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MSc in Geo-Information Science for Environment and Sustainable Development

STAKEHOLDER ANALYSIS IN WETLAND MANAGEMENT IN RWANDA: THE CASE OF RUGERAMIGOZI WETLAND IN MUHANGA DISTRICT

Thesis submitted to the University of Rwanda in partial fulfillment of the requirements for the award of the Degree of Master of Science in Geo-Information for Environment and Sustainable Development.

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Kigali, April, 2024

DECLARATION

I declare that this thesis entitled **"Stakeholder analysis in wetland management in Rwanda: The case of Rugeramigozi wetland in Muhanga District"** submitted for the award of the Degree of Master of Science in Geo-Information Science for Environment and Sustainable Development is my original work that has never submitted to any University or other higher learning institution.

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APPROVAL

It is hereby confirmed that this thesis entitled **"Stakeholder analysis in wetland management in Rwanda: The case of Rugeramigozi wetland in Muhanga District"** submitted by Claude UMUTONI was assessed in relation to the fulfillment of the requirements for the award of the Degree of Master of Science in Geo-Information for Environment and Sustainable Development, in the school of Architecture and Built Environment.

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Abstract

Wetlands are one of the most essential resources and features that make the Rwandan landscape. Those resources are important for biodiversity, people, and the national economy. However, they are gradually threatened due to the increasing pressure resulting from their use, specifically through agricultural activities. This concern necessitated the study consisting of identifying and describing the key stakeholders and assessing their interests in relation to the wetland management rules in order to ascertain if the implementation of those rules promotes the efficient management of wetland resources. Rugeramigozi wetland is used as the case study**.** The specific objectives were to ascertain how these stakeholders interact, how they make decisions over the use of the wetland and to examine whether those decisions promote the sustainable use of the Rugeramigozi wetland. Data sources include the semi-structured questionnaire, focus group discussions, key informant interviews, observation, and review of secondary data. The research also applied a stakeholder analysis framework that allowed for the identification of the key actors with a stake in the management of that wetland. The study further used the spatial-temporal dynamics analysis in relation to the use and change of the study area using multispectral Landsat images of 10 meters' resolution for the years 1992 and 2022. Results reveal that various stakeholders have different interests in the wetland use and management, as some may be interested in the utilization of wetland, whereas others are interested in wetland protection and conservation. Those interests contribute to conflicting situations at various levels. The research depicted key issue which still threatening the Rugeramigozi wetland sustainability. These are: over exploitation of its natural resources, lack of proper watershed management, construction in the buffer zone, urban and infrastructures (roads, hospitals, industrial park) development, peat mining and bricks making activities, limited and unsustainable use of wetland buffer zones. The study suggests that, for the Rugeramigozi wetland to be managed sustainably, all involved stakeholders must be integrated in the decision-making process. This can anticipate any conflicting and contradictory rules that may create wetland use problems in the study area. Therefore, highly effective enforcement mechanisms together with a good monitoring tool seem to be the best way to wisely use the wetland.

Keywords: *Wetland management, Rugeramigozi wetland, Stakeholder analysis, sustainable wetland*.

List of Abbreviations and Acronyms

Abbreviations	Meaning
CBNRM	Community-Based Natural Resource Management
CSO	Civil Society Organizations
DAP	Diamonium Phosphate
DEO	District Environment Officer
EIA	Environmental Impact Assessment
FAO	Food Agriculture Organization
GDP	Growth Domestic Product
GIS	Geographic Information Systems
GoR	Government of Rwanda
KIABR	Koperative Imparaniramusaruro y'Abahinzi Borozi ba Rugeramigozi
KOKAR	Koperative yo Kwihaza umusaruro y'Abahinzi ba Rugeramigozi
LULC	Land Use Land Cover
MINAGRI	Ministry of Agriculture
MoE	Ministry of Environment
NAEB	National Agricultural Export Board
NISR	National Institute of Statistics of Rwanda
NPK	Nitrogen, Phosphorus and Potassium
PH	Potential in Hydrogen
RAB	Rwanda Agriculture Board
REMA	Rwanda Environmental Management Authority
RLMUA	Rwanda Land Management and Use Authority
RMPGB	Rwanda Mines, Petroleum and Gas Board
RS	Remote Sensing
RSSP	Rural Sector Support Program
RWFA	Rwanda Water and Forest Authority
SOM	Soil Organic Matter
SSA	South Southern Africa
TEK	Traditional Ecological Knowledge
UNEP	United Nations Environment Program

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Chapter 1. INTRODUCTION

1. Background Information

The Ramsar convention defined wetlands as "areas of marsh, fen, peat land or water, natural or artificial, permanent or temporary with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" (Matthews, 1993). Wetlands are estimated to occupy around 8.6 million km^2 (6.4 %) of the earth's land surface (Mironga, 2021), and are among the earth's most productive ecosystems. They provide good and services to human considered valuable, these include fisheries, wildlife, mining, energy, and recreation (Crafter and Kmukala, 1993). They also play a critical role in global climate change regulation by serving as carbon sinks. For example, the global peat lands can store between 400 and 500 gigatons (Gt) of carbon (Abubakar, 2015). In addition, wetlands play an instrumental role by serving as a transition zone of varying water regimes, and act as natural filters that can improve water quality through reducing nutrients loadings, water aquifer, thus, often called "the kidneys of the catchment", and as "biological supermarkets" because of their rich food webs and biodiversity (Abubakar, 2015).

Over the recent years, various pressures have been exerted on the water and wetlands resources through emerging and increasing uses driven by the growing population. Some of these pressures consist of the threats which are manifested by the agricultural intensification, pollution, invasive species, overuse, and an inadequate institutional framework to manage the wetlands. Some of these threats, in the case of water, have affected both the quantity and quality of water available. Climate change has also been contributing to degradation of swamps. With the decreasing amounts of rainfall, the hydrological regime of wetlands is being threatened (REMA, 2010).

