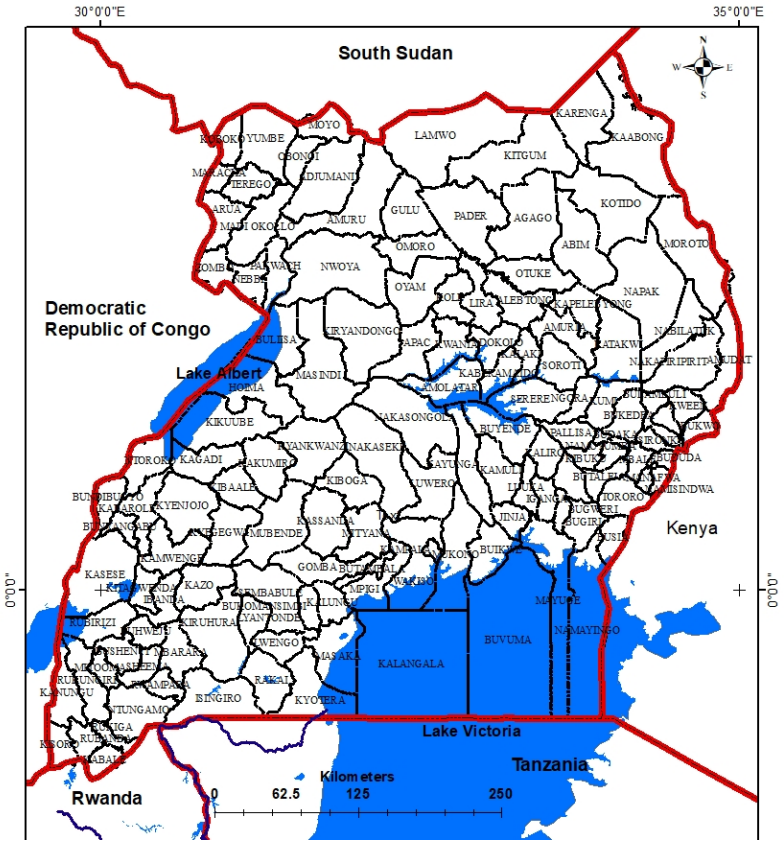

Figure 4-7: Map of Uganda showing districts as of 1 July 2016 (Source: UBOS (2014))

4.3.1.2. Economic Overview

According to the World Bank (online), Uganda's real gross domestic product (GDP) grew at 2.9% in Finical Year (FY) 2020, less than half the 6.8% recorded in FY2019, due to the effects of the COVID-19 (coronavirus) pandemic. GDP is expected to grow at a similar level in FY2021. Economic activity stalled during the latter part of FY2020 due to a domestic lockdown that lasted more than four months, border closures for all but essential cargo, and the spill over

effects of disruptions to global demand and supply chains. This resulted in a sharp contraction in public investment and deceleration in private consumption, which hit the industrial and service sectors hard, particularly the informal service sector.

On a calendar year basis, real GDP growth was expected to contract by up to 1% in 2020, compared to 7.5% growth in 2019, and, as a result, real per capita GDP growth is expected to contract by about 4.5%. Even if GDP growth rebounds strongly by 2022, the level of per capita GDP is likely to remain well below its pre-COVID trajectory.

Furthermore, the World Bank observed that the medium-term outlook for Uganda had worsened considerably due to the impact of COVID-19, and risks are tilted heavily to the downside. If the impact of COVID-19 lasts longer globally, or the virus spreads more widely in Uganda, this could deter the recovery in Uganda's exports, adversely impact a rebound in foreign direct investment (FDI), tourism and remittances, and further depress productivity and hence the domestic economic recovery. Such developments could lead to more severe social and economic impacts and amplify external and fiscal imbalances.

Furthermore, while lower oil prices are beneficial to Uganda's trade balance and real growth outcomes, they also mean increasing risks to investment plans in the Ugandan oil sector, which was expected to start producing and exporting by 2024/25. Finally, heightened uncertainty in the post-2021 election period and weather shocks could further exacerbate the aforementioned risks.

4.3.1.3. Population Characteristics and Distribution

According to Uganda Bureau of Statistics (UBOS) (2018), Uganda's population was estimated at 37.7 million of which 52 percent were females. The proportion of the population aged below 15 years constituted slightly more than half of the total population and the dependency ratio declined from 107 in 2012/13 to 97 in 2016/17. Three in every ten households (31%) were headed by females. Only one in every ten Ugandans aged less than 18 years (11%) had a birth certificate. The highest percentage of Ugandans aged less than 18 years who had birth certificates were in the Central region (12%) and the lowest percentage were in the Eastern region (8%).

UBOS (2018) noted that the population distribution shows the spatial spread of people within a given geographical area. Concerns over spatial distribution of the population are virtual in planning at the national, regional and district levels. Uganda's population is still predominantly rural (76%). This compares well with the findings of the 2014 Uganda Population and Housing

Census (79%). The proportion of the population living in urban areas largely remained the same between 2012/13 and 2016/17. Eastern and Western region had the larger share of the population (26% each respectively) compared to other regions. Kampala's comprised about four percent of the population in 2016/17 and has remained the same since 2012/13. The increase in the proportion of the urban population is attributed to the creation of more urban centres.

According to UBOS (2018), children aged less than 13 years constitute 46 percent of Uganda's population while the age-group 14 – 64 years accounts for 51 percent of the population. Regardless of residence, the age-group 14 – 64 years constitutes the largest percentage of the population i.e., rural areas (49%) and urban areas (58%). Compared to other sub-regions, Kampala had the highest percentage of the population aged 14 – 64 years (64%) while Karamoja had the lowest (42%). Overall, the household population aged 14 – 64 years slight increased from 48 percent in 2012/13 to 51 percent in 2016/17. Age dependency ratio, is the ratio of the dependent population (0 to 13 years and 65+ years) to the proportion of economically productive population (15 to 64 years). Age dependency ratios are calculated and used as proxy estimates for actual dependency in the population because a large proportion of persons included in the non-dependent age-group (15 to 64 years) could also be dependent.

4.3.1.4. Education

Based on statistics by UBOS (2018), the literacy rate for persons aged 10 years and above was estimated at 74 percent - a slight increase from 70 percent in the 2012/13. Literacy rate was higher for males than females. The overall Gross Enrolment ratio was estimated at 117 percent and was highest in the sub-regions of Teso (139%), Bukedi (133%) and West Nile (131%). Forty-three percent of persons aged 6 – 12 years had never attended school because their parents considered them too young for school. Furthermore, 12 percent of persons aged 15 years and above did not have formal education, while five percent of persons in the school-going-age (6 to 24 years) had never attended school. About half of persons aged 6 - 24 years in Karamoja had never attended school.

4.3.1.5. Labour force characteristics

According to UBOS (2018), the working age population increased to 19.1 million in 2016/17 from 16.5 million in 2012/13. The size of the working population was 15.1 million persons, an increase from 14.0 million in 2012/13. Overall, the working population constituted 79 percent of the of the working age population. The total population in employment was estimated at 9.1

million people of whom 46 percent were females. Overall, the employed population constituted 48 percent of the working age population. Overall, both LFPR and EPR declined from 62 percent to 52 percent and from 53 percent to 48 percent in 2012/13 to 2016/17 respectively. In regards to sub-regions, LFPR and EPR were highest in Kampala at 78 percent and 62 percent but lowest in Bukedi at 25 percent and 24 percent respectively. Overall unemployment rate was estimated at 9 percent. Kampala had the highest unemployment rates (21%) while West Nile sub-region had the least (3%). Unemployment was highest amongst persons aged 15 – 24 years (17%) while the age group 31 – 64 years had the lowest (5%). Overall, close to four in every ten persons (38%) was in employment (working for pay or profit) were in paid employment – i.e., 30 percent who were paid employee (not casual labourer in agriculture) and another 8 percent who were paid employee (casual labourer in agriculture).

UBOS (2018) concluded that overall, elementary occupation workers (34%) had the highest proportion of employed population followed by skilled service and sales workers (24%) while agricultural, forestry and fishery workers (18%). The agriculture sector accounted for the largest share of employment (36%) while other services other than trade sector ranked second with 29 percent of people reportedly employed in the sector. Overall, the median wage of an employee was UGX 168,000 per month. The median wages of the working population in urban areas (UGX 220,000) were almost double that of their rural counterparts (UGX 120,000). Persons in paid employment in the Western region received the lowest median monthly earnings (UGX 110,000) while those in Kampala earned the highest (UGX 300,000).

4.3.1.6. Health

According to UBOS (2018), overall, there was a reduction in the proportion of the population who were ill or injured by 12 percentage points; from 40 percent in 2012/13 (40%) to 28 percent in 2016/17. The female population (30%) was more likely have suffered from illness or injury compared with their male counterparts (26%). Malaria/fever (26%), and respiratory infections (18%), followed by severe headache (7%) were the most prevalent symptoms suffered. The prevalence of Malaria was highest in the Teso sub-region (49%) and Kigezi (38%) while in Bukedi sub-region (5%) registered the lowest. Overall, about four percent of persons aged 10 years and above reported that they suffer from high blood pressure, two percent from heart disease while about one percent indicated that they suffer from diabetes. The prevalence of NCDs increases with age – for instance 26 percent of the elderly suffered from any one of the NCDs compared to those in the youthful ages i.e., one percent for those age 10 – 24 years and 5 percent for those 25 – 39 years.

Regarding substance abuse, UBOS (2018) report noted that overall, about five percent of persons aged 10 years and above were using or had used tobacco in the past; 17 percent of Ugandans consume(d) Alcohol; while one percent of Ugandans currently use or used other drugs and narcotics. Health care seeking behavior was highest in sub-regions of Central I (90%), Busoga (93%), Kigezi (88%) and lowest in Karamoja (74%), Elgon (65%) and Bukedi (60%). In addition, close to a half (48%) of the persons that had suffered illness/injury and had sought healthcare went to private hospitals/clinics followed by Government health facilities – Hospital and Health Centres (34%). Furthermore, access to healthcare varied across sub-regions with over 34 percent of the persons in Acholi travelling a distance of at least 5 kilometers to access health care when they fell sick. In Uganda, only 11 percent of the population age 15 years and above are aware of health insurance service while only five percent were covered under health insurance. As regards households' expenditure on health, in real terms, there was a reduction in the average monthly household expenditure on health care services from UGX 27,600 in 2012/13 to UGX 22,800 in 2016/17.

4.3.1.7. Food Consumption and Food Security

UBOS (2018) report observed that Uganda's Mean Dietary Energy Consumption (DEC) stands at 2,226 kcal/person/day with female-headed households consuming slightly more calories than the male-headed households (2,241 and 2,220 kcal/person/day respectively). Considering the source of food, overall, food purchases (57%) contribute the largest share to the DEC followed by own-produced food (37%) with food received in-kind and food consumed away-from-home constituting the remaining 8 percent. The share of the DEC from food purchases was much higher in urban areas (77%) while rural areas had a larger share of the DEC from own-produced food (42%). Across sub-regions, households in Kampala (88%) had the highest share of their DEC from food purchases, those in Kigezi (53%) had the highest share of their DEC from own-produced food while those in Karamoja (11%) had a significant share of their DEC from food received in-kind. Overall, 37 percent of households in Ugandans were food poor with the highest cases recorded in Karamoja (70%) and Bukedi sub-regions (58%) while Ankole (14%) had the fewest. Rural households were nearly twice as likely to be food poor compared with their urban counterparts (40% and 26% respectively).

4.3.1.8. Household Expenditure and Welfare

Furthermore, UBOS (2018) report stressed that Uganda's average household monthly expenditure slightly dropped from UGX 328,200 in 2012/13 to UGX 325,800 in 2016/17, representing a marginal decline in monthly consumption expenditure between the two periods.

The proportion of the population living in poverty increased from 19.7 percent in 2012/13 to 21.4 percent in 2016/17 an equivalent of about 10 million people living below the poverty line. The increase in poverty was most prominent in the Eastern region than in Northern region which had consistently been the poorest region in the country. Specifically, poverty was highest in the sub-regions of Karamoja (60.2%), Busoga (37.5%) and Bukedi (43.7%) while Kampala (2.6%), Wakiso district (2.7%) and Ankole (6.8%). The proportion of people living in poverty significantly increased in absolute terms. The Northern region registered the most significant decline in poverty from about 44 percent in 2012/13 to 33 percent in 2016/17. The income inequality increased in all regions between 2012/13 and 2016/17.

4.3.1.9. Household Assets, Income Sources and Financial Services

The UBOS Report found out that the majority of owner-occupied houses (41%) were jointly owned by male and female household members. Ownership of bicycles, radios, motorcycles and cars was mostly dominated by males. Overall, 43 percent of households reported subsistence farming as their major source of income while one in every four households (25%) reported wage employment as the main source of income. Forty-one percent of respondents perceived savings as "putting money in a special place or account for the money to be safe" while about a third (30%) perceived savings as "putting money in an activity or somewhere so that it can yield returns". Keeping money at home/secret place (33%) was the most commonly used mechanism for saving followed by saving with VSLAs (16%). Overall, nearly one in every four persons aged 18 years and above (23%) had ever borrowed/got money to be paid back later in the 12 months preceding the survey. The common types of loans/credit obtained were personal loans (33%), goods obtained on credit (25%) and credit from friends (22%). One in every four persons aged 18 years and above (25%) who sought a loan/credit did so to buy consumption goods and services while 23 percent borrowed to pay education expenses. Seventy-five percent of the household population aged 16 years and above are knowledgeable about mobile money although only 59 percent of them are registered mobile money users. MTN money (75%) followed by Airtel (42%) was the most commonly used mobile money service by persons aged 16 years and above.

4.3.1.10. Housing and Household Conditions

Overall, according to UBOS (2018) report, 72 percent of households in Uganda live in owner occupied dwellings. The majority of households in rural areas were living in owner occupied dwellings (83%) while in urban areas it was 44 percent. Dwellings with iron sheet roofs accounted for 75 percent while those with thatched roofs were 24 percent. Two thirds of the

households (67%) lived in dwellings with brick walls while 59 percent lived in structures with floors made of earth. The use of 'tadooba' (canister wick lamp) for lighting declined from 66 percent in 2012/13 to 28 percent in 2016/17 while the use of grid electricity, solar and dry cells/batteries increased. Firewood and charcoal combined constituted the main source of fuel for cooking for 94 percent of the households. In addition, 83 percent of households used pit latrines, only three percent used flush toilets while about seven percent still use the bush because they do not have toilets. Also, 80 percent of households had access to improved sources of drinking water with 97 percent of the main drinking water sources within 3.0 kilometres. The burden of fetching water mostly rests on female adults and the girl child.

4.3.1.11. Vulnerable Groups and Social Protection

UBOS (2018) repot reveals that one in every ten (11%) children aged less than 18 years were orphaned i.e., they have lost either one or both parents which translates to approximately 2.4 million orphaned children in Uganda. Orphan hood increases with the increase in age of the child i.e., it ranges from four percent for those 0 - 4 years to 23 percent for 15 - 17 years. Karamoja (17%), Acholi (19%) and Lango (16%) sub-regions had the highest incidence of orphanhood. Out of 8.5 million households in Uganda, 1.3 million had an orphan, constituting about 15 percent of all households. Overall, about 14 percent of the children aged 5 - 17 years were in child labour. The number of older persons increased from about 1.6 million in 2012/13 to 1.7 million in 2016/17. Older persons constitute about five percent of the population of Uganda. Close to half of the older persons (42%) had never been to school and these were predominantly females (57%) compared to their male counterparts (23%). Overall, two in every ten persons (19%) aged 60 years and above was living below the poverty line with the majority in the Eastern region (29%). Overall, there were about 1.090 million widows in Uganda constituting 12 percent of the total population of women aged 15 years and above. The Northern region has consistently had the highest percentage of widows since 2009/10 – i.e., it increased from 13 percent in 2009/10 to 15 percent in 2016/17. On the other hand, the proportion of widows in Kampala dropped from seven percent in 2009/10 to six percent in 2016/17 which could imply that widows in Kampala were more likely to remarry.

4.3.1.12. Community Characteristics

UBOS (2018) report stated that overall, only 18 percent of the communities reported having access to markets that sell agricultural produce and markets that sell non-agricultural produce within the Local Council (LC) I respectively. The availability of a Police Station/Post within the LC I, increased from 12 percent of communities that reported existence of the facility in

2012/13 to 17 percent in 2016/17. There was an increase in the proportion of communities that indicated the availability of paved national roads, from 52 percent in 2012/13 to 73 percent in 2016/17. Availability of unpaved national roads increased from 60 percent to 67 percent while that of feeder/district roads increased from 81 percent to 89 percent respectively. Only five percent of communities indicated that they that had access to agricultural extension workers within their LC I, dropped from 21 percent in 2012/13.