On a global scale, humans have altered and destroyed wetlands either directly or indirectly because for long wetlands were thought to be "wastelands (Abubakar, 2015). This causes several wetlands loss worldwide through conversion of wetlands into human modified environments, through land reclamation for settlement and farming, deforestation, freshwater diversion and dumping sites for harmful toxic substances among others (Abubakar, Mohammad, Sulaiman, & Tasi', 2015). Wetlands are known to be the world most productive ecosystems. Some of their functions that human benefit from includes the nutrients cycling,

sediment and pollution retention, flood mitigation and groundwater recharge. In addition to these indirect benefits, wetlands are source of wildlife, wood, and several non-timber products that are widely used by neighboring populations. Most importantly wetland soils can have great agriculture potential when properly used (REMA, 2015).

Africa still has a significant number of pristine wetlands when compared to Europe or parts of North America. However, some wetland areas are experiencing immense pressure from human activities, the most important being drainage for agriculture and settlement, excessive exploitation by local communities and improperly planned development activities (Kabii, 2020).

In Rwanda, wetlands play a great role in the national economy as they can be used in different ways. Some of their functions include agriculture production, hydrological functions, biodiversity reservoir, peat reserve, mitigation of climate change, leisure and tourism, and culture value. Many rural households face food insecurity, poverty and vulnerability, these goods and services make an important contribution to livelihood (REMA, 2015). In particular, the conversion of wetlands to agricultural production has increased rapidly over the last two decades due to the acute scarcity agricultural land. To a great degree, the Rwandan government supports its development with the aim to boost the agricultural production, revitalize the rural economy and reduce poverty (REMA, 2015). All these need to be done in integrating all involved stakeholders.

The wetlands in Rwanda fall into one of two main types: floodplain and valley-bottom wetlands. Field visits were undertaken to confirm these wetland types, and also to assess how wetlands are used and what the impacts to wetlands are in the country. Wetland characteristics, reflected in physical structure and ecosystem processes, define the ecosystem functions of the wetland (Nabahungu, 2012). The diversity of wetlands across Rwanda means that they perform many valuable ecological, social and economic functions. There is currently no standardized assessment of the condition of Rwanda wetlands.

Current legislation categorizes wetlands into two categories, either wetlands with total protection, or non-protected wetlands. The latter category is further divided into those with status of use under specific conditions, and those with status of use without conditions as documented in the prime minister’s order gazette in 2017 drawing a list of all swamp lands, their

characteristics, boundaries and determining modalities of their use, development and management.

The area of wetlands under the status of "total protection" is approximately 48 021 ha or 27% of all wetlands in the country. Of this, approximately 31 000 ha (64% of wetlands under total protection and 17% of all wetlands) are formally protected within a national park. The remaining 17 021 ha (36%) have limited protection in reality and are vulnerable to livestock and cultivation encroachment, and poaching of wildlife. Articles (within the law/policy) designed for protection still provide room for reallocation of protected wetlands for the public good at the discretion of the Ministry in charge of Natural Resources (currently Ministry of Environment).

With respect to the wetland management, stakeholders are defined as the people and organizations who are involved in or affected by an action or policy and can be directly or indirectly included in the decision-making process. Broadly speaking, stakeholders are defined as the people and organizations who are involved in or affected by an action or policy and can be directly or indirectly included in the decision-making process (Annan, 2007). The United Nations Environment Program identifies and engages with nine specific major stakeholder groups for sustainable development projects under their oversight: farmers, women, scientific and technological community, children and youth, indigenous peoples and their communities, workers and trade unions, business and industry, non-governmental organizations, and local authorities (UNEP, 2015).

As emphasized by Nabahungu (2012), the effective and sustainable wetland management can, and must, be organized from a range of integrated scales. At the national level the policymakers in the agricultural and water resources sectors are powerful stakeholders in the wetland management debate. These policy makers need a good overview of functions, problems and opportunities of wetlands to be able to make sound decisions on further reclamation of wetlands in Rwanda. Given all these considerations it is hypothesized that an integrated watershed management approach which includes farmers' knowledge and experience about wetland uses, problems and opportunities, is key to development of strategies for sustainable wetland management in Rwanda (Nabahungu, 2012).

The consequences of wetland management and/or mismanagement affect all sectors of the society. However, the values which people attribute to wetlands and the impacts of wetland

management decisions are sometimes not adequately considered in decision-making processes. Different stakeholders derive different benefits from wetlands and attribute different values to wetlands. Therefore, it is critical to recognize, assess and integrate these multiple perspectives in policy-making processes relating to wetland management (Kumar et al., 2017) explicitly and easily.

In the past, agricultural and natural resource management development projects were often based on top-down transfer of expert knowledge from development agencies to the intended beneficiaries. Farmers' reluctance to adapt new technologies was blamed on their ignorance, which could be overcome with a higher input of extension activities (Oudwater and Martin, 2003).

It is becoming increasingly recognized that natural resource management is a complex process requiring full participation from different stakeholders. This is necessary, given that constraints to natural resource management require a broader management approach that considers not only biophysical aspects but also farmers' knowledge, socio-economic aspects, and policy considerations. In this respect, only with farmers' participation, a successful practical approach to sustainable wetland management can be developed (Dixon, 2005).

The tenure and land rights have played a major role in balancing the activities and interests related to wetland protection and their use. Prior to the organic law governing the management of land (GoR, 2005), the members of the local community could enjoy the use rights on land plots located in wetlands, while some were granted freehold titles through sector leaders in charge of handling land claims. Very recently, the government has started to reclaim those land plots, but lacks a comprehensive process and the funds to expropriate the existing landowners with freehold titles in compliance with the Expropriation Law of 2015.

The land use Intensification program promotes the gradual increase in tractor use to improve agricultural productivity. In contrast however the strategy for Agricultural Mechanization, which was adopted by MINAGRI in 2010, warns against the indiscriminate use of mechanical cultivation in wetland agriculture and must be carefully considered in terms of the potential negative impacts. The Strategy for Agricultural Mechanization (MINAGRI, 2010). The principles of conservation agriculture which embrace the concept of conservation tillage methods should also be tested and expanded in wetland cropping areas.