4.3.2. Socio-economic Environment in Kagera Aquifer Area within Uganda

4.3.2.1. Extent of Kagera Aquifer in Uganda

The Kagera aquifer effectively crosses six of the 136 districts of Uganda namely , Rakai, Isingiro, Ntungamo, Masaka and Kyotera. (Figure 4-10). Most of the areal extent of the Kagera aquifer within Uganda lies in Kyotera district (69%) where its spans about 39% of the total area of the district. The total population within the aquifer area in the six districts of Uganda is estimated to be about 192,000 by 2020. Table 4-16 shows the areal distribution of the Kagera Aquifer within the districts of Uganda.

Table 4- 16: Areal Extent and Population of Kagera Aquifer within Districts of Uganda

Sector Name	Sector Area (Km^2)	Sector Population	Area of Aquifer within Sector	% Aquifer extent in Uganda within Administrative Unit	Population within Aquifer area within Administrative Unit
Isingiro	2,650	596,400	113.0	8.1	25,438
Kyotera	2,448	261,000	955.6	68.7	101,884
Lwengo	1,024	290,500	4.4	0.3	1,251
Masaka	2,197	335,700	102.5	7.4	15,662
Ntungamo	2,025	540,800	81.7	5.9	21,816
Rakai	1,592	317,700	133.4	9.6	26,615

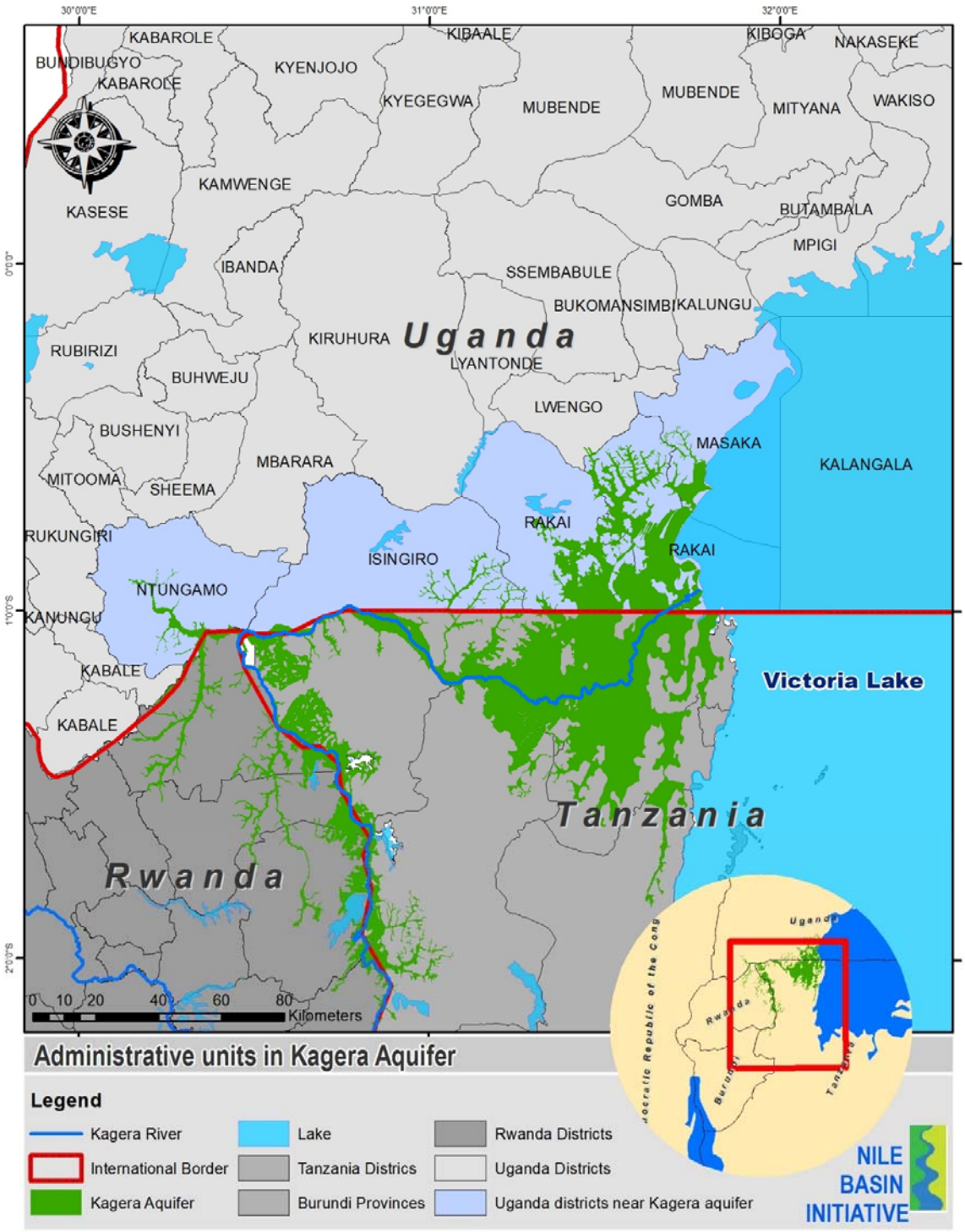

Figure 4-8: Uganda Districts Spanned by the Kagera Aquifer

4.3.3. Indigenous stakeholders found in the study area

In the Kagera aquifer areas, the main Indigenous group there are the Batwa. The Batwa, also known as Twa are found around Kagera aquifer, in western Uganda. They were evicted forcefully from the forests where they lived all their lives in 1991 to pave way for the Bwindi and Mgahinga forests. Since then, many of them are scattered around the surrounding districts,

with limited livelihoods opportunities. They are estimated to be around 6,800. Since then, they have faced many challenges coping up with the new ways of life outside the forests. The Batwa have been denied the right to access their ancestral land. As such, they live a hopeless and meaningless life. The Indigenous peoples of Uganda experience challenges, especially in relation to the lack of security in land tenure and marginalization in terms of political representation. They have experienced the indigence and historical injustices induced by the state caused by the creation of conservation areas in Uganda.

They have also suffered various human rights violations, including continued forced evictions and exclusion of ancestral lands without consultation with the community, consent or adequate compensation, violence and destruction of homes and property, including the denial of livestock of their livelihoods and their livelihoods, cultural and religious values, exclusion of ancestral lands and natural resources. As a result, they continue to live with impoverishment, social and the 1995 Constitution does not offer express protection for Indigenous peoples, but Article 32 imposes a mandatory duty on the state to take affirmative measures in favour of historically disadvantaged and discriminated groups. This provision, which was initially designed and conceived to address the historical disadvantages of children, persons with disabilities and women, is the basic legal source of affirmative action in favour of Indigenous peoples in Uganda. The Land Law of 1998 and the National Environmental Statute of 1995 protect customary interests in land and traditional uses of forests. However, these laws also authorize the government to exclude human activities in any forest area by declaring it a protected forest, thus nullifying the customary rights to the land of Indigenous peoples.

4.3.4. The key findings on Social economic context of the local communities living within the areas of Kagera aquifer

In Kyotera District, 77.6% of people living in rural area depend on subsistence farming; crop and livestock production. The main food crops include finger millet, maize, beans, bananas, sorghum, sweet potatoes, Irish potatoes, cassava and groundnuts (NELSAP, 2021). Coffee is the major cash crop. Other crops include fruits and vegetables such as passion fruit, tomatoes, pineapples, onions and cabbage are also grown. Generally, Agro-forestry is dominant at the Aquifer. Youth are predominantly engaging with sand excavation and brick making. The huge percentage of the population are engaged in unsustainable agriculture for livelihoods which in turn has an impact in water resources through degradation.

The majority of the population in Masaka district in Uganda is of the Bantu group of which majorities are Baganda (77%), Banyankole (9%), Banyarwanda (8%), and other groups (6%).

It is estimated that about 65% of the population are dependent on the natural resources of the area and the rest depend on the urban businesses. Women has been an important group in farming in the Aquifer area. For instance, in Masaka District in Uganda, Agriculture is the biggest economic activity with 73% of households mostly women involved in agriculture. The major Crops include sweet potatoes, rice, cassava, ground nuts, sorghum, simsim, millet, cowpeas and beans. Animal husbandry is also common mainly with cattle, goats, piggery and poultry. Fish farming is also practiced in some areas mainly for Nile perch, tilapia, silver fish, and lung fish. Fisheries is however mostly dominated by men and Male-youth. Other economic activities are stone quarrying, clay and sand mining are which is mostly dominated by Male youth. Youth also lead provision of factory labour; Hides and Skins Preparation and Preservation Areas, Fish processing plants, construction companies, Milk Processing Plants, Animal Feeds Mills, Fruit processing and Maize processing.

The economies of the Ntungamo and Insingrio districts are predominantly agrarian dominated by subsistence Agriculture activities with emphasis on coffee growing, Livestock rearing and Matooke production. Trading involves the sale of agricultural products and sale of small-scale manufacturing products.

There are varying degrees of information in the study region regarding water access, usage and management. Rates of access[5] to clean water vary across sub-counties from a low of 30% to a high of 95%, with significant reliance on groundwater sources in the form of deep boreholes, shallow boreholes and protected springs in rural areas. It is estimated that over 90% of the clean water facilities in rural Uganda use groundwater. Groundwater constitutes more than 50% of the water sources for the small and medium municipal water supply systems used in urban areas. Table4-17 shows the estimated access rates for the districts crossed by the Kagera Aquifer.

Shallow and deep boreholes with public access/taps are the prevalent technologies used by rural communities in the Kagera aquifer area. These installations are primarily operated and managed

[5] Access to safe water is the ratio of people served by a safe water point and piped water supply to the total population

by the local communities, with a small percentage being privately operated. The functionality[6] of the water supply installations is many times reduced by technical failures, contamination of the water sources or vandalism. Funding for the water supply sector in Uganda comes primarily from the government (62%) (24.2% Central Government 38% Local Government) with significant contribution from NGOs (27.4%) and small participation from the Private sector and other sources (6.4% and 4.0% respectively). The communal management structure of water facilities is usually ill prepared to attend to the cost of maintenance and repair, as regular contributions to meet such expenditures is not practiced or observed. The failure of a water facility initially caused by a technical failure may be prolonged due to the inability of the community to immediately raise the cost of needed repairs.

Table 4- 17: Safe Water Access Rates for Uganda

Sector Name	Access to Safe Water		Rural Functionality
	Range	Total	
Isingiro	22% - 95%	45%	97%
Kyotera	30% - 95%	60%	68%
Lwengo	42% - 95%	71%	80%
Masaka	47% - 95%	67%	81%
Ntungamo	49% - 95	76%	83%
Rakai	6% - 95%	35%	82%

Source (Directorate of Water Development, Ministry of Water & Environment, Republic of Uganda, 2021).

A significant portion of the population has to fetch water for domestic use particularly in rural Uganda. Members of the communities (mainly women and children) in rural areas, reportedly walk for distances of up to eight kilometres to fetch water. Occurrence of conflicts at crowded water points reportedly occurs and incidents of harassment on women during their water fetching treks were reported. Water is usually fetched from open surface water sources which is used by animals and is highly susceptible to contamination thus increasing the risks of water borne diseases. The task of fetching water may be a direct cause of missing school by the youth

[6] Functionality is the ratio of functional water sources to all available water sources

involved in the task either to meet the water needs of their families or as a relatively lucrative earning job for those who choose to fetch water in exchange for money. A Jerri can of water is reportedly sold for 500 shillings in some districts.

4.4. Tanzania

4.4.1. General Information and Economic Indices of Tanzania

Tanzania is the largest country in East Africa with an area of 945,000 km^2 with a population of about 60 million and is endowed with vast water resources including three of the largest fresh water lakes in the world and Africa; Victoria, Tanganyika and Nyasa. Besides water, the country is also rich in other resources such as minerals, natural gas, livestock, agricultural land, fisheries in inland lakes and rivers and the Indian Ocean to the east.

The country is a middle-income developing country, whose economy is predominantly based on peasantry agriculture but making big strides in among others mining, tourism, fishing, livestock keeping, manufacturing, trading, banking, communication, transport and import and export serving land locked countries of Uganda, Rwanda, Burundi and DR Congo. Tanzania is divided into 31 administrative regions with each region subdivided into district councils which are further divided into division and further into wards.

Table 4- 18: Economic Indices and General Information of Tanzania

Indicator	YEAR			
	2015	2016	2017	2018
Population, total	53,470,420	55,155,473	56,877,529	58,636,512
Urban population	16,528,155	17,402,287	18,307,606	19,244,709
Real per Capita GDP Growth Rate (annual %)	3.658	3.685	3.231	3.492
Inflation, consumer prices (annual %)	5.588	5.174	5.522	4.998
GDP (current US$)	44,822,837,365	46,293,785,843	53,291,358,846	57,310,242,338
GDP (constant 2000 US$)	27,305,467,291	29,204,019,381	31,088,871,857	33,169,528,240
GDP per capita, (current US$)	838	839	937	977
GDP per capita, (constant 2000 Prices, US $)	511	529	547	566
Population, Total	53,470,420	55,155,473	56,877,529	58,636,512
Human development index (HDI)	0.531			
Rural population	35,762,641	36,448,790	37,131,440	37,811,137
Population growth (annual %)	3.180	3.151	3.122	3.093

Kagera Basin (catchment) in Tanzania is one of six catchments of the Lake Victoria Basin, one of nine River/Lake basins in the country for purposes of water resources development and management. It is located on the north-western corner of Tanzania, shared with Uganda, Rwanda and Burundi, with an area of 22,098 km2, being the largest catchment, about 25%, of the Lake Victoria Basin area. The Kagera Aquifer spans six of Tanzania 169 districts namely Kyerwa, Missenyi, Bukoba, Muleba, Ngara and Karagwe (Figure 4-11). It engulfs 20 administrative divisions and 81 wards. The most significant parts of the aquifer within Tanzania (95%) are within the four districts of Missenyi, Bukoba , Kyerwa and Karagwe.

Most of the area of the Tanzanian part of the Kagera aquifer falls within the Missenyi council district (50%) spanning over almost the entire district. Areas of the Aquifer within each council district and the percentage of the area of the district they underlie are shown in Table 4-19

Table 4- 19: Areas of Kagera Aquifer within Tanzania Districts

District	Land Area (sq. Km)	Aquifer area within the District (Km^2)	% of the District Area underlain by the Aquifer
Karagwe	4,342.0	668.9	15.4
Bukoba	2,595.5	517.4	19.9
Muleba	3,444.0	87.1	2.5
Ngara	3,744.0	57.3	1.5
Bukoba MC	83.0	1.1	1.4
Missenyi	2,000.0	1953.1	97.7
Kyerwa	2,783.0	649.2	23.3

4.4.2. Socio-economic Environment in Kagera Aquifer Area within Tanzania

Agriculture forms the basis of rural livelihoods in the Aquifer with households experiencing low agricultural productivity, poverty and land degradation. As a result of low productivity and poor income households registers a low socio-economic status and resilience resulting to engagement in environmentally-degrading activities (such as sand mining, brick-making and charcoal production) to fill gaps in food and income. Fishery is a major source of food and

income to households at the aquifer. This dependency in fisheries has imposed an increasing pressure on wild fish stocks through over/illegal-fishing, consequently to decreasing fish yields.

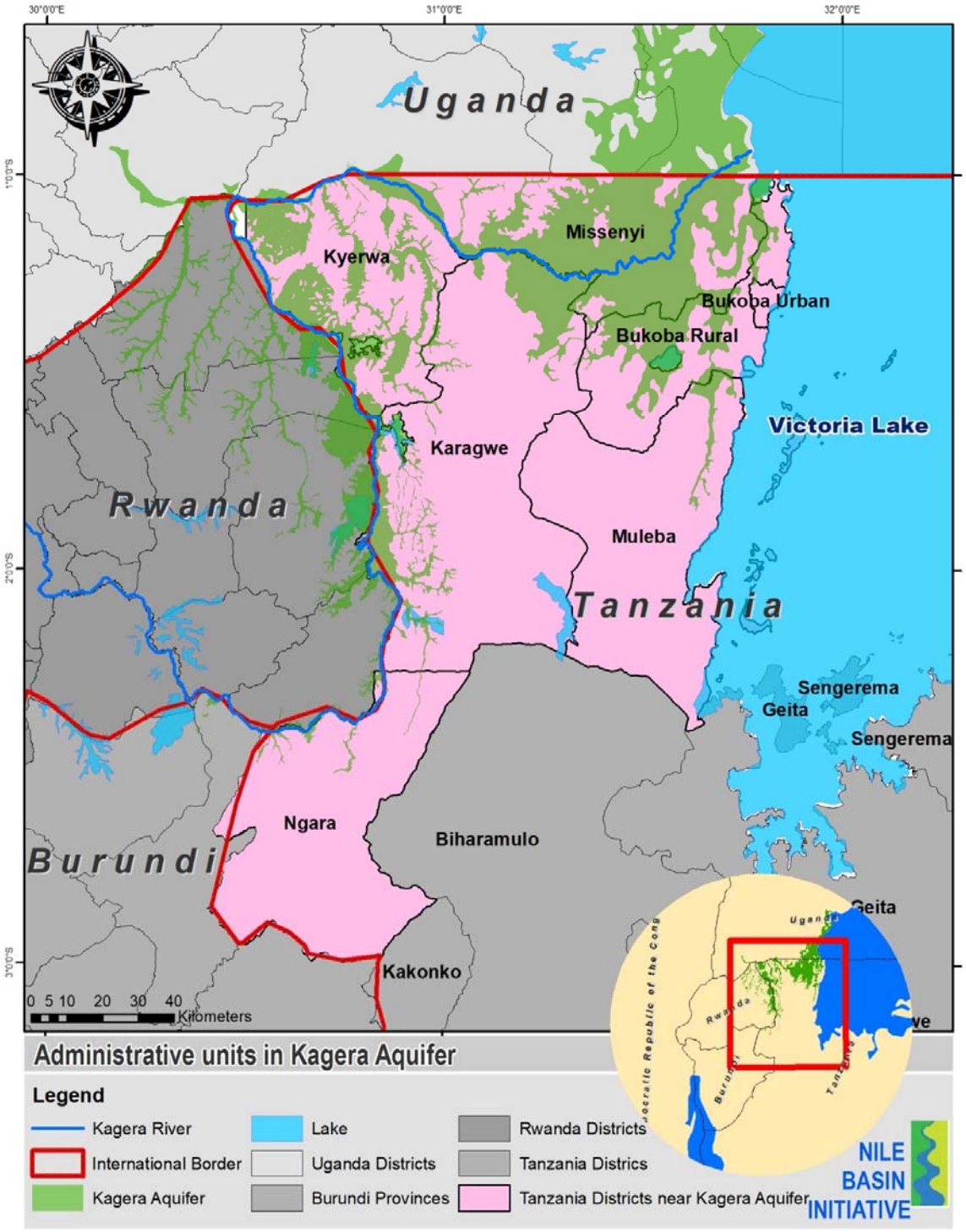

Figure 4-9: Districts of Tanzania crossed by Kagera Aquifer

4.4.3. Demography

The Kagera region of Tanzania have experienced significant population growth between 2002 and 2012. It had 2,458,023 inhabitants in 2012 compared to 1,777,823 in the 2002 population census accounting for 5.6% of the total population of the Tanzania mainland. The districts' high population growth is attributed by high birth rates and migration. The population in the seven districts spanning the aquifer area was recorded at 2,134,537 (female 51% and Male 49%) in 2012 census thus accounting for about 87% of Kagera region population. The population of Kagera region is considered to be young with 47.7% below 15 years and 48.8% between the age of 15 and 64 (working age) in 2012. According to the socio-economic profile of 2015 the region's population increased by 38.3% between 2002 and 2012 with significant differences in nature and change level within the different council districts (Table 4-20) and much higher urban (139.8%) versus rural rate 35.3%. At 71 people per sq km in 2002 and 87 people per sq Km in 2012, the population density in the Kagera region is higher than the national average and the region ranks fifth among Tanzania 31 regions.

The main indigenous ethnic group in the region is the Haya's. Other groups with significant numbers include the Nyambo, Hangaza, Subi, Ha, Sukuma, Nyarwanda, Zinza, Rundi and the Kerewe. The Hangaza, Subi and Sukuma are found in all the councils while the Ha and Kerewe are mainly in Karagwe, and Ngara district councils. The Nyarwanda on the other hand are mainly in Kyerwa and Muleba district councils. The Sukumas who are mainly herders are found in Kyerwa, Muleba, Ngara, and Karagwe district councils.

Table 4- 20: Population distribution in Districts Crossed by Kagera Aquifer.

Year	District Council						
	Karagwe	Bukoba	Muleba	Ngara	Bukoba MC	Misenyi	Kyerwa
2012	332,020	289,697	540,310	320,056	128,796	202,632	321,026
2017	395,811	343,438	641,092	379,362	154,884	240,675	381,709
2020	437,423	381,664	711,837	421,661	169,684	266,960	422,939
2022	470,229	406,283	760,521	451,847	184,933	285,515	454,209
2027	559,350	482,867	903,776	534,188	220,573	400,979	538,991
2032	659,321	570,683	1,066,561	628,356	260,701	442,770	635,217
2035	726,134	630,241	1,175,322	320,056	287,772	202,632	697,069

Table 4- 21: Population Density in Aquifer Area by District

Council	Land Area (sq. Km)	Population Density per sq Km 2012	% Population Increase 2002 to 2012	Dependency Ratio (2012)
Karagwe	4,342.0	76	64.8	101
Bukoba	2,595.5	112	20.1	105
Muleba	3,444.0	157	40.3	104
Ngara	3,744.0	85	-4.3	111
Bukoba MC	83.0	1,552	59.3	68
Missenyi	2,000.0	101	32.6	98
Kyerwa	2,783.0	115	44.1	111

The population living within the areas of the Kagera Aquifer of Tanzania in 2020 is projected be about 529,175 which amounts to about 16% of the total population of the administrative Kagera Region of Tanzania. About 50% of the Tanzanian Aquifer population are in the Missenyi district (Table 4-22).

Table 4- 22: Population within Aquifer Area in Tanzania by District

Council	Total District Population 2020	Population within Kagera Aquifer in Tanzania	% District Population within Kagera Aquifer
Karagwe	437,423	67,363	12.7
Bukoba	381,664	75,951	14.4
Muleba	711,837	17,796	3.4
Ngara	421,661	6,325	1.2
Bukoba MC	169,684	2,376	0.4
Missenyi	266,960	260,819	49.3
Kyerwa	422,939	98,545	18.6
Total	**2,812,167**	**529,175**	**100**

4.4.4. Socio-Economic activities at the aquifer.

Kagera Region has a mixed economy dominated by the agriculture sector. Both commercial and peasantry farming are practiced with the latter dominating. According to results of the 2012 Population and Housing Census, the agriculture sector in Kagera engages 77.4 percent of the people of age 10 years or above. In rural areas 95.1 percent of the population was engaged in agriculture while only 4.9 percent of the urban population was engaged in agriculture. Agriculture contributes most of the region's cash income mainly from coffee, beans, tobacco, bananas, cotton, tea, fruits and vanilla production. Generally, the crop sub-sector's performance has been adequate to ensure food security. Poor performance of this sub-sector in some years has been attributed to the dependence on variable climatic conditions especially rainfall. Thus, the relatively high growth rates of the economy in some years reflect the availability of favourable rainfall in those years.

Trade is the second most important occupation after agriculture, involving 5.3 percent of the population age 10 years or above in the region while domestic service sub-sector comes third engaging 4.3 percent. The fourth most important occupation in the region is fishing, hunting, livestock and other related activities engaging 2.9 percent and the fifth occupation (mining and quarrying businesses) engaging 1.9 percent of the population age 10 years or above. The census results also show that manufacturing occupation accounted for 1.5 percent of the Kagera Region population age 10 years or above while the construction sector engaged 1.4 percent.

Looking at the distribution of the regional economy, Missenyi DC had highest per capita GDP in the region, TZS 2,767,397 in 2013, TZS 3,068,050 in 2014 and TZS 2,672,439 in 2015 followed by Karagwe DC where in 2013 had TZS 1,526,634, TZS 1,492,873 in 2014 and TZS 1,787,299 in 2015. The least council was Bukoba DC in all the three years. Per capita GDP in the Kagera region is about 65% of the national average.

In Misenyi district in Tanzania which is almost entirely underlain by the Kagera Aquifer and has 50% of the aquifer extent withing Tanzania, the major ethnic group of Haya tribe is the dominant in the district. The communities depend on subsistence farming and pastoralism and Agro-forestry is dominant. National and local management forestry areas are also in the district. Forests in communities surrounding Minziro Nature Forestry Reserve play a greater role in surface water flow and Ground water recharge. The economy of the adjacent communities of Minziro NFR and the district as well is mainly dependent on subsistence agriculture. There is relatively little irrigated agriculture. The cropping system has three typical land use types: a)intensive perennial banana-coffee home garden (*kibanja*) with multi layers and mixed crops (species and varieties) such as beans and maize, where nutrient cycling is concentrated (banana

is the staple food crop); b)the small fields of mixed annual crops (*kikamba*) with lower inputs and poor soil fertility; and c)the extensive annual crops (*omusiri*), such as Bambara groundnut, with long fallow periods on low quality grasslands on steep, shallow or sandy soils (*rweya*), these are grazed, cut for mulch and provide patches of woodlots. Increasing production of cereals, beans and roots and tubers and use of the *rweya* for species that require low management such as pineapple is reported. Women Predominantly play a major stake in production of the later. Pastoralism, led by men, have a stake in the local economy of the area.

4.4.5. Livelihoods

The average Household consumption in Tanzania stands at TZS 294,275 including food TZS 39,334 and non-food TZS 28,246 per month. The main economic activity is agricultural for more than 90 percent of the population. The most important food crops are bananas and beans. Coffee, cotton, tea and sugar cane grown on a commercial scale. Fishing is also a growing sector. Other productive sectors include livestock, mining, tourism and natural forestry. Kagera Region has the largest percentage (87.5%) of households using firewood as a source of energy for cooking.

4.4.6. Water consumption per household

The average total domestic water use per person per day in Tanzania is below the minimum requirement (the basic human needs requirement of 25 liters/person/day, at about 10.1 liters (NELSAP 2019). According to the Percentage of Households with Improved Water Source during Rainy and Dry Seasons in Rural/Urban and Region, Tanzania Mainland, 2017-18 HBS, Kagera ranks relatively high at Improved Water Source During the Rainy Season (90%), Improved Water Source During the Dry Season is (39.8%) with a relatively large percentages of households with un- improved toilet facilities (Higher than the national average of 42.8%) On the other hand, 55.2% of schools in the region has water services and 15.8% sanitation services as reported by 2018 School Water, Sanitation and Hygiene Assessment.

According to WSSR (2015 – 2020) cost socio-economic activities in the river basins are supported by surface water resources. For Lake Victoria Basin of which Kagera is its sub basin, ground water utilization for socio-economic is less than 1%, while surface water provides the remaining 99%. Groundwater however is increasingly being used to improve the access to safe water in rural communities. WSDP (Water Sector Development Plans) target for 2019 was to have a total of 76,334 water points serving a total of 19,080,000 person in rural areas with increased reliance on groundwater resources. The target was to increase the access rates to safe

water to 80% (compared to 59% in 2014). By 2019 a cumulative of 139,000 water points were established of which about 30% were non-functional.

Table 4- 23: Access to Rural Water Supply Services 2019

District	Population	No. water Points	No. Working points	Pop. covered	%
BUKOBA MC	35,432	242	218	25,500	72
BUKOBA DC	333,907	1,082	881	185,501	56
KARAGWE	369,963	992	785	216,500	59
KYERWA	371,687	672	468	237,000	64
MISSENYI	221,716	812	494	123,500	56
MULEBA	540,310	1,156	859	445,350	82
NGARA	391,169	1,046	729	215,350	55
Total	**2,264,184**	**6,002**	**4,434**	**1,448,701**	**64**

Table 4- 24: Water Tariff including Operation and Maintenance and Energy (bills)

Water Cost (TZS/m^3)					
District	**2017/18**	**2018/19**	**2019/2020**	**2020/21**	**Cost/20ltrs (2018/19)**
BUKOBA DC	1,385.00	1,613.00	1,888.00	2,206.00	32.26
BUKOBA MC					
KARAGWE DC	1,461.00	2,211.00	2,211.00	2,211.00	44. 22
KYERWA DC					
MISSENYI DC					
MULEBA DC	800.00	800.00	800.00	800.00	16. 00
NGARA DC	592.00	1,303.00	1,444.00	1,485.00	26. 06

organ at Basin and Sub Basin level.

Kagera Region has a significant number of livestock mostly owned by individual households. Livestock keeping is the second most important economic activity after crop production in Kagera Region. Provision of water resources for the watering of livestock is of significant importance for the rural population.

Table 4- 25: Livestock Population per District

Livestock Type and Number								
District	**Cattle**	**Goat**	**Sheep**	**Pigs**	**Camel**	**Chicken**	**Dogs**	**YEAR**
BUKOBA DC	34,287	38,064	3,255	6,128		108,455		2,016
BUKOBAMC	2,132	1,454	261	1,069		25,633		2,015
KARAGWEDC	167,627	140,201	16,313	17,190	5,171	159,440	8,899	2,021
KYERWADC	75,927	73,168	8,392	13,924		73,535		2,017
MISSENYIDC	88,474	49,118	3,459		6,895	62,170		2,015
MULEBADC	93,678	133,635	17,368	33,634				2,021
NGARADC	117,714	123,345	10,846	19,221		235,113		2,019
Total	579,839	558,985	59,894	91,166	12,066	664,346	8,899	14,124

4.4.7. Economic Gender and Equity at Kagera Aquifer

According to the study conducted by NELSAP in 2020, gender roles are disaggregated based on harvesting and utilization of various resources per sectors depending in utilization of water resources. Males are more likely to harvest and use clay for construction and brick-making, while females are more likely to use clay for pottery. Collecting water for domestic use is mainly performed by girls and women, while livestock watering by boys.

Women plays essential roles in agriculture - providing inputs, managing production, stewarding natural resources and generating off-farm income - but often benefit less than men. High-value agricultural production chains are usually run by male-dominated institutions, while women are often limited to local markets where they sell low-quality and residual products. All landscape-level interventions therefore need to attend to this imbalance through gender mainstreaming, in order to maximize the benefits of agriculture to women farmers, providing incentives to increase their productivity.

Tanzania ranks130 out of 189 countries on the Gender Inequality Index rank of 2018 (UNDP 2019). The Gender Inequality Index is 0.539 for Tanzania at a scale of 0 to1. The Sango Bay Minziro Monograph (2020) reports that gender mainstreaming in economic sectors is still a

challenge. This challenge is reported to have been attributed by inadequate funding of gender programmes and lack of facilitation for the gender focal point person because of lack of clarity of gender investments and gender outcomes, intangibility of gender mainstreaming initiatives because there are not direct benefits visible from carrying out gender related activities, hence little or no commitment in investing in such activities, inability to transform women's representation in gender sensitive decision making because of limited inclusion of women in decision-making process among others.

In the Aquifer the Social Development Sectors such as Community Development, Community, elderly, children and women welfare departments, cooperative societies, youth organizations foster the rights of the vulnerable population, addresses gender inequalities, labour and employment as well as community mobilization and empowerment. Addressing the rights and needs of the vulnerable and disadvantaged populations such as People with Disabilities (PWDs), older persons, youth, women, orphans and other vulnerable children and the chronically poor underpins the core concerns of governments, donor agencies through projects and programs, NGOs and development partners. For instance, in Tanzania, TASAF – Tanzania Social Action Fund has been established to help poor and elderly people.

Not only that, various measures are taken to minimize time spent by women and girls in attending to home activities and thus give them more time to be used in socioeconomic activities. These measures include the use of family planning, opening and operating of day care centres, establishment of women economic groups and participation in Savings and Credit Cooperatives (SACCOs), Community Based Organizations (CBOs), Village Community Banks (VICOBA) and other cooperative activities. Running of day care centres enables mothers to participate in various economic activities which contribute significantly to the household socioeconomic growth. Day care centres are meant for children of age three to four years. For instance, Missenyi District had 21-day care centres in 2013 with 552 pupils.