The crops and the cropping systems are selected by the district or by the management committee. The small and unofficial reclaimed and traditional farmed wetlands are managed either by individuals or by families, and each farmer chooses which crops to plant. In cultivation and sowing periods, when high labor demand is observed, informal groups are formed in which farmers help each other in agriculture-related activities. Official reclaimed wetlands are intensively used for single crop production, following government policy. Existing reports (Denny and Turyatunga, 1992; Lema, 1996; MINAGRI,2002) however, indicate that these intensively managed wetlands have proved to be less sustainable in crop production compared with traditionally managed wetland. The intensive management has been applied without accommodating local peoples' knowledge. Thus, multi-stakeholder processes represent the forms of cross-sector collaboration, which have become common practice over the last decade in the management of wetlands (UNEP, 2015). Therefore, it is important to conduct a stakeholder mapping to understand who might be impacted, who should be involved, and what concerns they bring to wetland governance. It is crucial to include all the relevant stakeholders and to assess all activities that are related to the wetlands management and find ways to meet the needs of their users or at least to mediate them in the case they are conflicting. The identification of these viewpoints and interests is essential to creating a fully participatory process.

2. Problem Statement

Wetlands constitute a critical component of the global ecosystem, offering a plethora of ecological functions and socio-economic benefits that transcend mere agricultural productivity (Atkins et al., 2011). Historically, the peripheries of wetlands in regions such as Ethiopia, Uganda, and Rwanda have been utilized for agricultural purposes, employing practices such as drainage and multi-cropping to enhance productivity (Ngarambe & Kanyarukiga, 1998; Roggeri, 1998). This traditional exploitation of wetlands, however, is increasingly threatened by the escalating demand for agricultural land, necessitating a reevaluation of wetland use strategies.

In Rwanda, particularly in its eastern part, the onset of wetland agricultural exploitation did not occur until the 1960s, influenced significantly by historical and subsequent governmental policies (Nabahungu, 2012). Following the enactment of legislation governing the use and management of marshlands, the ownership model delineated wetlands as public entities, contrasting with the private ownership of uplands (REMA, 2009). Consequently, agricultural activities within wetlands necessitate authorization from district authorities, with public or

project-initiated reclamation efforts incurring substantial costs due to the construction of water management infrastructures (MINAGRI, 2002). This legal and operational framework underscores the importance of public participation and stakeholder engagement in wetland management, aligning with both national and international environmental policy directives that advocate for a comprehensive understanding of stakeholder dynamics and their impacts on decision-making processes (Reed et al., 2009).

Previous studies, such as those by Nabahungu and Visser (2011) and Dusabimana (2012), have explored various aspects of wetland management in the Rugeramigozi wetland, focusing on farmer knowledge and perceptions, water distribution challenges, and management constraints without delving into the interactions among stakeholders or addressing the overarching issues of sustainable wetland use and stakeholder collaboration benefits. This presents a critical research gap, particularly in understanding the complex interplay between stakeholder engagement and the sustainable management of wetland resources.

The present study aims to bridge these identified gaps by proposing an integrative framework for the sustainable use of the Rugeramigozi wetland, premised on the collaborative management of all relevant stakeholders. By addressing the deficiencies in existing literature and focusing on the multifaceted challenges hindering sustainable wetland utilization, this research endeavors to contribute significantly to the body of knowledge on wetland management, offering viable solutions that ensure the long-term preservation and productivity of these invaluable ecosystems.

3. Objectives

3.1 General Objective

This research aims to analyze institutional arrangements in managing Rugeramigozi wetland, including legal framework, structures, stakeholder engagement, resource allocation, and conflict resolution mechanisms.

3.2 Specific Objectives

Specifically, the objectives of this research are:

1. To examine the key stakeholders and their interests in relation to Rugeramigozi wetland management;

2. To understand the decision-making process for Rugeramigozi wetland management and better assess if they contribute to its efficient use;
3. To explore potential conflicts among stakeholders regarding the management of Rugeramigozi wetland;
4. To propose solutions for handling those conflicts towards the sustainable management of Rugeramigozi wetland.

3.3 Specific research questions

1. Who are the primary stakeholders involved in the management of Rugeramigozi wetland, and what are their respective roles, perspectives, and objectives in relation to wetland conservation and use?
2. Do the decisions made regarding Rugeramigozi wetland support its effective and sustainable use and management?
3. What are the primary sources of conflict among stakeholders involved in the management of Rugeramigozi wetland, and how do these conflicts manifest in terms of differing interests, values, and perceptions?
4. What are the most effective mediation strategies for resolving conflicting interests among stakeholders involved in the management of Rugeramigozi wetland, and how do these strategies contribute to consensus-building and sustainable management outcomes?

4. Research matrix

This section summarizes and compares different sources within the research. It also illustrates the research design, or what the researcher intends to do. It does, however, provide a very clear understanding of what will be done in the study and the kinds of results that can be expected.

Research objectives	Research questions	Methods and data sources	Expected data
1. To examine the key stakeholders and their interests in relation to Rugeramigozi wetland management	1.Who are the primary stakeholders involved in the management of Rugeramigozi wetland, and what are their respective roles, perspectives, and objectives in relation to wetland conservation and use?	- Review of the literature about stakeholder analysis in general context. - Review of the literature about Rugeramigozi wetland - Interviews, survey by questionnaire, and observations	- Lists and descriptions of key stakeholders involved in Rugeramigozi wetland. - Information about past interactions and decisions related to the wetland, providing insight into stakeholder relationships over time. - Information on the level of influence each stakeholder has in decision-making processes. - Policies, regulations, and legal rights affecting stakeholder involvement in wetland management.
2.To understand the decision-making process for Rugeramigozi wetland management and better assess if they contribute to its efficient use	2.Do the decisions made regarding Rugeramigozi wetland support its effective and sustainable use and management?	- Review of documents related to wetland management in Rwanda. - Interviews, survey by questionnaire. - Review of literature on efficiency and effectiveness of wetland resources use.	- Information on the roles of various stakeholders in the decision-making process, - Information on areas of disagreement among stakeholders and how consensus was reached or managed. - Insights into the factors considered in decision-making, such as ecological sustainability, economic viability, and social equity.
3.To explore potential conflicts among stakeholders regarding the management of Rugeramigozi wetland	3.What are the primary sources of conflict among stakeholders involved in the management of Rugeramigozi wetland, and how do these conflicts manifest in terms of differing interests, values, and perceptions?	- Interviews, survey by questionnaire.	- Detailed accounts of specific conflicts, including the nature of disputes, issues at stake, and involved parties. - Information on past conflicts related to the wetland, including their resolutions and impacts on stakeholders. - Stakeholders' views on management practices and potential sources of conflict. - Documentation of any previous mediation or facilitation efforts aimed at resolving conflicts, including their outcomes.
4.To propose solutions for handling those conflicts towards the sustainable management of Rugeramigozi wetland.	4.What are the most effective mediation strategies for resolving conflicting interests among stakeholders involved in the management of Rugeramigozi	- Qualitative and interpretative data analysis: sustainability of the wetland land use and development. -Interpreting factors of change in spatial data sharing practices with regards to different factors of land use land cover change over time.	- Detailed accounts of the specific conflicts among stakeholders, including their causes and consequences. - Information on successful conflict resolution strategies from other wetland management scenarios or similar contexts.