4.4.8. Community role in water management in Kagera Basin

As in all other river basins in Tanzania, water management at community level in the Kagera Basin is led by Water Users Associations (WUAs), a lowest level of water management in Tanzania. WUAs fosters Integrated Water Resources Management through coordinated development and management of water, land and related resources for economic and social prosperity of the local communities. WUAs save as a political and technical arm to implement the principles outlined by IWRM in the basin including to conserve and manage water catchments, increase the usage of water for economic and social improvements and develop

sustainable and responsive institutions, resolve conflicts on water use and monitor water availability and use on behalf and with technical support from Basin Water Board as per guidelines set-up by the Ministry of Water.

Led by Ministry of Water Tanzania, water resources management is also contributed by other sector ministries through the well-established community networks.; For instance, Ministry of Natural resources and Tourism has a wide network of Natural Resources Management Community clubs, Community Forestry Management Groups and Village Natural and environmental Management Committees in each village. Kagera river basin also has a Wetlands Conservation Committee at local and transboundary level which coordinate community's water resources management at the basin.

Level of communication with authorities: Communities communicate with River Basin Board and Ministries through the established Water User Association channels. There is a representative from each Water User Association to the River Basin Board, a decision-making

5. STAKEHOLDERS MAPPING

5.1. Overview

Stakeholder engagement is a key element in sustainable management and utilisation of natural resources and is accorded great priority in IWRM. It even becomes more important when transboundary water resources including transboundary aquifers are involved. This section therefore, presents a synopsis of the stakeholders who are likely to be involved in the sustainable development of the Kagera Aquifer. Key stakeholders in the Kagera catchment were identified and categorized at different levels of involvement. These include the local community; civil society; local government; central/National government; political representatives, semi-autonomous agencies, water supply and sanitation operators; private sector, representatives of ongoing water/ environment projects within the catchment. The main categories of stakeholders include

Central/National Government: This category is interested in ensuring sustainable natural resource use and management. It is mandated to establish an enabling environment for catchment management in form of relevant resource use and management guidelines, policies, and institutional frameworks. The category in addition, plays the role of providing relevant information and technical support to all other stakeholders.

Districts and Lower Local Governments: This group mostly includes districts, sub-counties, parishes and village councils. The interest here, is to ensure that the people represented, have access to resources and services, and that development needs of the people including water, food, and income, among others, are met. The group is mandated with coming up with appropriate local policies and bye-laws relevant in guiding access to, and utilisation of resources. In order to get their buy-in, it is important to engage this group early enough at planning stage. The group should also be involved implementation phase to put in place the necessary policy, legal and institutional frameworks and build a sense of ownership that is very crucial to sustainability of resources.

Local Community: These are the actual beneficiaries of the of the available resources within the catchment. They include among others, crop and livestock farmers, fisher folk, women and youth. The main interest in this category is having access the resources and services such as water, land, trees, fish within the catchment, and meeting their livelihood and development aspirations. 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 in general and the aquifer in particular.

Civil Society: This group is made up of NGOs and CBOs involved in the water, community development, natural resources, land and environment sub-sectors. The interest of the group is in sustainable resource use and management, community livelihoods and development. There is hence need for full participation in the planning process - identifying watershed issues, engaging communities, presenting community views and concerns, discussing options, and providing recommendations and approaches to address the issues. The civil society ought to be engaged implementation phase, to guide wise use of catchment resources for sustainable community development; and provide knowledge and experiences on best practice gained from elsewhere.

Water Supply and Sanitation Operators: Water supply and sanitation operators include National Water & Sewerage cooperation, water boards, water user associations, umbrella organisations among others. In the catchment, they are chiefly interested in availability of water; and demand for water and sanitation services. They ought to therefore be engaged during the catchment planning process to identify key issues and agree on proposed solutions. They therefore have responsibility to support plan implementation if they are to be assured of sustainable catchment goods and services. They can be engaged through Corporate Social Responsibility approaches e.g., ploughing resources back towards management of catchment areas for sustainable water supply.

Private Sector & Semi-autonomous Agencies: The private sector and semi-autonomous agencies' interests are in Catchment goods and services such as water, agricultural produce, Livestock and livestock products. Their mandate is to maintain sustainable catchment goods and services; investment in programmes that support catchment sustainability for example, tree planting, sustainable agriculture, wetland rehabilitation.

5.2. Mapping of Stakeholders

Lists of stakeholders of stakeholders involved in the groundwater development and management within Kagera Basin were prepared for each of the four countries. The lists attempted to profile the relevant actors through identifying their mandates and field of action. The lists were used to characterize the legitimacy, available resources and strength of relationships with other actors of each stakeholder.

(A) Legitimacy: Institutional position of the key stakeholder, ascribed or acquired rights that are – for instance – underpinned by the law, the institutional mandate and public approval, loyalty of other social groups, and are considered legitimate. This also includes key stakeholders without whose explicit approval the proposed reform would be inconceivable. These veto players can create key impetus and scope, or can obstruct the reform.

(B) Resources: Knowledge, expertise, skills and material resources that enable the key stakeholder to significantly influence the issues at stake and the change objective, or to steer and control access to these resources. This is also linked to the question of whether the key stakeholder disposes of the necessary resources.

(C) Networks: Number and strength of relationships with other actors who are obligated to, or are dependent on, the key stakeholder. Key stakeholders are usually well-connected, i.e., they have a large number of institutionally formalized and of informal relationships with other actors. Key stakeholders therefore wield significant influence on the participation of other actors, structuring some decisions as to whether certain actors will be included or excluded

Stakeholders were classified into four different categories as follows:

- *Primary Stakeholders (PS)*: those actors who are directly affected by the Kagera aquifer development, either as designated beneficiaries, or because they stand to gain – or lose – power, economic resources and privilege, or because they are negatively affected by the project in some other way.
- *Secondary Stakeholders (SS): Those* are actors whose involvement in the any aquifer development or management activities is only indirect or temporary, as is the case – for instance – with intermediary service organizations.
- *Key Stakeholders (KS):* those are actors without whose support and participation the targeted results of any aquifer development normally cannot be achieved. Actors who are able to use their voice, skills, knowledge or position of power to significantly exercise influence on a reform are termed key stakeholders.
- *Veto Players (VP) :* Those are key stakeholders who can veto any potential intended development of the Kagera Aquifer (By law, tradition or sheer defacto power)

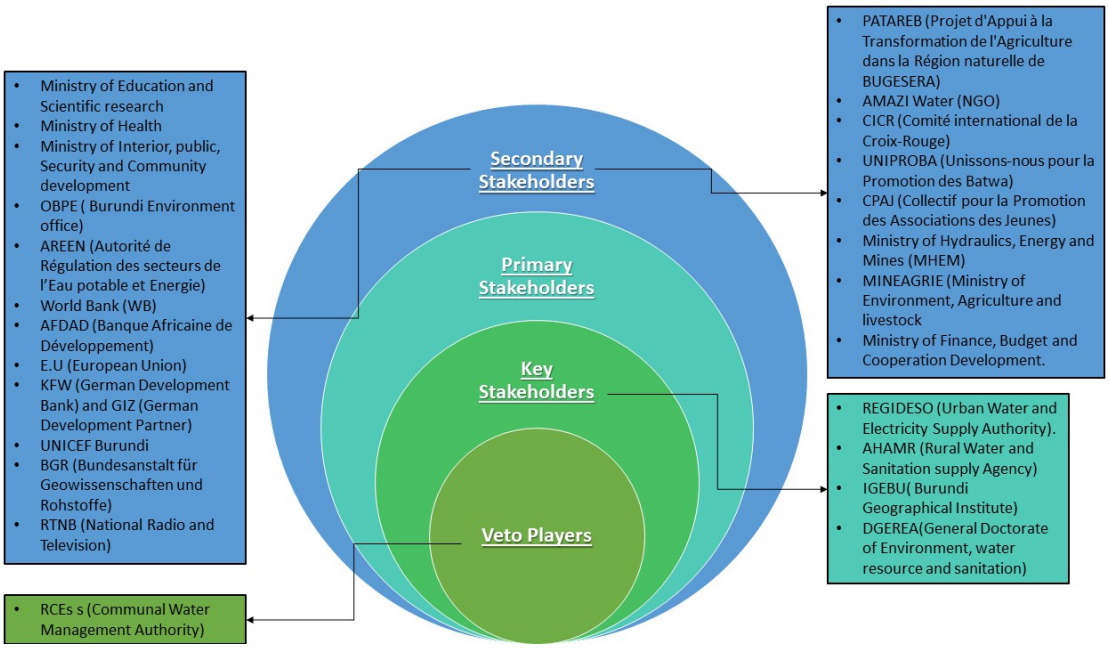

Figure 5-1: Stakeholders Map – Burundi

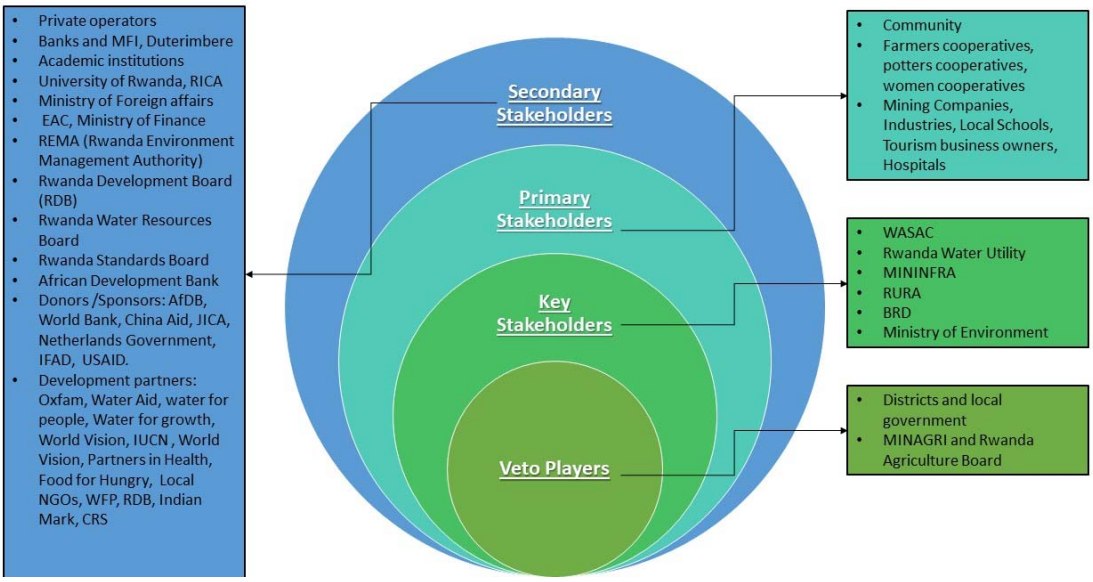

Figure 5-2: Stakeholders Map – Rwanda

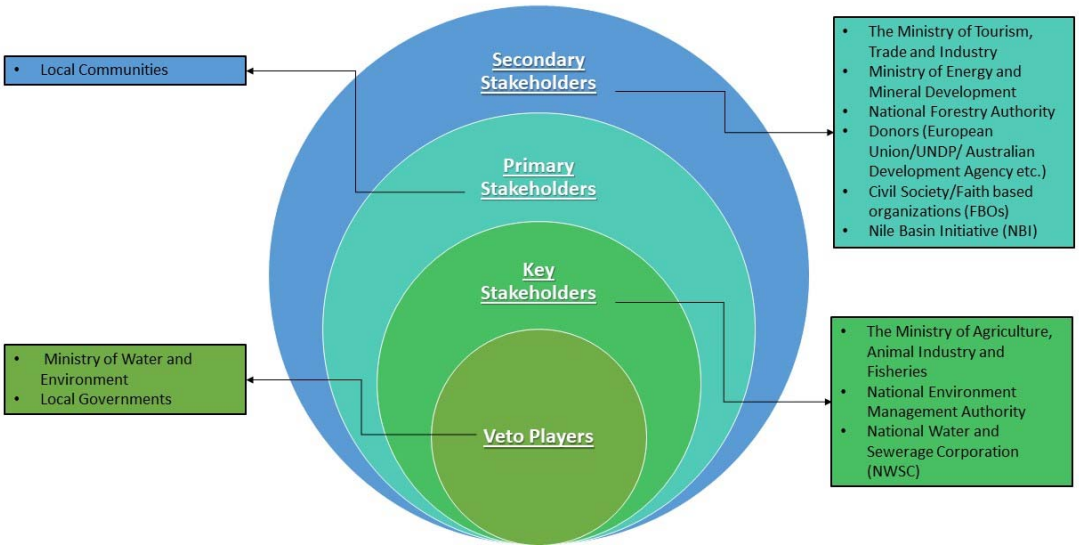

Figure 5-3: Stakeholders Map – Uganda

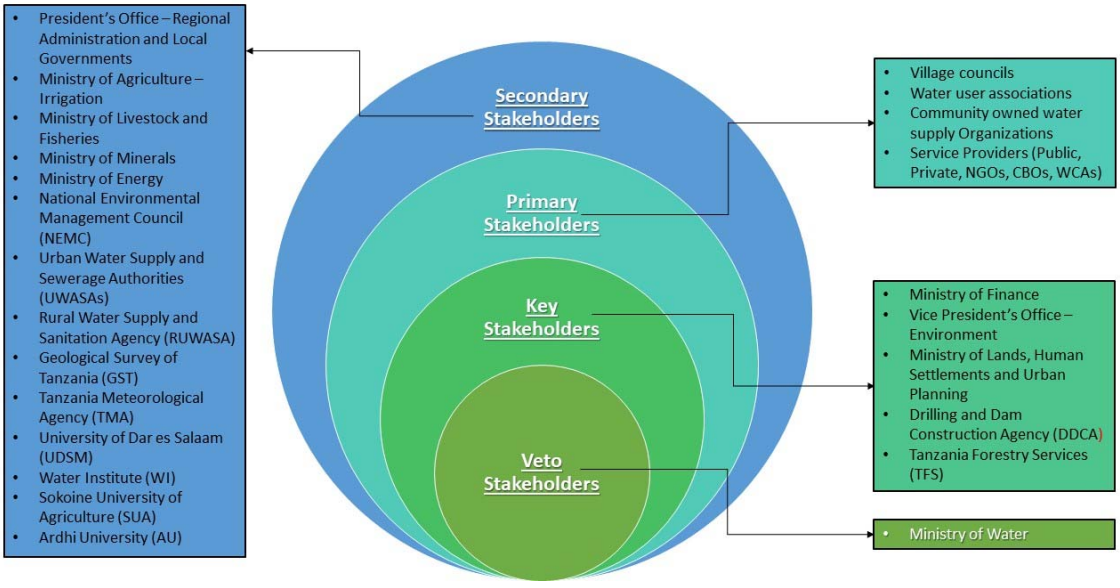

Figure 5-4: Stakeholders Map – Tanzania

Table 5-1: Stakeholders List - Burundi

Actor **Name, function**	**Agenda** **Mandate/mission, strategic Objectives**	**Arena** **Field of Action, outreach**	**Alliances** **Relations with other actors****
Ministry of Hydraulics, Energy and Mines (MHEM)	Drinking Water Policy setting and monitoring water service provision	National	Public
MINEAGRIE (Ministry of Environment, Agriculture and livestock)	Setting effluent standards or licensing private operators	National	Public
Ministry of Public Health and AIDs Control	Formulates norms for sanitation facilities, approval of construction permits through its National Sanitation Service and enforcing sanitation norms, especially for public or private commercial settings	National	Public
Ministry of Public works, transport, equipment and Land Planning	Delivers housing construction permits, which should hold permit holders to account for ensuring adequate sanitation facilities	National	Public
Ministry of Interior, Public Security and Community development	Manages the fund for local development, the Fond National Communal Investment (FONIC)	National	Public
Ministry of Education and Scientific research	In charge of ensuring adequate water and sanitation facilities within schools, Curricula and research	National	Public
Ministry of foreign affairs and international Cooperation		National	Public
Ministry of Finance, Budget and Cooperation Development.	Budgeting and Fiscal policy	National	Public
REGIDESO (Urban Water and Electricity Supply Authority).	Urban water service provider	Provincial	Para-state actor
AHAMR (Rural Water and Sanitation supply Agency)	Rural water service provider	Local and Community level	Public
IGEBU (Burundi Geographical Institute)	mandated forecast weather, mapping services and monitoring quantity, quality of groundwater and surface water	National	Public
DGEREA (General Directorate of Environment, water resources and sanitation)	Mandated to make policy and strategies about water resources and environment	National	Public