Research objectives	Research questions	Methods and data sources	Expected data
	wetland, and how do these strategies contribute to consensus-building and sustainable management outcomes?	- Validation of possible solutions for conflicts handling based on the results from data analysis.	- Ecological status of the wetland, including biodiversity, water quality, and ecosystem services, which can inform sustainable management practices.

5. Structure of the thesis

The study is organized into five chapters, structured as follows:

The study begins with an abstract section that succinctly presents the essence of the research. This section introduces the study by outlining its objectives, defining the research problem, and detailing the methodology employed to address the problem. It also highlights the key findings and draws relevant conclusions. Chapter 2 delves into the current status of wetland management in Rwanda, providing a detailed examination of stakeholder analysis. This chapter explores the primary attributes of the nation's wetlands and pinpoints the challenges that need to be tackled through improved institutional arrangements for wetland management. Chapter 3 is devoted to presenting detailed field observations and responses to questionnaires collected in the study area. It explains how the research methods were utilized to answer the research questions and achieve the study's objectives.

Chapter 4 showcases the research findings. It includes the presentation and discussion of results, along with strategic measures proposed to address the research questions. Conclusively, Chapter 5 offers the study's conclusion and recommendations, summarizing the insights gained and suggesting steps forward based on the research findings.

Chapter 2. LITERATURE REVIEW

2.1 Introduction

In the course of this chapter, the researcher gives a detailed account of the conceptual framework about wetland management and stakeholders. The literature was used in this research to get relevant information from different publications, NGO archives, internet, and reports. Some important data obtained in literature are mentioned in the following categories:

- General overview of wetland, related laws governing their use, functions, and management
- Background information and analysis about stakeholder and its related concepts
- National policy for Wetland Management, (MINIRENA,2011)
- General overview of the concepts and approaches for stakeholder analysis.
- Stakeholders Collaboration in wetland management.

2.2 Definition of key concepts

In the course of this section, we are going to give the literature about the conceptual framework of the study that include: the wetland and stakeholders and their associated or related concepts in the research context.

2.2.1 Wetland definition

The Ramsar Convention on Wetlands defines wetlands as "a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as saltmarshes, mangroves, and seagrass beds, but also coral reefs and other marine areas no deeper than six metres at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs" (Ramsar, 2010).

Wetlands exist globally in every country, in every climate, and on every continent, except Antarctica. Global estimates of the extent of wetlands vary from 560 million to 1.2 billion ha of wetlands, including marine and freshwater wetlands. More recently, a minimum estimate of global wetlands ranged from 748 to 778.1 million ha, using the Ramsar Convention definition of wetlands.

2.2.2 Current Wetland definition

Within Rwanda, wetlands are currently interchangeably referred to as “marshlands”, “swamps” and “wetlands” across environmental policies and laws. The Rwandan government sees wetlands as providing an important niche for improving food security and income through the production of rice and other commodities. In the Rwandan context, ‘wetland’ is defined as all lowlands and comprises the entire valley bottom, both the well-drained and wet areas. The total area of wetland in Rwanda is 278 536 ha (10·6 per cent) (REMA, 2009). However, out of 148 344 ha under cultivation in 2010, only 5000 ha are officially reclaimed, often with a poor design and maintenance (Nabahungu and Visser, 2012).

Rwanda’s wetland and catchment ecosystems provide a wide range of services and are critically important to the sustainable development plans of the country. Services include provisioning and regulating services such as water availability and flood mitigation. These wetland and catchment ecosystems significantly contribute to the resilience of communities to adverse effects of climate change (REMA, 2009). The wetlands in Rwanda fall into one of two main types: floodplain and valley-bottom wetlands. Wetland characteristics, reflected in physical structure and ecosystem processes, define the ecosystem functions of the wetland (Nabahungu, 2012).

Current legislation categorizes wetlands into two categories, either wetlands with total protection, or non-protected wetlands. The latter category is further divided into those with status of use under specific conditions, and those with status of use without conditions as documented in the prime minister’s order gazetted in 2017 drawing a list of all swamp lands, their characteristics, boundaries and determining modalities of their use, development and management (UR, 2020).

- Wetlands with the status of total protection: The area of wetlands under this status is approximately 48 021 ha or 27% of all wetlands in the country. Of this, approximately 31 000 ha (64% of wetlands under total protection and 17% of all wetlands) are formally protected within a national park;
- Non-protected wetlands with status of use under specific conditions: There are currently 120,492 ha of wetlands in this category, forming 68% of all the country’s wetlands. An EIA is required before wetland development is allowed;
- Non-protected wetlands with status of use under specific conditions: These wetlands make up only 4% of all wetlands in the country, or 7,834 ha. All of these wetlands are

under cultivation or plantation, with no natural vegetation remaining. It is, however, strongly proposed that these wetlands be grouped with the other "non-protected wetlands" described above as there is no indication that they do not provide a certain level of ecosystem service delivery despite their current status as human-dominated; further use without conditions could have negative impacts to the surrounding community and minimally proposals for a change in use should be subject to an EIA.

2.3 Multifunctional use of wetlands

Over the last decades there has been growing recognition throughout countries of the developed world that, rather than being unproductive wastelands, wetlands are in fact multifunctional ecosystems that provide a range of services of inherent value to human well-being (Dugan, 1990). The RAMSAR convention (Ramsar, 1971) highlights the importance of wetlands for global biodiversity, and, in recent years, research has drawn attention to the environmental functions and socio-economic benefits that wetlands can provide; what the Millennium Ecosystem Assessment (MA) (2005a) terms the "ecosystem services" of wetlands.

Discussions on the services provided by wetlands are numerous (Dugan, 1990) and considerable research has been carried out on specific roles wetlands play in the livelihoods of local residents and local environmental interactions (Adger & Luttrell, 2000). However, despite the wealth of literature, classifications of these services (often called functions and benefits) have rarely been consistent. Hence, the recent MA (2005a) terminology, and its widespread acceptance, is helpful. The MA uses the term "ecosystem services" for all wetland functions and benefits, and subdivides these into: "provision" (goods produced or provided by ecosystems, e.g. food, fuel and fibre); "regulate" (benefits from the processes of ecosystem regulation, e.g. water partitioning, and climate regulation); "cultural" (non-material benefits from ecosystems, e.g. spiritual, recreational and aesthetic); and "support" (factors necessary for producing ecosystem services, e.g. hydrological cycle, soil formation, and nutrient cycling). The MA ecosystem concept has received widespread recognition and has been formally adopted by the RAMSAR convention as a principal framework for wise use of wetlands (Houghton-Carr, 2009). The first three categories of services are directly useful for or beneficial to humans or human well-being as they provide the primary means for food production, natural resources management, and spiritual beliefs. The fourth service is related to the system's capability to continue providing services through sustained natural resource process cycles. Not all wetlands support the full

range of ecosystem services, and specific services may be associated with specific types of wetlands.

The main functions of wetlands in Rwanda include agricultural production, hydrological regulation, biodiversity reservoir, peat reserve, and mitigation of climate change (REMA, 2008). Though the Rwandan government is keen to reclaim wetlands for agricultural production, costs of wetland reclamation should consider the multiple functions and services provided by wetlands ecosystems. The ‘’wise-use’’ concept, advanced through the convention of wetlands (Ramsar, 1971), acknowledges that human development necessitates adjustment of wetland ecosystems, but defers from conventional natural resources management because much higher priority should be given to those processes that sustain the ecosystem and the people that depend on them (Ramsar Convention Secretariat, 2007). A key tenet of the ‘’wise use’’ 9 idea, also re-affirmed in the Millennium Ecosystem Assessment (Houghton-Carr, 2009), is that all the benefits provided by wetlands must be incorporated in resource planning and decision-making.

2.4 Assessing the impact and sustainability of the land-use in wetlands

The Ramsar Convention Secretariat (2006) defines the wise use of wetlands in terms of the maintenance of their ecological character (environmental condition), achieved through the implementation of ecosystem approaches, within the context of sustainable development.

Sustainable development comprises three mutually reinforcing pillars: economic development, social development and environmental protection — at the local, national, regional and global levels (UN, 2002). Sustainable development is development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987).

The concept of sustainable development has proved useful, and a wide range of non-government and government organizations have embraced it as the new paradigm of development. However, Lélé (2002) cautions that although the all-encompassing nature of the concept gives it political strength, its formulation by the mainstream of sustainable development thinking contains significant weaknesses. These include an incomplete perception of the problems of poverty and environmental degradation, and confusion about the role of economic growth (Lélé, 2002, Hopwood et al., 2005). Too much focus is on “well-having” rather than “well-being” (Hopwood

et al., 2005) and the term sustainable development is open to misuse in situations where the economic dimension predominates over the social and environmental.

"WET-Sustainable Use" (Kotze, 2010) is an environmental management tool that has been developed in South Africa to assist in assessing the ecological sustainability of wetland use. It focuses on grazing of wetlands by livestock, cultivation of wetlands and harvesting of wetland plants for crafts and thatching. "WET-Sustainable Use" asks to what extent the use of the wetland has altered (or is likely to alter) the following five components of the wetland's environmental condition: (1) the distribution and retention of water, (2) the erosion of sediment, (3) the accumulation of Soil organic matter (SOM), (4) the retention of nutrients and (5) the natural species composition of the vegetation in the wetland.

The model assists in answering these questions by providing a set of indicators for each of the five components, and a structured way of scoring these indicators and deriving an overall score for each component. The five key environmental components considered in assessing the extent to which use of a wetland alters the environmental condition of the wetland (and consequently the impact on the sustainability of the land-use).

WET-Sustainable Use focuses on land-uses taking place in the wetland itself, and does not cover in any detail the effect of land-uses in the catchment upstream of the wetland. Nevertheless, catchment effects are recognized as being potentially great, 12 and users are referred to WET-Health (Macfarlane et al., 2008) for assistance in dealing with the detailed assessment of such effects, and to Pollard et al. (2009), which provides a set of simple indicators that can be used with farmers and practitioners to assess the sustainability of use of the uplands surrounding the wetland.

2.5 Institutional framework to wetland management

There exists the enabling environment that provides the framework for the management of wetlands in Rwanda. The framework comprises a series of policies, laws, and Ministerial Orders gazetted by the Government of Rwanda (GoR), setting out the management, utilization and protection of wetlands throughout the country. The enabling environment is structured through policies which set out the national approach to a topic such as environmental management law which then formalizes the policy in a regulatory framework, and Orders which support the implementation of the Law.

2.5.1 Legislation

2.5.1.1 The constitution of Rwanda as amended (2015)

The need for environmental protection and management are set out in the Constitution of the Republic of Rwanda, adopted by referendum on May 26, 2003 and revised in December 2015. Article 53 states that: "…every citizen is entitled to a healthy and satisfying environment. Every person has the duty to protect, safeguard and promote the environment. The State shall protect the environment. The law determines the modalities for protecting, safeguarding and promoting the environment". The Ministry of Environment was established to ensure the implementation of this right, and was responsible for the drafting of all laws and policies related to the management of natural resources in Rwanda (MoE, 2019).

2.5.1.2 National Strategies and Vision

The links between environmental protection and the country's priorities to promote economic development and reduce poverty are interlinked in Rwanda. Vision 2050 (GoR, 2000) envisioned the transformation of Rwanda from a low to middle income country, with natural resources and environmental management identified as cross-cutting issues that would contribute to this transformation. Vision 2050 proposed to implement adequate land and water management techniques and effective biodiversity conservation measures, and informed most policies which are currently in place, including the Land Policy (2019), Environment and Climate Change Policy (2019), the National Policy for Integrated Water Resources Management (2011) and the Biodiversity Policy (2011). The National Strategy for Transformation (2017-2024) (NST1) of the GoR, which is based on the other strategic documents such as vision 2050, EDPRS2 and SDGs 2030, aims to achieve economic growth and development founded on the private sector, local knowledge and Rwanda's natural resources (of which wetlands are a critical component). More importantly, the NST1 envisages to improve small-scale irrigation schemes within the wetland areas and to implement strategies which will assist the country to achieve sustainable development without compromising the environment (Ministry of Finance and Economic Planning, 2019).