OBPE (Burundi Environment office**)**	Mandated to monitoring Environment in its forms	National	Public
AREEN (Regulatory Authority for the drinking water and energy sectors)	mandated to provide economic regulation of water (and energy) services	National	Public
CPEA (Provincial water Coordination of AHAMR)	Mandated to coordinate management of water resources in province	Provincial	Public
RCEs s (Communal Water Management Authority)	municipalities have the responsibility to plan and oversee services, as well as to allocate resources	Local	Private
Water committee	Manage and operate water point, public water taps	Community	Private
University of Burundi	Research initiative	National	Public
World Bank (WB)	Finding development institution	National	Bilateral Donor
AfBAD (Banque Africaine de Développement)	Finding development institution	National	Bilateral Donor
E.U (European Union)	Finding development institution	National	Bilateral Donor
KFW (German Development Bank) **and GIZ** (German Development Partner)	Finding development institution	National	Bilateral donor
UNICEF Burundi	Promote School Water supply and Hygiene awareness and promotion of low-tech management practices	Local and school	UN Agency Donor
PATAREB (Projet d'Appui à la Transformation de l'Agriculture dans la Région naturelle de BUGESERA)	Water for Irrigation Services delivery	Local	Private
ENABEL (Belgian Development Agency)	Finding development institution	National	Bilateral Donor
BGR (Bundesanstalt für Geowissenschaften und Rohstoffe)	Management and Protection of Groundwater Resources	National	Bilateral donor
Amazi Water (NGO)	Water provision through boreholes	National	INGO
CICR (Comité international de la Croix-Rouge)	Water provision	National	INGO
AVEDEC (Association Villageoise d'Entraide et de Développement Communautaire)	Water and Sanitation service delivery and Capacity building	Local	CSO

UNIPROBA (Unissons-nous pour la Promotion des Batwa)	Advocacy	National	CSO
CAFOB (Collectif des Associations et ONGs Femines du Burundi)	Advocacy	National	CSO
CPAJ (Collectif pour la Promotion des Associations des Jeunes)	Advocacy	National	CSO
RTNB (National Radio and Television)	Communication, awareness and sensitization	National	Public

Table 5-2: Stakeholders List - Rwanda

Actor **Name, function**	**Agenda** **Mandate/mission, strategic Objectives**	**Arena** **Field of Action, outreach**	**Alliances** **Relations with other actors****
1. WASAC (Rwanda Water Utility)	To provide technical assistance for water quality monitoring to districts and POs. • To provide training for water quality monitoring to districts and POs. • To keep records of water quality analysis for future references.	• To coordinate all water supply activities. • To feed MIS and provide data for national or sector wide report • To have an overview of the progress of the sector towards partners in order to evaluate the achievements of goals and targets	RURA, Mininfra
2. MININFRA	To keep and manage the water quality data in national MIS. • To coordinate the concerned stakeholders. • To advocate to raise funds for rural water quality control.	• To inform policy decision for strategic planning • To stimulate discussions for the improvement of interventions	Prime Minister's Office, Donors, Ministry of Local government, PSF
3. RURA	• To regulate the provision of water services including the water quality for all rural water supply facilities. • To evaluate capability of POs in the water quality management. • To monitor		Prime Minister's Office Rwanda Revenues Authority, WASAC

	water quality and propose corrective measures to POs and districts. • To set water tariff including cost of water quality control		
4. Ministry of Environment, REMA	To coordinate and make policy and strategic planning for all natural resources management	Water resource policy making and strategic planning. Monitoring international commitments on the environment	MINALOC, Ministry of Health, Ministry of Agriculture, FONERWA, Sponsors, GEF, IFAD, World Bank, Bilateral donors
5. Rwanda Water Resource Board	Water resource policy making and strategic planning. Issue water permit for ground water use.	Water resource policy making and strategic planning. Issue water permit for ground water use.	All stakeholders involved in WRM
6. MINAGRI and Rwanda Agriculture Board	Agriculture policy making and strategic planning for irrigation master plan	Agriculture policy making and strategic planning for irrigation master plan Report for irrigate schemes water needs and consummations	MINALOC, Farmers Cooperatives, inhabitants, sponsors in irrigation
7. Rwanda Standards Board	To provide the portable water quality standard. • To provide certification to POs.		Ministry of Health, RURA
8. AfDB African Development Bank	Chair of development partners in the WASH Sector working group	Coordination and funding	
9. Donors /Sponsors: AfDB and World Bank, China Aid, JICA, Netherlands Government, IFAD, USAID	Support in financial means and technical assistance for institutional capacity enhancement	Sponsors in WASH and WRM, Implementer of WASH	Ministry of Foreign Affairs, Ministry of Finance, AfDB
10. Development partners: Oxfam, Water Aid, water for people, Water for growth, World	Water supply Training of stakeholders Data collection	Implementation in WASH and WRM	

Vision, IUCN, World Vision, Partners in Health, Food for Hungry, Local NGOs, WFP, RDB, Indian Mark, CRS,			
11. Academic institutions University of Rwanda, RICA	Water quality monitoring	Laboratory services for water quality control, research and development	
12. Districts	To develop the annual water safety plan for all rural water supply facilities including budget plan and implementation schedule. • To supervise water quality monitoring for all rural water supply facilities. • To keep water quality monitoring report. • To enter water quality data to National MIS. • To assess water quality of both raw water and distributed water. • To ensure protection of the water source from contamination. • To inform results of the water quality for all rural water supply facilities to the community. • To provide community sensitization for proper water use including implementation plan and budget plan	To Inform authorities or collectives the status of water service provision To compare services between users and service providers (private operators) in order to see how to improve service provision.	MINALOC, Vulnerable groups, women organizations, historically marginalized people,
13. Private operators (i.e.: Individuals, Inuma, Ayateke Star)	To disinfect water regardless of whether the source is surface or ground water. • To protect water sources and watersheds. • To submit reports of water quality tests to the District, WASAC and RURA. • To operate and maintain the water treatment facilities through certified or trained		MINALOC, District

	operators. • To disinfect water networks after repair. • To request an authorized water laboratory to conduct water quality test. • To ensure water disinfection. • To ensure the quality of the chemicals used in water treatment		
14. Community	To protect water sources and watersheds from contamination such as livestock, animals and human activities. • To have awareness of the ownership of water supply infrastructure and their protection To inform any issue related to water quality deterioration to districts and POs	To compare services between users and service providers (private operators) in order to see how to improve service provision.	MINALOC, Farmers cooperatives
15. Mining Companies, Industries, Local Schools, Hospitals	Water user industries		
16. BRD, Banks and MFI, Duterimbere.	Financial Institutions and MFIs Provide loans and micro credits	Financial support to water projects Financing women projects	Private operators
Rwanda Development Board (RDB)	Chair investments and tourism activities (national parks)	Environment Impact Assessment, investments decision and influence	Investors, FDI
17. Ministry of Foreign affairs, EAC, Ministry of Finance, REMA (Rwanda Environment Management Authority),	Cooperation Environment management Authority, All public funds management and economic planning, Districts budget allocations.	Key decision making, financial influence, international commitments on water and the environment	Donors, EAC, African Union, Nile riparian countries,

Table 5-3: Stakeholders List - Uganda

Actor Name, function	**Agenda** Mandate/mission, strategic Objectives	**Arena** Field of Action, outreach	**Alliances** Relations with other actors**
Actor 1: Ministry of Water and Environment	Setting national policies and standards; Managing and regulating water resources; Determining priorities for water development and management; and Monitors and evaluates sector development programmes	Water development, management and supervision	The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National
Actor 2: Directorate of Water Resources Management (DWRM)	It is responsible for implementing the water laws in the country, policies, plans and regulations, monitoring water quality and quantity and transboundary water resources	Implementing water related laws and transboundary water resources	The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/**National The National Forestry Authority (NFA). Public body/ **National
Actor 3: Directorate of Water Development (DWD)	responsible for water development and water service in urban areas (investment preparation and implementation)	Water development in urban areas	The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/**National The National Forestry Authority (NFA). Public body/ **National
Actor 4: The Ministry of Agriculture, Animal Industry and Fisheries	formulate, review and implement national policies, plans, strategies, regulations and standards and enforce laws, regulations and standards along	Lead agency for water use and management for agricultural development on-farm.	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority

	the value chain of crops, livestock and fisheries		(NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community
Actor 5: The Ministry of Tourism, Trade and Industry	to formulate and implement policies, strategies, plans and programs that promotes tourism, wildlife and cultural heritage conservation for socio-economic development and transformation of the country	water use and management of industries, commerce, wildlife and tourism	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community
Actor 6: Ministry of Energy and Mineral Development	to Establish, Promote the Development, Strategically Manage and Safeguard the Rational and Sustainable Exploitation and Utilization of Energy and Mineral Resources for Social and Economic Development	water use and management for hydropower generation	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community
Actor 7: Local Government Councils (LC 3 to 5)	responsible for the provision of primary and secondary education, safe water supplies and public health, and are encouraged to devolve some services to the lower tiers. Local economic development	Identifies resources and oversee water development, use and maintenance at community levels	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National

	(LED) is the responsibility of the districts and lower tiers of government		The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community International/Local Non-Governmental organizations and Faith based organizations (FBOs) Civil Society/ **regional/ community
Actor: 8 Donor community	Financing and funding development projects as a bilateral or multilateral cooperation	Support the funding of water and its related infrastructure	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community International/Local Non-Governmental organizations and Faith based organizations (FBOs). Civil Society/**community
Actor 9: National Water and Sewerage Corporation (NWSC)	operates and provides water and sewerage services for large urban centres across the country	expanding water service coverage, improving efficiency in service delivery	Ministry of Water and Environment. Public/** National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community
Actor 10: National Environment Management Authority	responsible for the regulatory functions and activities that focus on compliance and enforcement of	Oversees the implementation of all environment conservation programmes and activities of the relevant agencies both at the	Ministry of Water and Environment. Public/** National The National Forestry Authority (NFA). Public body/ **National

	the existing legal and institutional frameworks on environmental management	national and local Government level.	Local Governments. Public/ **Regional/community
Actor 11: National Forestry Authority	responsible for sustainable management of Central Forest Reserves (CFRs), supply of seed and seedlings	Provision of technical support to stakeholders in the forestry sub-sector on contract.	Ministry of Water and Environment. Public/** National NEMA. Public body/ **National Local Governments. Public/ **Regional/community
Actor 12: Local Communities	Manage and use sustainably all the resources within their communities	mobilize resources for community development	Local Governments. Public/ **Regional/community Faith based organizations (FBOs) Schools/churches/mosques. Civil Society/** community
Actor 13: Civil Society/Faith based organizations (FBOs)	Provide social services to the communities based on their areas of operations	Humanitarianism/extending their services and beliefs through service delivery	Faith based organizations (FBOs) Schools/churches/mosques. Civil Society/** community
Actor 14: Nile Basin Initiative (NBI)	to develop the Nile Basin water resources in a sustainable and equitable way to ensure prosperity, security, and peace for all its peoples; to ensure efficient water management and optimal use of the resources; to ensure cooperation and joint action between the riparian countries	Provides all-inclusive platform for the Basin States to discuss with trust and confidence, how to collectively take care of and jointly use the shared Nile Basin water and related resources.	Ministry of Water and Environment. Public/** National The National Water and Sewerage Corporation (NWSC), Public body/ **National The National Environment Management Authority (NEMA), Public body/ **National The National Forestry Authority (NFA). Public body/ **National Local Governments. Public/ **Regional/community

Table 5-4: Stakeholders List - Tanzania

Stakeholder groups	Description	Main interest and activity	Role on GW utilization
6.1 Policy makers **Sector Ministries**	Often (but not always) government institutions, at levels ranging from local, regional to national. Examples: • Ministries and their departments, (water, environment, agriculture, public works, tourism, etc.) • districts and town councils • environmental management authorities • water management authorities	Develop policy in line with existing (higher level) policies. They balance the needs of people (socio- economic) and nature. For this they analyze, formulate, evaluate policies, support politicians, and achieve policy targets.	They provide background and rationale for management, legal framework/justification and institutional context.
6.1.1 Agriculture		Agriculture development	Water utilization
6.1.2 Local Government Authorities (TAMISEMI)		Water supply	• Water supply • Extension education • Sources Protection
6.1.3 Natural Resource and Tourism		Management of protected areas	• Water Sources Protection • Water Utilization

6.1.4 Lands, Housing and Human Settlements		Land, housing and settlement development	• Water Utilization
6.1.5 Livestock and Fisheries		Fisheries and Livestock development	• Water Utilization
6.1.6 Industry, Trade and Investment		Investments and trades	• Water Utilization • Water resources development • Investment in water resources
6.1.7 Finance and Planning		Financing development water resources management plans	• Water resources development • Investment in water resources
6.1.8 Vice President Office Environment		Environmental management	• Water Resources management
6.1.9 Health, Community Development, Gender, Elderly and Children		Improving community Health, Development, Gender, Elderly and Children	• Water resources utilization
Regional Bodies			

6.1.10 East African Community (EAC)	Intergovernmental organizations, agencies, commissions and Boards	Regional Water resources management	• Transboundary water resources management protocol establishment. • Oversee transboundary water resources utilization
6.1.11Nile Basin Initiative		Regional Water resources management	• Transboundary water resources management protocol establishment. • Oversee transboundary water resources utilization
6.1.12 East African Community Lake Victoria Basin Commission Secretariat (EAC-LVBCS)		Co-ordinate sustainable development and management of the Lake Victoria Basin	• Transboundary water resources management protocol establishment. • Oversee transboundary water resources utilization
6.2 Implementing Agencies / RBO (incl. NGOs)	Often these are governmental bodies and authorities from various departments and sectors. Examples: • River Basin Board • water and sanitation	Develop policies into strategies and management plans (objectives, activities and budgets) and implement them, e.g.: • enforce Water Allocation Plans • manage irrigation systems,	They know a lot about the water resources including GW management and its context and can provide important knowledge and data to the GW management plan. They can actively contribute to the development,

	departments or corporations	• build water supplies or sewage systems, • enforce water regulations. They are responsible for implementing policies for the common good and the interests of the state.	monitoring and enforcing of the management effort.
6.2.1 Lake Victoria Basin Water Board (LVBWB)		Water resources management	• Management of Water resources • Water Allocation • Permitting • Water Sources protection
6.2.3 National Irrigation Commission (NIC)		Irrigation development	• Water Utilization
6.2.4 National Land Use Planning Commission		Land use plans	Water Sources protection
6.2.5 Tanzania Investment Centre (TIC)		Catalyzing investments	Water resources utilization
6..2.6 National Development Cooperation (NDC)		National development plans	• Water resources allocation • Water resources development

6.2.7 Tanzania Electric Supply Company (TANESCO)		Electricity generation and supply	• Management of Water resources • Water resources utilization • Water Sources protection
6.2.8 Drilling and Dam Construction Agency (DDCA)		Exploration and drilling well development	• Water resources investment • Management of Water resources • Water resources utilization • Water Sources protection
6.2.9 Bukoba Urban Water and Sewerage Authorities		Water distribution and sewerage management	• Water resources investment • Management of Water resources • Water resources utilization • Water Sources protection
6.3 Higher learning and research institutions		Knowledge brokers	• Disseminating knowledge in water resources management • Water Utilization

6.4 Communities and CBOs	People with GW in their daily lives and often depending on the GW for part or all of their livelihoods. Sometimes they are organized into community-based organizations (CBOs) Examples: • farmers • fishermen • women groups • Irrigators Associations/ Water User Associations	They benefit from the water services. This can be in the form of products (food, water, other materials) harvested or other services (e.g., irrigation, selling water, religion).	They know a lot about the GW resources therefore they can contribute to the planning process. They also need to stand up for their interests in the GW as a support for their livelihoods, i.e., their role is to negotiate with the other stakeholders so that a reasonable portion of their claims are honored;
6.5 Private sector	Individuals or companies with a commercial interest in GW. Examples: • commercial farms • tourism operators and hotels • mining companies	They use the GW for economic activity -	They have an interest in GW for their economic activities. Their role is to negotiate with the other stakeholders so that they can get a reasonable part of their claims honored and respect the other interests in the GW and become an active partner in the wise use of GW.
6.5.1 Kagera Sugar Company		Commercial farming	• Water utilization • Water Allocation • Water sources conservation

6.5.2 Drilling companies		Drilling wells (community and private)	• Water Utilization • Water level monitoring
6.5.3 Water User Groups (Farmers, Livestock)		Water utilization	• Water utilization • Sources conservation
6.6 Research and academia	Faculty and students of universities or staff of government or private research institutions. Examples: • universities • fisheries institutes • agricultural research stations • biological research stations • national statistics bureau	They do research in the GW and use the results for teaching programmes or for publications.	They know a lot about the GW therefore they can contribute to the planning process. They can generate new knowledge based on the requirements of the GW management process. They can share knowledge about GW with different stakeholder groups in the appropriate form. They can play a role in facilitating the management process and in monitoring the management process once a plan is being implemented.
6.7 Donors, NGOs, and CSOs			
6.7.1 Local NGOs	**CARITAS, COLPING, Nature Tanzania**	Community water supply services	Community water supply services

6.7.2 International NGOs	**Wetlands International**	Community Education	• Community Education • Support Water sources conservation • Income generating activities

6. IMPACT OF CLIMATE CHANGE

6.1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (IPCC 2014 and 2018). The variability that climate change may introduce such as rise in temperature and the changes in precipitation can potentially impact ecosystems, biodiversity and the way of life of the population in affected regions. Africa in particular is considered as highly vulnerable to climate change which is expected to have a severe impact on the availability of water resources, food security, economic development and biodiversity. It should be noted that climate changes may have positive consequences for some areas in the form of increased precipitation. The assessment of the sustainability of water resources should thus always take the impact of climate change into consideration.