The National Strategies and vision highlight Rwanda's strategic approach to integrating environmental protection with economic development and poverty reduction. Vision 2050 set the stage for this integration, emphasizing the importance of natural resource management for the country's transformation. Subsequent policies, such as the Land Policy, Environment and

Climate Change Policy, and others, were influenced by this vision, indicating a commitment to sustainable development.

The National Strategy for Transformation (NST1) builds upon Vision 2050 and other strategic documents, aiming to achieve economic growth while leveraging Rwanda's natural resources, including wetlands. Notably, NST1 emphasizes the importance of small-scale irrigation schemes within wetlands, indicating a recognition of the critical role these ecosystems play in supporting agriculture and livelihoods.

2.5.1.3 National Biodiversity Strategy and Action Plan (NBSAP) and Rwanda Biodiversity Policy

The Revised NBSAP was developed in 2016 (Republic of Rwanda, 2016) as a key tool for the implementation on the Convention on Biological Diversity objectives and Aichi targets. The first NBSAP was developed in 2003, for wetland management this aimed to achieve an improved conservation of protected areas and wetlands, sustainable use of the biodiversity of natural ecosystems and agroecosystems. In Annex 1 of the revised NBSAP, a list of the national protected areas which include some wetlands is provided. Some of these wetlands to protect are the Akagera National Park which comprises many swamps, the Akagera Wetland Complex, the Ibanda-Makera Remnant Forest, Nyungwe National Park which comprises Kamiranzovu Wetland, Gishwati-Mukura National Park, Rugezi wetland complex and Rweru-Mugesera wetland complex. The revised NBSAP feeds into the Rwanda Biodiversity Policy (2011) which aimed “to secure and effectively manage the country's wetlands and freshwater systems, and ensure that the future management of such areas will take place in an integrated manner and their resources utilized sustainably, and adverse impacts on aquatic biodiversity minimized” (Republic of Rwanda, 2011). To achieve this objective, the Biodiversity policy set the strategies below:

- Support the principle that domestic and environmental needs will enjoy priority use of water;
- Facilitate the development of appropriate legislation to secure the conservation of wetlands, and to maintain their ecological and socio-economic function and promote the establishment of a National System of Protected Wetlands;
- Determine the impact of aquaculture species and management practices on biodiversity, and develop appropriate guidelines for aquaculture developments;

- ❖ Strongly promote the development of catchment-specific partnerships and joint management plans between the range of institutions, organizations and individual engaged in managing and using wetlands, catchments and associated aquatic areas;
- ❖ Provide leadership in regional wetland conservation efforts, through the effective and coordinated management of transboundary water and biological resources in the Albertine Rift.

The Revised National Biodiversity Strategy and Action Plan (NBSAP) demonstrates Rwanda's commitment to implementing the Convention on Biological Diversity objectives and Aichi targets. The integration of wetland management objectives within the NBSAP and its linkage to other key policies like the Rwanda Biodiversity Policy (2011) signify a coherent approach to conservation and sustainable use of natural resources.

2.5.2 Policies and Strategies

2.5.2.1 National Environmental Policy

The new national environment and climate change policy enacted in 2019 especially in its second policy statement of the policy objective 2 whereby guidelines for the use of wetlands shall be developed as one of the actions. Other parallel actions include the following:

- ❖ Develop a master plan and implementation strategies for wetland management in Rwanda. The enactment of the National Environment and Climate Change Policy in 2019 reflects Rwanda's commitment to addressing environmental challenges, including wetland management. The inclusion of specific actions related to wetland management, such as the development of guidelines, a master plan, and strategies for wetland management, demonstrates a proactive approach to conservation.
- ❖ Identify all polluted wetlands and develop a decontamination plan including the use of environmentally-sound technologies (Phytoremediation) for pollution prevention, control and remediation. The commitment to identifying and decontaminating polluted wetlands using environmentally-sound technologies like phytoremediation is commendable. Practical examples of successful phytoremediation projects in other countries, such as the use of constructed wetlands to treat industrial effluents in the United States or the restoration of polluted wetlands in China using native plant species, could serve as benchmarks for Rwanda's efforts.

- Promote and intensify wetland protection, and restoration and rehabilitation of degraded wetlands. The emphasis on promoting wetland protection, restoration, and rehabilitation aligns with the ecosystem-based approach to conservation. Practical examples from other countries, such as the restoration of degraded wetlands in Europe through re-vegetation and habitat creation or the protection of critical wetland habitats in Australia through targeted conservation efforts, could provide insights into effective strategies for Rwanda.
- Strengthen collaborative and participatory management of wetland resources. Strengthening collaborative and participatory management of wetland resources is essential for ensuring sustainable outcomes. Practical examples of successful community-based wetland management initiatives, such as the Ramsar Community Management Guidelines implemented in various countries, could inform Rwanda's approach. Additionally, investing in wetland research and conservation efforts, such as the establishment of wetland research centers or the implementation of citizen science programs, could enhance understanding and stewardship of wetland ecosystems.
- Strengthen existing wetland research and encourage conservation and restoration of ecosystems critically threatened by climate change. The tension between agricultural expansion and wetland conservation underscores the need for sustainable land-use practices. Practical examples of agro-ecological approaches to wetland agriculture, such as the cultivation of wetland-adapted crops or the promotion of integrated farming systems, could demonstrate how to maximize agricultural productivity while minimizing adverse impacts on wetland ecosystems.
- Ensure the protection of wetlands, riverbanks, hilltops and slopes from unsustainable practices to prevent soil erosion and environmental degradation.
- Ensure that developmental activities within wetlands or in the buffer of wetlands conform to EIA process and procedures (Republic of Rwanda, 2019). Ensuring that developmental activities within wetlands adhere to environmental impact assessment (EIA) processes and procedures is crucial for minimizing negative impacts on wetland ecosystems. Practical examples of integrated land-use planning and EIA frameworks, such as those implemented in the European Union or Canada, could provide guidance on balancing development needs with environmental protection priorities.