General circulation models (GCMs) are a type of climate models. It employs a mathematical model of the general circulation of a planetary atmosphere or ocean. It uses the Navier–Stokes equations on a rotating sphere with thermodynamic terms for various energy sources (radiation, latent heat). These equations are the basis for computer programs used to simulate the Earth's atmosphere or oceans. Atmospheric and oceanic GCMs (AGCM and OGCM) are key components along with sea ice and land-surface components.

GCMs and global climate models are used for weather forecasting, understanding the climate, and forecasting climate change.

6.2. The Representative Concentration Pathway (RCP)

A Representative Concentration Pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory. They **make predictions of how concentrations of greenhouse gases in the atmosphere will change in future as a result of human activities**. The four RCPs range from very high (RCP8. 5) through to very low (RCP2. 6) future concentrations. The RCPs considered in this study are as follows

RCP 1.9: is a pathway that limits global warming to below 1.5 °C. It is an optimistic scenario, which describes **a world where global CO_2 emissions are cut to net zero around 2050** and societies switch to more sustainable practices.

RCP 2.6: is a "very stringent" pathway. It requires that carbon dioxide (CO_2) emissions start declining by 2020 and go to zero by 2100. It also requires that methane emissions (CH_4) go to approximately half of the 2020 level, and that Sulphur dioxide (SO_2) emissions decline to approximately 10% of those of 1980–1990. RCP 2.6 is likely to keep global temperature rise below 2 °C by 2100.

RCP 4.5: is described by the IPCC as an intermediate scenario. Emissions in RCP 4.5 peak around 2040, then decline. According to specialists' emission scenarios are biased towards exaggerated availability of fossil fuels reserves; RCP 4.5 is the most probable baseline scenario taking into account the exhaustible character of non-renewable fuels.

RCP 6.0: emissions peak around 2080, then decline.

RCP 8.5: emissions continue to rise throughout the 21st century. RCP8.5, is generally taken as the basis for worst-case climate change scenarios, and is based on what proved to be overestimation of projected coal outputs. It is still used for predicting mid-century (and earlier) emissions based on current and stated policies.

Projections of climate change across all RCPs predicts that global mean temperature is expected to rise by 0.3 to 4.8 °C by the late-21st century and that the mean sea level is projected to rise by 0.26 to 0.82 m.

Table 6-1: Global Climate Change Projections

AR5 and SSP Scenarios and temperature change projections		AR5 global mean sea level (m) increase projections [22]	
SSP Scenario	**Range of Global Mean Temperature Increase (Celsius) – 2100 from pre-Industrial baseline**	**2046–2065**	**2081–2100**
RCP 1.9	~1 to ~1.5		
RCP 2.6	~1.5 to ~2	0.24 (0.17 to 0.32)	0.40 (0.26 to 0.55)
RCP 4.5	~2.5 to ~3	0.26 (0.19 to 0.33)	0.47 (0.32 to 0.63)
RCP 6.0	~3 to ~3.5	0.25 (0.18 to 0.32)	0.48 (0.33 to 0.63)
RCP 8.5	~5	0.30 (0.22 to 0.38)	0.63 (0.45 to 0.82)

6.3. Climate Change at Kagera Basin

Analysis and prediction of the climate change for the Kagera Basin was conducted through the World Climate Research Program (WCRP) Coupled Model Intercomparison Project (CMIP5).

Bound by coordinates -5.0 to 0.0 degrees North and 29.0 to 32.0 degrees East. The analysis considered three climate parameters; Temperature, Precipitation and Evapotranspiration.

CMIP5 encompasses data from 34 Global Circulation Models (GCM). Data series for each parameter. In this study the monthly aggregated mean for the investigated parameters was calculated from the results of all CMIP5 models for the period from 1950 to 2100. The analysis was conducted for four RCPs, namely RCP2.6, RCP4.5, RCP6.0 & RCP8.5

6.3.1. Average Temperature at Surface (SAT)

The analysis results show that under RCP 8.5 scenario, the Average Temperature at Surface (ATS) within the area of the Kagera Basin will continue to rise throughout the last 50 years of the projected period, and will peak to approximately 26°C by 2100 (Figure 6-1) The likelihood of this scenario is however rated as low it was however adopted as the worst-case scenario for this study. Results of the stringent RCP 2.6 scenario shows that the (SAT) is projected to stabilize at slightly above 22° C by 2100 thus limiting temperature rise to about 1°C from the 1950 levels. Results of the RCP 4.5 and RCP 6.0 scenarios also predicts the continual rise of annual average surface temperatures predicting these values to reach values of 23.3°C and 24°C respectively.

The four RCP scenarios indicate an expected rise of surface temperatures within the basin, with similar rates till 2035 after which the four projections show different trends. The results of the monthly SAT shows that the months of June, July, August and September are expected to experience highest level of temperature changes.

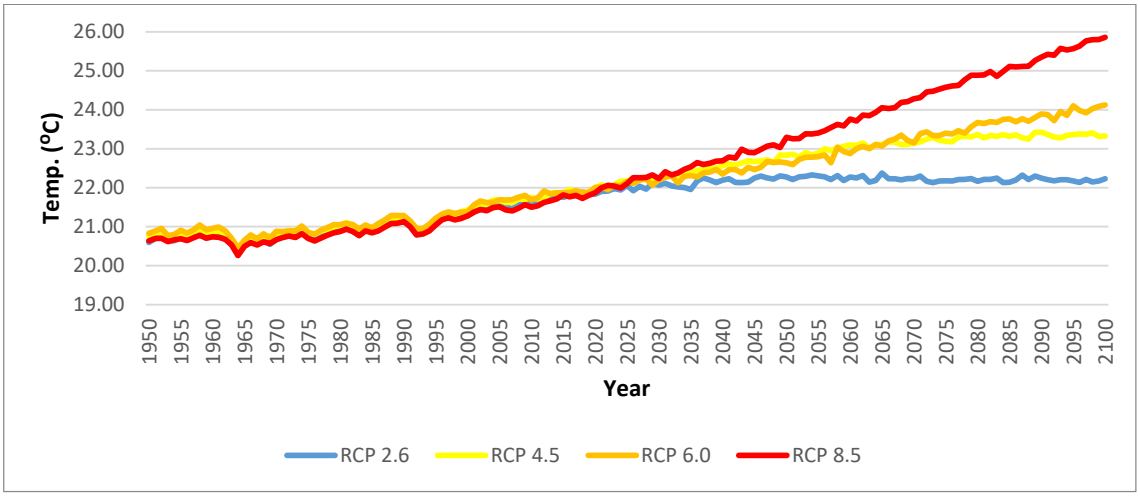

Figure 6-1: Annual Average Temperature at Surface

Table 6-2:Monthly Temperature Comparison (Year 2050)

Year	2050 (°C)						
Scenario	RCP 2.6 (baseline)	RCP 4.5		RCP 6		RCP 8.5	
Month	Value	Value	Deviation	Value	Deviation	Value	Deviation
Jan	**21.6**	22.0	0.4	22.0	0.4	22.4	0.8
Feb	**22.2**	22.8	0.6	22.6	0.4	23.1	0.9
Mar	**22.8**	23.1	0.3	23.1	0.3	23.7	0.9
Apr	**22.7**	23.1	0.4	23.1	0.4	23.7	1.0
May	**22.2**	22.8	0.5	22.5	0.3	23.4	1.2
Jun	**21.7**	22.2	0.5	21.8	0.2	22.7	1.0
Jul	**21.5**	22.2	0.6	21.8	0.3	22.8	1.3
Aug	**22.6**	23.4	0.8	23.1	0.5	23.9	1.2
Sep	**23.6**	24.3	0.8	24.0	0.5	24.6	1.0
Oct	**23.2**	23.8	0.6	23.6	0.4	24.2	1.0
Nov	**22.0**	22.6	0.6	22.4	0.4	22.8	0.8
Dec	**21.3**	21.9	0.6	21.7	0.5	22.2	0.9

Table 6-3: Monthly Temperature Comparison (Year 2100)

Year	2100 (°C)						
Scenario	RCP 2.6 (baseline)	RCP 4.5		RCP 6		RCP 8.5	
Month	Value	Value	Deviation	Value	Deviation	Value	Deviation
Jan	**21.6**	22.5	0.9	23.2	1.6	24.9	3.3
Feb	**22.2**	23.3	1.1	23.9	1.8	25.6	3.5
Mar	**22.6**	23.6	1.0	24.5	1.8	26.1	3.5
Apr	**22.7**	23.6	0.9	24.6	1.9	26.3	3.6
May	**22.3**	23.2	0.8	24.2	1.9	25.9	3.6
Jun	**21.6**	22.7	1.0	23.5	1.9	25.4	3.8
Jul	**21.5**	22.8	1.3	23.4	1.9	25.7	4.2
Aug	**22.5**	23.9	1.4	24.7	2.2	26.7	4.2
Sep	**23.4**	24.8	1.4	25.7	2.2	27.2	3.8
Oct	**23.1**	24.3	1.1	25.0	1.9	26.6	3.5
Nov	**21.9**	22.9	1.0	23.7	1.8	25.2	3.3
Dec	**21.3**	22.3	1.1	23.1	1.8	24.6	3.3

6.3.2. Precipitation (Pr)

The Kagera Basin is endowed with significant surface resources as a result of the abundant precipitation it annually receives. Its biodiversity and environmental settings are a result of these precipitation levels and are bound to be greatly affected it is subjected to significant changes in quantity or pattern. Significant changes of precipitation levels will also impact the livelihood of the basin inhabitants and severe consequences may occur if there are significant decreases in precipitation levels.

The potential impact of climate change on precipitation trends within the Kagera basin was projected with the four RCP scenarios RCP2.6, RCP4.5, RCP6.0 and RCP 8.5. The results projects that the basin is not expected to witness a decrease in total precipitation. Indeed, with the exception of RCP2.6 which indicate almost no change in total annual precipitation, the three other RCP scenarios indicate a marked increase in precipitation particularly after the year 2050. (Figure 6-2) RCP 8.5 projects an increase of about 15% in total annual precipitation by the year 2100 as compared to the 1950 levels. RCP 4.5 and RCP 6.0 projects increases of 75-10% in annual precipitation yields for the same periods.

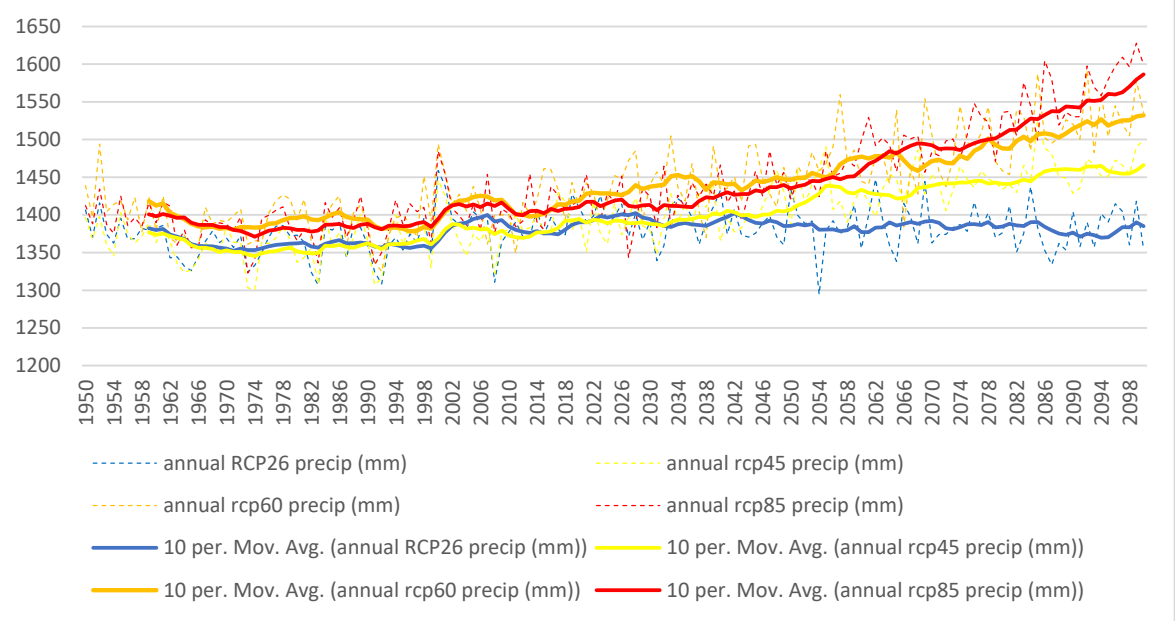

Figure 6-2: Total Annual Precipitation

Analysis was conducted to estimate the changes in the number of rainy days per annum under the different RCP scenarios. The analysis was conducted for the number of rainy days in which precipitation exceeds 10mm, which is also expected to witness an increase in line with the increase in total annual precipitation. The average annual number of rainy days is expected to increase to 61 days/month for RCP8.5 in comparison to 55 days for RCP2.6 at 2100.

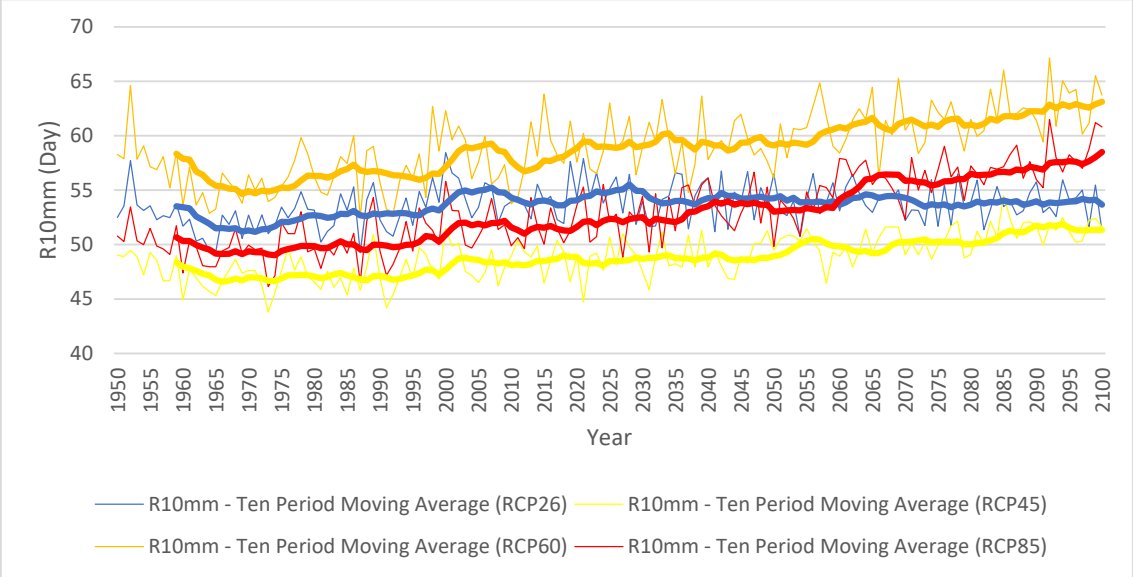

Figure 6-3: Annual Number of Rainy Days

Table 6-4 Projected Number of Rainy Days (2050, 2100)

	2050				2100			
	2.6	4.5	6	8.5	2.6	4.5	6	8.5
R10mm (days)	56.5	49.5	56.1	49.8	51.2	51.6	63.7	60.8
Deviation from Baseline (days)	0.00	-7.0	-0.4	-6.7	0.0	0.4	12.5	9.6

Changes of rainfall patterns can also have an impact on the environment the livelihood of the basin's population. Projections of monthly precipitation values for the four RCPs scenarios used in this climate change analysis were obtained for the years 2050 and 2100 (Table 6-5and Table 6-6). The results show that the bimodal nature of precipitation will be retained with peak precipitations in the months of November and December. Precipitations are expected to increase with variable proportions for all of the twelve months by 2100. Slight decreases are however temporarily expected prior to and at 2050. The month of December is expected to witness higher rates of increase in precipitation compared to the other months to the extent that precipitation rates for month of December may exceed November rates by 2100 under the RCP8.5 scenario.