With the need to have sufficient agriculture production, wetlands were the remaining available free land to be used and were progressively reclaimed for agriculture purposes. However, wetlands have several functions and provide numerous services to man, some of which are flood water and erosion control, ground water replenishment, and biodiversity protection. They also constitute biological diversity reservoirs (Ministry of Environment, 2019).

2.5.2.2 National Land Policy

The national land policy of 2004 was revised to consider updated policy legal and institutional framework, national and international commitments related to land and the coordination with updated sectoral polices that touch on land use. In the new land policy, wetlands are well considered as follows:

- Wetlands together with marshlands, water bodies, lakes, water ways, buffer zones, road reserves, national parks, protected areas, land with public infrastructure, marginal lands, are considered state land. However, the key challenges of state land were highlighted as being claims on marshlands and swamps by individuals and private sector, lack of policy guidance on how buffer zones shall be managed and used, illegal activities in protected areas, and some protected areas with high but unused economic potential.
- One of the policy actions targets the appropriate management of state land;
- Further the policy indicates that District Developments strategies (aligned to the implementation of the NST) consider improvement conservation of soil, wetlands and riverbanks (Republic of Rwanda, 2019).

Efficient use and management of land and other natural resources is critical to ensure sustainable development. Concerning sustainable land management, the overall principle is that land must be used for productive and development purposes without compromising its use by future generations. The following key issue is identified as priority areas in the course of this policy:

Management of state lands: In this context, state lands consist of lakes, waterways, national roads reserves, national parks, water bodies and wetlands, marshlands, buffer zones, protected areas, land with public infrastructures, marginal land. The main issues pertaining these types of land include: continued claims made on marshlands and swamps by individuals and private sector; lack of policy guidance on how buffer zones should be managed or used; illegal activities in protected areas and some protected areas with high but-unused economic potentials. There is

also lack of proper mechanism to follow up on lease agreements between Government and investors where Government has allocated land for investment (Ministry of Environment, 2019).

The policy identifies several key challenges related to the management of state lands, including encroachment on marshlands and swamps, lack of policy guidance for buffer zones, illegal activities in protected areas, and underutilization of economically valuable protected areas. Practical examples from other countries, such as successful enforcement mechanisms for protected areas in Costa Rica or community-based management approaches in wetland conservation areas in Thailand, could inform Rwanda's strategies for addressing these challenges.

2.5.2.3 Agriculture policy

The agriculture policy does not specify necessary measures for sustainable and wise use of wetlands for which agriculture is allowed. However, under the third pillar on productivity and sustainability it stresses on the need for investing in improved inputs, soil and water conservation, irrigation and sustainable land husbandry to address soil erosion and degradation through erosion control measures (terracing, check dams, trenching, …) and agroforestry (intercropping, integration of trees on farm plots, tree belts, protective forest, …) (Republic of Rwanda, 2018).

The adverse effects on wetland resources and climate change must be countered with continued efforts to increase inputs and sustainable climate smart practices; protecting agricultural land against fragmentation, erosion, and degradation; and shifting production toward higher-value products and introducing land-saving technologies (Republic of Rwanda, 2018).

The absence of specific measures for the sustainable and wise use of wetlands within the agriculture policy indicates a potential gap in addressing the unique challenges and opportunities associated with wetland agriculture. While the policy emphasizes investment in improved inputs, soil and water conservation, and sustainable land husbandry, it may overlook the specific considerations necessary for wetland ecosystems. A critical analysis would assess the implications of this omission and explore ways to integrate wetland-specific measures into agricultural policies and programs.

The agriculture policy's emphasis on sustainability and productivity is in line with more general development goals, such as mitigating soil degradation and erosion, halting climate change, and encouraging climate-smart agricultural methods. Agroforestry and terracing are two real-world

examples of successful soil and water conservation programs that could offer insightful information about practical approaches to sustainable land management for Rwanda's agriculture industry.

2.5.2.4 Forestry policy

The forestry policy is aligned with national, regional and international commitments like the sustainable development goals, Paris Agreement, Bonn challenges which considers restoration of deforested and degraded land, including protected areas and wetland riparian areas. Among other guiding principles, agroforestry, biodiversity conservation, integrated approach watershed management), etc. (Republic of Rwanda, 2018).

The alignment of Rwanda's forestry policy with national, regional, and international commitments such as the Sustainable Development Goals, Paris Agreement, and Bonn Challenges demonstrates the country's commitment to addressing global environmental priorities. By focusing on the restoration of deforested and degraded land, including protected areas and wetland riparian areas, the policy contributes to broader efforts to combat climate change, conserve biodiversity, and promote sustainable development.

The incorporation of guiding principles such as agroforestry, biodiversity conservation, and integrated watershed management into the forestry policy reflects a holistic approach to forest management. These principles not only support ecological sustainability but also contribute to improving resilience and promoting ecosystem services. The emphasis on restoring deforested and degraded land, including protected areas and wetland riparian areas, is crucial for strengthening ecosystem resilience and biodiversity conservation. Real-world instances of effective restoration projects, such as reforestation programs in Brazil's Atlantic Forest or mangrove restoration projects in Indonesia, could inform Rwanda's efforts to restore degraded landscapes and promote ecosystem recovery.

2.5.2.5 Integrated Water Resource Management (IWRM) Policy

The National Policy for Water Resources Management (2011) is a revised version of the policy on Water and Sanitation formulated in 2004. The policy of 2004 was revised to address the pressures of rapid urbanization, changing demands for water uses, degradation of watersheds from unsustainable and inappropriate land use practices, and the uncertainties of climate change (Byers et al., 2014).

According to the 2011 policy, the vision of the current IWRM Policy is to have a water resources sub-sector governed by a policy, legal and institutional framework that promotes sustainable use of water resources and which contributes meaningfully to the socio-economic development of Rwanda (Republic of Rwanda, 2011).