Table 6-5: Monthly Precipitation Comparison (Year 2050)

Year	2050 (mm)									
Scenario	RCP 2.6 (baseline)	RCP 4.5			RCP 6			RCP 8.5		
Month	Value	Value	Deviation	%	Value	Deviation	%	Value	Deviation	%
Jan	**190.9**	177.0	-13.9	7%	187.0	-3.9	2%	187.8	-3.1	2%
Feb	**170.7**	156.1	-14.6	9%	181.9	11.2	7%	163.1	-7.6	4%
Mar	**164.4**	167.6	3.2	2%	171.1	6.7	4%	145.3	-19.1	12%
Apr	**132.3**	116.2	-16.0	12%	125.2	-7.1	5%	122.1	-10.2	8%
May	**48.4**	49.6	1.2	2%	44.4	-4.0	8%	47.4	-1.0	2%
Jun	**12.2**	12.2	0.0	0%	9.2	-2.9	24%	13.2	1.0	8%
Jul	**6.9**	9.0	2.1	31%	6.4	-0.5	7%	6.6	-0.2	3%
Aug	**12.3**	14.1	1.8	15%	14.3	2.0	16%	14.8	2.5	21%
Sep	**47.2**	55.6	8.5	18%	43.4	-3.8	8%	59.7	12.5	27%
Oct	**141.5**	146.1	4.6	3%	144.5	3.0	2%	145.4	3.9	3%
Nov	**261.7**	259.3	-2.4	1%	276.0	14.3	5%	270.8	9.1	3%
Dec	**245.2**	224.0	-21.2	9%	222.6	-22.6	9%	244.9	-0.4	0%

Table 6-6 Monthly Precipitation Comparison (2100)

Year	2100 (mm)									
Scenario	RCP 2.6 (baseline)	RCP 4.5			RCP 6			RCP 8.5		
Month	Value	Value	Deviation	%	Value	Deviation	%	Value	Deviation	%
Jan	**181.2**	196.8	15.6	9%	200.4	19.2	11%	210.7	29.5	16%
Feb	**175.2**	176.9	1.7	1%	176.4	1.1	1%	175.3	0.0	0%
Mar	**157.2**	181.0	23.8	15%	185.0	27.8	18%	169.2	12.0	8%
Apr	**110.0**	141.3	31.3	28%	146.6	36.6	33%	139.8	29.8	27%
May	**41.2**	51.9	10.6	26%	54.9	13.7	33%	58.8	17.6	43%
Jun	**8.2**	10.0	1.8	22%	8.9	0.7	9%	11.6	3.4	41%
Jul	**3.7**	7.7	4.0	107%	6.8	3.1	84%	9.1	5.3	143%
Aug	**13.1**	17.7	4.6	35%	15.1	2.1	16%	18.3	5.3	40%
Sep	**51.5**	59.1	7.5	15%	49.6	-1.9	4%	68.8	17.3	34%
Oct	**127.5**	152.8	25.2	20%	154.9	27.4	21%	165.8	38.3	30%
Nov	**253.2**	270.4	17.2	7%	276.4	23.2	9%	279.4	26.3	10%
Dec	**232.5**	233.2	0.7	0%	260.6	28.1	12%	292.2	59.7	26%

6.3.3. Evapotranspiration

Increase in evapotranspiration levels in a warming climate can potentially decrease the generation of surface runoff and surface waters, cause a shrinkage of wetlands and reduce the amount of recharge to groundwater. The potential impact of the climate on evapotranspiration levels in the Kagera Basin were projected under the four considered RCP scenarios. The analysis projects that the evapotranspiration rate trends will remain the basically the same for

the four scenarios till the year 2030 after which a marked and continuous increase in total annual precipitation will be occur till 2100 under the scenarios RCP4.5, RCP6.0 and RCP8.5. Referring to the projections of the stringent baseline scenario of 2.6, an increase of total annual precipitation by 70mm/year is expected for RP8.5 by 2100 and a marked increase of about 35mm per year is expected by 2050. Even though an increase of the transpiration rates is expected by 2100 for all of the twelve months of the year, the pattern of monthly evapotranspiration is not expected to remain the same with March being the month with highest evapotranspiration and August the least.

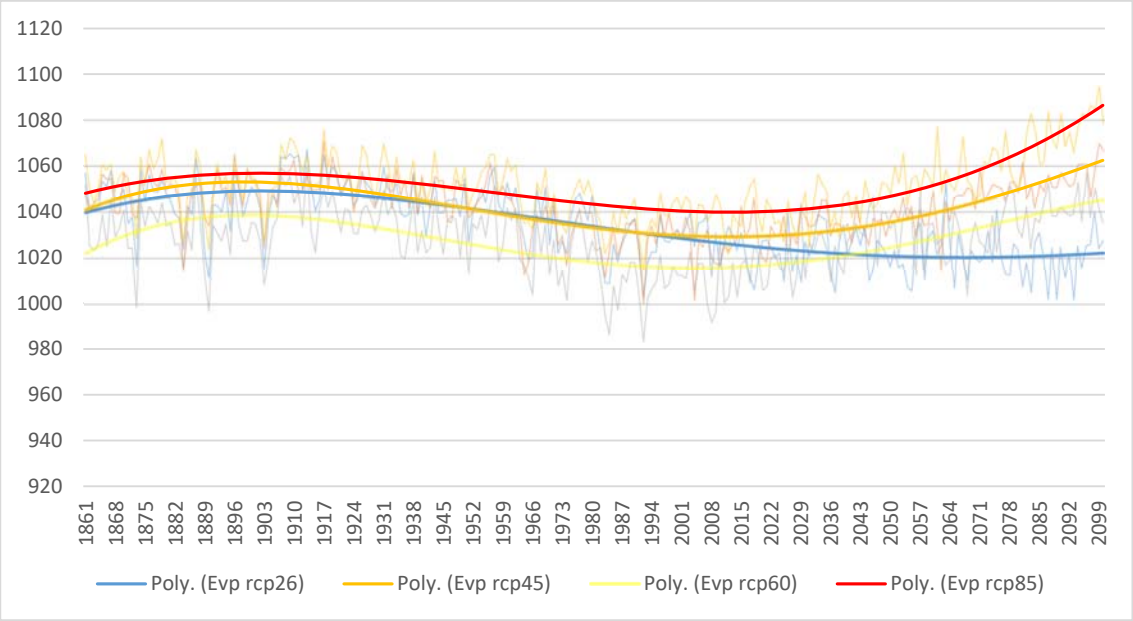

Figure 6-4: Total Annual Evapotranspiration

Table 6-7 Monthly Evapotranspiration Comparison (Year 2050)

Year	2050									
Scenario	RCP 2.6 (baseline)	RCP 4.5			RCP 6			RCP 8.5		
Month	Value (mm)	Value	Deviation	%	Value (mm)	Deviation	%	Value (mm)	Deviation	%
Jan	**102.3**	101.4	-0.9	1%	105.0	2.7	3%	104.7	2.4	2%
Feb	**111.7**	110.9	-0.9	1%	111.9	0.2	0%	113.8	2.0	2%
Mar	**116.5**	115.8	-0.7	1%	117.6	1.1	1%	118.1	1.6	1%
Apr	**107.3**	112.6	5.3	5%	111.7	4.5	4%	110.1	2.8	3%
May	**86.8**	92.1	5.3	6%	89.2	2.4	3%	89.6	2.8	3%
Jun	**66.7**	70.3	3.6	5%	68.2	1.6	2%	69.9	3.3	5%
Jul	**55.8**	56.9	1.1	2%	54.0	-1.8	3%	56.6	0.8	1%
Aug	**52.2**	52.7	0.5	1%	52.7	0.5	1%	52.6	0.4	1%
Sep	**58.0**	60.4	2.5	4%	57.7	-0.3	0%	61.6	3.6	6%
Oct	**74.1**	77.4	3.3	4%	76.3	2.2	3%	78.5	4.4	6%
Nov	**89.7**	90.0	0.3	0%	92.3	2.6	3%	94.5	4.8	5%
Dec	**95.2**	96.9	1.7	2%	96.0	0.8	1%	97.7	2.4	3%

Table 6-8 Monthly Evapotranspiration Comparison (Year 2100)

Year	2100									
Scenario	RCP 2.6 (baseline)	RCP 4.5			RCP 6			RCP 8.5		
Month	Value (mm)	Value (mm)	Deviation	%	Value (mm)	Deviation	%	Value (mm)	Deviation	%
Jan	**103.6**	105.5	1.9	2%	102.5	-1.0	1%	105.6	2.0	2%
Feb	**113.0**	113.7	0.6	1%	111.3	-1.8	2%	113.3	0.3	0%
Mar	**119.7**	118.4	-1.4	1%	114.0	-5.7	5%	119.5	-0.3	0%
Apr	**109.8**	113.8	4.0	4%	108.4	-1.5	1%	114.3	4.5	4%
May	**87.8**	96.2	8.4	10%	91.4	3.6	4%	96.0	8.2	9%
Jun	**65.4**	73.1	7.7	12%	69.0	3.6	6%	73.8	8.4	13%
Jul	**53.8**	57.7	3.9	7%	56.4	2.6	5%	57.7	3.9	7%
Aug	**52.1**	55.1	3.0	6%	52.5	0.4	1%	55.5	3.4	7%
Sep	**58.4**	62.7	4.2	7%	59.6	1.2	2%	66.0	7.6	13%
Oct	**73.0**	79.2	6.3	9%	77.3	4.3	6%	82.9	9.9	14%
Nov	**91.6**	93.2	1.5	2%	95.6	3.9	4%	96.4	4.8	5%
Dec	**99.3**	98.0	-1.3	1%	97.1	-2.2	2%	97.2	-2.1	2%

6.3.4. Conclusions of Climate Change Analysis

The analysis of the impact of climate change on the Kagera basin area was conduced through the World Climate Research Program (WCRP) Coupled The analysis projected the changes to three climate parameters; Temperature, Precipitation and Evapotranspiration to the year 2100 under four Representative Concertation Pathways, namely RCP2.6, RCP4.5, RCP6.0 and RCP8.5. The results of the analysis projected that the Kagera Basin Catchment area will witness the following changes:

- The average surface temperatures are expected to rise by 1^{O}C to 4^{O}C by the year 2100 depending on the level of success to reduce CO2 emissions.
- The basin is projected to witness an increase in average annual precipitation and the number of effective rainy days per year, with an increase in the frequency of occurrence of serve events. The rainfall pattern is not projected to significantly change. December is projected to replace November as the month with the highest monthly precipitation rates.
- Failure to reduce CO_2 emissions to zero by 2100 (RCP2.6) will cause a gradual and marked increase of annual evapotranspiration rates as of 2050. An increase of 70 mm/year can be expected according to the RCP8.5 Scenario.
- Indications are that the Kagera basin catchment area is one of the regions that is projected to experience increases in precipitation. In spite of this, surface and groundwater resources may still be negatively impacted. Increased precipitation

variability, the inevitable surface temperature rise and potential increase of evapotranspiration may affect hydrological responses within the catchment, reduce the surface runoff and cause drying of the wetlands. The issue of impact of climate change is not trivial and indications of the increase precipitation is not an assurance of an increase in groundwater recharge. Changes of environmental flow and the periodicity of replenishment event may lead to reduction of groundwater recharge in spite of increases in total annual precipitation. Without quantification of the amount of recharge to the Kagera aquifer from the different identified recharge sources, the impact of climate change on Kagera aquifer cannot be discerned. In addition to the quantification of the recharge rates to the Kagera Aquifer, tools to assess the effect of climate change on environmental flows and model the climate change groundwater linkages are needed.

7. SUMMARY AQUIFER STATUS ANALYSIS

Aquifer Characteristics: The Kagera aquifer is for the most part defined as the low areas of alluvium deposits around the Kagera River. The transboundary aquifer thickness is not precisely mapped but is expected to be in the order of 50-80m at the downstream part of the aquifer and shallower at the upstream. It is underlain in either by a fractured basement complex / Metasedimentary rocks or by consolidated sedimentary formations. The area of the whole aquifer is estimated to be 6300 Km^2 with 1 % of it within Burundi, 13 % within Rwanda, 22 % within Uganda and 64 % within Tanzania. Population living within the aquifer boundary is estimated to be about 900,000 (59% in Tanzania, 22% in Uganda, 17% in Rwanda and 3% in Burundi. The Kagera aquifer may be the most prominent groundwater resource in the Kagera Basin which is known for its mountainous terrain, significant rainfall, flowing rivers and lakes. The basement complex rocks that cover most of the terrain of the Kagera Basin allow for limited storage and transmission of groundwater through their fissures.

Recharge to the Kagera aquifer is not quantified and the available data and information are insufficient to ascertain this information. Sources of recharge to the alluvium aquifer were identified to occur from three potential sources;

- Direct Recharge from the Kagera River: Aquifer replenishment apparently occurs when the river stage is higher than the groundwater level thus generating a hydraulic gradient where by the river loses to the aquifer. The process may be reversed when the river stage becomes lower than the groundwater level in which condition the river gains water from the aquifer
- Direct Recharge from Wetlands: The Kagera basin features a number of wetlands in its low elevation areas, a number of which around the depressions of the Kagera River. These wetlands are contact zone through which the aquifer may be recharged. Wetlands may also be points of groundwater discharge to the surface of the land.
- Flow from the surrounding fractured basement complex: The heterogeneous mixture of crystalline rocks forming the basement complex around the Kagera River are highly fissured and thus have the ability to store and transmit rain water through these fissures. Water moves slowly through these fissures and often emerge in the study area in the form of spring in the side of the mountain, the flow may also emerge below the ground surface to latterly recharge the alluvium aquifer in the pediplain. The storage of the basement complex is finite and relatively small, however the large contact area of these

hills along the boundaries of the aquifer means that significant volumes of recharge may be introduced to the aquifer with recharge sources as far west as the Congo-Nile Ridge.

Socioeconomic Background: The total population of the four riparian countries of Kagera is estimated to be more than 120 million with Tanzania being the most populous (~49%) followed by Uganda (~32%), then Rwanda (~10%) and Burundi (~9%). The average annual population growth rate in the four countries is about 3% and about half of the total population is below the age of 15. The population within the Kagera aquifer area is estimated to be about 900,000 distributed between the four countries as follows; Tanzania 59%, Uganda 21%, Rwanda 17% and Burundi 3%

Farming activities are the most dominant livelihood activity in Kagera aquifer area. The main livelihoods structure in the aquifer are dominated by subsistence farming; crop and livestock production. The main food crops include finger millet, maize, beans, bananas, cassava, potatoes, in addition to fruits and vegetables with Coffee being a major cash crop.

Other livelihood activities include small scale fish farming, agroforestry and brick making. Agricultural activities are dominated by women, while the remaining aforementioned activities are dominated by men. The aquifer region is generally one of high poverty, with poverty status varying from one location to another depending on existing opportunities for economic activities. Urban centres within the aquifer serve as regional trade and service centres relying primarily on trade and services and small manufacturing activities.

Precipitation and surface water from rivers and lakes are the source of water for the different livelihood activities in the Kagera region. Groundwater is used primarily as a source of drinking water and for animal watering accounting for about 70% of water supply (springs and boreholes). Women and children are mostly responsible for the collection of water. The average time spent to collect the water ranges between 20-30 minutes. Access to improved safe water sources varies greatly within the project areas and ranges in average from 60% to 80% with average per capita water use of about 25L/day. The development of groundwater resources in the area is increasingly sought by the authorities in the four riparian countries to improve access to safe water in a declared effort by the four countries to achieve universal access by 2030 in line with the sustainable development goals. Groundwater can contribute to the reduction of the risks of waterborne diseases as in general it is of better quality than surface water sources. The challenge however, is to prevent groundwater contamination from anthropogenic sources. While the development of groundwater can effectively contribute to the enhancement of the

domestic water supply, it is generally hampered by a number of technical, financial and/or managerial factors.

The Kagera aquifer in not well mapped within the four riparian countries. Its extent and storage capacity are not delineated. Basic data pertaining to aquifer properties and its current level of development are lacking, there are no operational monitoring activities within the aquifer and none of the riparian countries have a plan for the aquifer development.

Data Gaps: Groundwater is hidden resource, the characterization of which requires the collection of various types of data. Identification of data gaps and continuous data collected efforts are required to enhance the level of knowledge of aquifer and its properties. A narrative of some of the basic data used to characterize the Kagera Aquifer and identified gaps is given hereinafter:

- Geological Maps: Geological maps for the project area were compiled from the geological maps of the four riparian countries. These country maps are available in different formats and scales. The variability of the maps' scales and the adoption of different formation names and lithological description details, pose a challenge to the compilation of the available data into one geological map. Detailed geological surveys in parts of Kagera Aquifer area to produce a joint geological map for the aquifer at a scale of 1:20,00 for the four countries will enhance the aquifer characterization efforts.
- Information about aquifer thickness, depth to water, water quality, groundwater use and aquifer stratification can be ascertained from well data. This information is usually obtained during the well drilling process. Indeed, the regulations in Uganda and Tanzania stipulate the attainment of a license from the ordained authority prior to well drilling, and the submission of well log sheet after the drilling process. However, the enforcement of these regulation is not consistent and the well logs of drilled wells are either missing or dispersed among different drilling companies and NGOs. Furthermore, when available these logs for the most part are not electronically archived nor are they prepared with consistent standards. From the hundreds of well logs compiled during the study, very few were found to be within the delineated boundary of Kagera Aquifer, and primarily located within Uganda and Tanzania. The compiled data provided local information about the aquifer thickness. However, they were not accurate nor sufficient to provide information about groundwater flow directions or water quality.
- The determination of groundwater level from the available log data was hampered by the limited size of data and the absence of accurate elevation data at the points of

measurements as the information was available in the form of depth below ground level. Errors within the digital elevation model used to reduce the groundwater level and the differences in the resolutions of the models available for the four countries is bound to smear the ascertained results of groundwater level. The low frequency of measurement, the limited spatial distribution of measurements and the inaccuracies associated with the measurement and the reference data make to difficult to detect or filter out seasonal fluctuations in groundwater levels.

- Field surveys to compile an inventory of all wells within the Kagera Aquifer and the establishment of a spatial database to archive this data is needed for the assessment of flow dynamics within the aquifer and its use. The establishment of a monitoring system for the aquifer is essential for the successful implementation of an effective system for its management.

Governance and Institutional Setup: The beginning of the third millennium witnessed the development of national visions within the four riparian countries that share the Kagera aquifer to reduce poverty, and health problems and improve access safe clean water and adequate sanitation within 20 to 25 years. National policies to achieve the set targets were subsequently developed. At the core of these policies were the water policies which embraced the UN sustainable development goals for water and sanitation to achieve the equitable and sustainable use and management of water resources for poverty alleviation, socio-economic development, and the protection of the environment.

The policies adopted by the four counties were similar in that they followed the same principles which regarded water as human resource which is to be used for the public good, emphasized the human right of access to water, and adopted the concepts of Integrated Water Resources Management (IWRM) for water management with emphasis on participatory approach. The policies embraced the concepts of catchment-based water resources management, management of water taking into consideration conservation of water sources, environmental impacts and consideration to the aspect of internationally shared water resources. If not specifically cited in these policies groundwater is addressed as in the case of Burundi as part of the water resources to be conserved and sustainably managed. The water policies of the four countries have in essence the same core set of guiding principles and goals and do provide a coherent set of strategies to guide the sector and allows for the establishment of joint legal framework for joint management of transboundary water resources.

The evolution of the legal frameworks for the governance of water resources was influenced in each of the four riparian countries by the adopted water policies, history, socio-cultural structures and practices as well as the existing political climate. In spite of the existence of differences in focus and structure the legal frame works governing water resources management in the four countries have similar perspective elements. They provide binding set of rules that govern the vision established in the country's policy and establish the institutional setup responsible for water resources management within the country. Furthermore, they provide aligned legal frameworks that address the use and management of water resources including its protection from pollution. Existing legislations also allows for cooperation and sharing of data with riparian countries for the management of transboundary water resources. Legislations however are more centred towards the use and management of surface water and address groundwater with different levels of emphasis. Groundwater management regulations are more developed in the four countries in the following order Tanzania, Uganda, Rwanda and Burundi which apparently reflect the order of prevalence of use of groundwater within the four countries.

Legislations and regulations pertaining to groundwater management in the legislative frameworks of the four riparian countries include:

Water Allocation: Development of groundwater resources requires the attainment of water permits and the legislations specifies the level of government from which the water allocation permits can be obtained. The amount of water that can be allocated and time for which water rights are granted are subject to the discretions of the authorizing agency. It is bound to be different within the four countries as it is most likely influenced by local legal traditions. Water allocation for human consumption is considered as basic right and can apparently be readily obtained. The issue groundwater allocation for irrigation or other industrial purposes may be a source of controversy in establishing joint management efforts of the transboundary aquifer.

Water Tariffs: The concept of payment of tariffs for used Groundwater is enshrined in the water resources legislative frameworks of the four riparian countries. The basis for the fee determination is not set and may differ in different areas within the same country. Water tariff may be specified based on cost recovery principles, market value principle or as a conducive element for the efficient use of water. Agreement on the basis of water tariff specification will be conducive to efforts of developing transboundary aquifer management systems.

Environmental Considerations: Environmental legislations are similar within the four countries in that they take into consideration water quality when issuing groundwater allocation, require

environmental impact processes for proposed interventions and put controls on discharge to water sources.

The water management structure practiced in the four riparian countries is a state-centered or technocratic system of management. This system is based on the notion that the state, through its administrative and political institutions can and should allocate and plan the nation's water resources in the interest of the common good.

Water resources management is sought in the riparian countries within the framework of the river basin adopting IWRM principles. Planning management and conflict resolution is undertaken by the government with emphasis on decentralization through governing boards and regional and local authorities/agencies with the involvement of Primary stakeholders (local communities, farmers, water users).

The water governance institutional setup in the four countries can be divided into four levels (i) the National level responsible for formulating national policies, oversight, budgeting, resource mobilization, regulating and overall performance monitoring. (ii) The regional level (or Basin/Catchment Level) which is responsible for the development, management of water facilities. (iii)The local level (subbasin/subcatchment level), responsible for the direct operation of water facilities, monitoring, conflict resolution, regulation enforcement. (iv) Community Level: This may comprise individuals or water user committees whose role is to monitor service delivery and functionality, report problems and sensitize users to pay for water services.

The implementation of existing water resources regulations requires the establishment of a range of mechanisms aiming to ensure compliance with existing regulations. These mechanisms, situation monitoring, issuing warnings, imposing fines, revoking water licenses or suspending operations. There is an apparent weakness in the performance of the enforcement mechanisms within the four countries which attributed to number of factors:

- Lack of funding for monitoring activities
- Shortage of trained enforcement officers
- Weak involvement of primary stakeholders due to lack of awareness and/or poor communication with stakeholders at the local level.
- Poor coordination between stakeholders at the national, regional, and local levels

The development of an enabling environment for attaining the effective joint management of the Kagera Aquifer requires the alignment of the water resources policies and legislations, the

establishment of effective regulatory agencies, and monitoring systems and the full engagement of the primary stakeholders in the decision-making process.

Impact of Climate Change: The analysis of the impact of climate change on the Kagera basin area was conduced conducted through the World Climate Research Program (WCRP) Coupled The analysis projected the changes to three climate parameters; Temperature, Precipitation and Evapotranspiration to the year 2100 under four Representative Concertation Pathways, namely RCP2.6, RCP4.5, RCP6.0 and RCP8.5. The results of the analysis projected that the Kagera Basin Catchment area will witness the following changes:

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Indications are that the Kagera basin catchment area is one of the regions that is projected to experience increases in precipitation. In spite of this, surface and groundwater resources may still be negatively impacted. Increased precipitation variability, the inevitable surface temperature rise and potential increase of evapotranspiration may affect hydrological responses within the catchment, reduce the surface runoff and cause drying of the wetlands. The issue of impact of climate change is not trivial and indications of the increase precipitation is not an assurance of an increase in groundwater recharge. Changes of environmental flow and the periodicity of replenishment event may lead to reduction of groundwater recharge in spite of increases in total annual precipitation. Without quantification of the amount of recharge to the Kagera aquifer from the different identified recharge sources, the impact of climate change on aquifer cannot be discerned. In addition to the quantification of the recharge rates to the Kagera Aquifer, tools to assess the effect of climate change on environmental flows and model the climate change groundwater linkages are needed.

It should be noted that climate change direct impacts are not limited to water resources, temperature rise may cause events of shock (floods/droughts) which may lead to loss of vegetation and lower yields for crops thus causing food insecurity for the affected areas.

Aquifer Management and Development: The joint development and management of Kagera Aquifer requires the development of a management structure that will be entrusted with the coordination of the process of allocation and development of groundwater resources in the riparian countries to meet the needs of designated end users as well as conserve, protect or improve groundwater basins in terms quantity and quality. Some of the factors that constrain the development of these structures and their ability to operate if established include:

- Poor groundwater information database in terms of data quality and the ability to readily consolidate data for the purpose of planning and management.
- Lack of the basic hydrogeological data required to adequately map the groundwater basins and plan their development. This may include: lithology data, values of hydrogeological parameters, recharge rates, water level data, water quality data…
- Absence of the monitoring systems necessary to fully ascertain water level and water quality as well as the behavior of the water table to pumping and recharge within the different groundwater basins.
- Lack of information about end user current and projected needs.
- Poor connection and coordination with decision makers and planers to adequately plan or implement projects relying on groundwater.
- Poor public awareness about the susceptibility of groundwater resources to depletion and contamination.
- Absence of national plans for the aquifer development.
- Absence/deficiencies of adequate laws and institutional setups

Policies, plans and regulations pertaining to the management of water resources within the four riparian countries of Kagera Aquifer (Burundi, Rwanda, Uganda and Tanzania) are primarily centered on surface waters. While the management structures for the planning and development of groundwater resources do exist within the water resources governing bodies in the four countries, regulations and policies specifically targeting groundwater resources may not exist or are insufficient. Rules pertaining to groundwater development and protection are usually inferred from those intended for the management of surface water resources if specific rules for groundwater are lacking.

Bylaws pertaining to the regulation and licensing of groundwater development are either not fully developed or are not enforced due to budgetary constraints and the absence of the mechanisms and protocols needed to enforce these regulations if they exist.

Enhancing the capacity of the water governance sector in the four countries should be addressed. Some of the issues that should be targeted in the capacity development process of groundwater resources governing institutions in the four countries include.

- Establishment of a stable management structure for Kagera aquifer in particular and transboundary aquifers in general in the four countries, and ensure their stability in the case of the occurrence of national institutional changes
- Enhance the capacity of national to conduct exploration and aquifer assessment research activities including the training and retainment of qualified and trained staff, equipment and tools as well securing the necessary budgets.
- Improve coordination between national water resources management bodies in each of the four countries and eliminate conflicting responsibilities between key national institutions.
- Improve linkage and cooperation among national institutions working in the groundwater research and development sector (e.g., research centers, universities, drilling companies), as well as agencies in other sectors related to groundwater.
- Prepare well-developed training and capacity building plans for national staff.

Planning the development of groundwater resources may sometimes contest the land right or customary laws of local population. Such land tenure or water rights issues may differ within the different countries and/or communities in the aquifer area. Attention to the resolution of such conflicts should be part of any long-term development plans for the Kagera Aquifer.

A main step towards establishing transboundary aquifer management system/process for the Kagera Aquifer is the sharing of comprehensive aquifer development plan based on the national plans of the riparian countries. The joint management plan should determine a set of realistic goals and objectives and consolidate all the available resources thereafter to formulate and achieve these objectives

8. CONCLUSIONS

1. The Kagera has an area of about 6300 Km^2 and is crosses and has the potential to contribute to the improvement of access to safe water for about 900,000 in the rural areas within the adjacent parts of the four riparian countries which are underlain by the aquifer.
2. The aquifer extent and properties are not well delineated, to the extent that the potential of the resource could not be ascertained and its full development thus effectively hindered.
3. The absence of a groundwater monitoring system for the Kagera aquifer is bound to hinder the prospects of its effective development or its protection.
4. The aquifer recharge is linked to the precipitation in the Kagera basin which indirectly replenishes the aquifer through contact with the river flow it generates or the wetlands it forms or through preferential fracture flow from the surrounding basement complex formations.
5. The societies living across the borders of the four riparian countries are engaged in similar livelihood activities, live similar socio-economic conditions that are characterized by high poverty rates and lack of access to safe water for a significant portion of their communities. (>30%).
6. The governments of the four riparian countries have similar water policy targets and objectives that emphasize IWRM principles and meeting sustainable development goals targets and achieving economic development for the rural communities. The legal frameworks adopted by the four countries are conducive to the joint transboundary management of the shared Kagera Aquifer.
7. The organizational and management setup of the Kagera aquifer in the four countries is adversely affected by the absence of coordination and synergy between the central/regional and local/community levels of aquifer management.
8. The absence of effective enforcement mechanisms of existing groundwater laws and regulations is a governance deficiency that exists the four riparian countries.
9. Preliminary Climate change analysis do forecast that the Kagera Basin is expected to experience increases in precipitation. In spite of this, surface and groundwater resources may still be negatively impacted. Increased precipitation variability, the inevitable surface temperature rise and potential increase of evapotranspiration may affect hydrological responses within the catchment, reduce the surface runoff and cause drying of the wetlands. The impact on groundwater needs the establishment of the correlation between precipitation and the ensuing groundwater recharge.

9. RECOMMENDATIONS

The sustainable development of groundwater resources requires the acquisition of the knowledge about the resource, the required development tools, identifying achievable goals, mobilization of the needed resources as well as employing adequate administration and control mechanisms for the resource management. The following recommendations are hereby made to outline some of the actions needed to enable the sustainable development of the Kagera Aquifer

1. Establishing a Repository of Existing Data: A concerted effort by each of the four riparian countries to compile the available groundwater related information and data within their institutions into a dynamic and easily accessible spatial database will enhance the knowledge about the current state of the aquifer. The repository should consolidate all the existing data ad maps obtained from previous studies and development activities within the aquifer and include all the data needed for the aquifer planning whether physical or social.
2. Data Sharing Protocols to ease the accessibility to available data and information for the purpose of aquifer development and research will expand and disseminate knowledge about the aquifer and its status. The data sharing should include stakeholders at all levels including the end users and should facilitate the sharing of data and information between the four riparian countries.
3. The development of a transboundary groundwater monitoring systems for the Kagera Aquifer is urgently needed. The proposed system should monitor groundwater levels and quality and should be integrated with the climatic and surface water resources monitoring network in the basin. The monitoring system should be designed and optimized to provide regional and local information about the aquifer.
4. A joint exploratory program to assess the aquifer extent, storage and hydrogeologic properties is needed. The program which could be undertaken by each country within its national borders could include detailed geological mapping, exploratory drilling, geophysical investigations, pumping tests and well inventory surveys to determine aquifer abstractions.
5. It is paramount to engage and actively include the local communities in the aquifer management and planning. Undertaking community outreach programs to assess the needs of the local communities and enlist their efforts in the aquifer protection and monitoring is highly recommended. Awareness, outreach and training programs should be designed to attain this objective with a focus on sharing the aquifer development plans and engaging local communities' efforts in implementing them.

6. Field investigations to identify the sources of recharge to Kagera aquifer and assess its quantity are highly recommended. This could include isotope studies. Studies to investigate the correlation between precipitation levels and patterns in the Kagera Basin with groundwater recharge should be undertaken.
7. There seems to be no clear long term and well-structured plans for the Kagera aquifer development within the four riparian countries. Aquifer development is driven by immediate needs to provide water sources for local communities with little coordination between the various stakeholders. Preparation of national development plans for the aquifer development, sharing of these plans with the other riparian countries are the first steps for developing a regional development plan for the Kagera Aquifer.
8. It is recommended given the limited current state of knowledge about the aquifer and until a full-fledged aquifer management system is in place, that aquifer development be limited to providing access to safe water and avoiding large scale concentrated development.
9. The objective of establishing and maintaining an aquifer management system for the Kagera aquifer that employs state of the art decision making tools including numerical modelling should be sought. The time line to realize it should be identified and the resources required to implement it should be availed.
10. Future planning of the Kagera aquifer development should take into consideration the impact of climate change.

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