Within the strategic plan developed in support of this policy (2011-2015) the value of and risks to wetlands were defined. In particular, the policy identified that the economic value of wetlands needs to be established, and a national programme for the conservation and management of these wetlands be implemented. – which is not unlike the Environment and Climate Change Policy (2019) which identified the need to develop a Master Plan and implementation strategy for wetland management in Rwanda. This duplication suggests that the Master Plan identified in the Environmental Policy was never developed or at least not published.

The IWRM Policy (2011) was established to promote the sustainable use of water resources. However, it lacks specific provisions for wetlands (Heermans and Ikirezi, 2015). Its primary focus is on surface water bodies, such as streams, rivers, lakes, and groundwater. The elements of the policy that address wetlands recommend that end users assume management responsibilities, with the government's role being to create an enabling environment through incentives, regulations and procedures as opposed to acting as a project implementer. The policy also suggests that the economic value of wetland should be used to determine approvals for projects in wetlands; however, the policy does not stipulate whether ecosystem services is to be included in addition to traditional cost-benefit valuations (Heermans and Ikirezi, 2015).

The recognition of the economic value and risks associated with wetlands in the strategic plan developed in support of the water resources management policy is commendable. However, the critical analysis would assess the implementation of strategies aimed at establishing the economic value of wetlands and implementing national programs for their conservation and management. The identification of duplication between the 2011 IWRM Policy and the 2019 Environment and Climate Change Policy regarding the development of a Master Plan for wetland management raises questions about policy coherence and implementation effectiveness.

2.5.2.6 Biodiversity Policy

The purpose of the Biodiversity Policy is to provide an overarching framework for the conservation, sustainable utilization and access to biodiversity resources, and for fair and equitable sharing of benefits derived from these resources. Wetlands provide a habitat for these

biodiversity resources, and are inherent in the management, conservation and sustainable utilization of these biodiversity resources. This policy identified that wetlands represent some of the most threatened ecosystems, and as such their conservation and sustainable use is a crucial component of the policy. The policy specifically sets an objective to secure and effectively manage the country's wetlands and freshwater systems. Also, to ensure that the future management of such areas will take place in an integrated manner, their resources utilized sustainably, and adverse impacts on aquatic biodiversity minimized. The policy sets out five strategies and activities to achieve this objective. The Government, in collaboration with interested and affected parties therefore, shall:

- Support the principle that domestic consumption and environmental needs will enjoy priority use of water;
- Facilitate the development of appropriate legislation to secure the conservation of wetlands, maintain their ecological and socio-economic function and promote the establishment of a National System of Protected Wetlands;
- Determine the impact of aquaculture species and management practices on biodiversity, and develop appropriate guidelines for aquaculture developments;
- Strongly promote the development of catchment-specific partnerships and joint management frameworks between the range of institutions, organizations and individuals engaged in managing and using wetlands, catchments and associated aquatic areas;
- Provide leadership in regional wetland conservation efforts, through the effective and coordinated management of transboundary water- and biological resources in the Albertine Rift (Republic of Rwanda, 2011).

The identification of wetlands as some of the most threatened ecosystems highlights the urgent need for their conservation and sustainable use. The policy's objective to secure and effectively manage wetlands and freshwater systems demonstrates a commitment to addressing the specific challenges facing wetland ecosystems.

2.5.2.7 National urbanization policy

Under local development and poverty reduction of the fourth policy pillar “Economic development, the policy provides for the sustainable use of urban wetland areas for agriculture and horticulture. In addition, it states that for any urban farming scheme, ground water protection shall be ensured and the use of untreated affluent for irrigation purposes strictly controlled and

prohibited in wetland areas to avoid transmission of water-borne diseases (Ministry of Infrastructure, 2015).

Moreover, farming and horticulture are the basis of livelihood for many families. During urbanization, its regulated continuation shall be supported, while helping land holders of formerly agricultural land in the transition toward non-farming opportunities. Urban agriculture is also seen as a contributor to social and emotional well-being (Ministry of Infrastructure, 2015). In evaluating the policy's recognition of urban wetlands for agriculture and its support for urban agriculture and livelihoods, it is imperative to assess the effectiveness of implementation mechanisms, enforcement measures, and support programs. This evaluation aims to ensure that these initiatives contribute meaningfully to sustainable development and inclusive growth. Moreover, integrating considerations for long-term environmental sustainability and social equity into policy implementation strategies is essential for fostering holistic and enduring positive impacts.

2.5.2.8 Green Growth and Climate Resilience Strategy (GGCRS)

The strategy recommends that building for different purposes (housing, industry, mining, etc.) shall be located in areas, less vulnerable and without interfering with wetlands or natural forests. It insists that sensitive ecosystems including wetlands shall be rather protected (Republic of Rwanda, 2011).

The GGCRS recognizes the significance of strategic location selection for infrastructure development projects to minimize negative environmental impacts and enhance climate resilience. This approach aligns with the principles of sustainable development and ecosystem protection. However, a critical analysis would evaluate the effectiveness of mechanisms in place to enforce these recommendations and ensure adherence by relevant stakeholders, particularly in sectors such as housing, industry, and mining where development pressures may be high.

While the GGCRS provides clear recommendations for protecting wetlands and sensitive ecosystems, challenges may arise in translating these recommendations into actionable policies and practices. These challenges could include competing development interests, limited resources for enforcement and monitoring, and the need for stakeholder engagement and capacity building.

Overall, the GGCRS's recommendations regarding the location of infrastructure development projects and the protection of sensitive ecosystems like wetlands represent important steps

towards promoting green growth and climate resilience. However, the effectiveness of these recommendations will depend on the degree of commitment, coordination, and capacity to implement them effectively at both policy and operational levels.

2.5.2.8 National industrial policy

The policy recognizes the negative externalities that industrial development may have on environment, particularly pollution associated with untreated effluents. The majority of industries are located in Kigali and most of them were initially located in valley, mostly Former Gikondo Industrial Park (now relocated to Kigali Special Economic Zone. The Cleaner Production Centre was established to assist in resource efficiency and environmental performance. Rwanda Industrial Policy committed to enforce environmental laws and policies, such as the relocation of industries from marshland areas (Ministry of Trade and Industry, 2011). The acknowledgment of potential negative externalities associated with industrial development, particularly pollution from untreated effluents, is a positive aspect of the National Industrial Policy. By recognizing these environmental risks, the policy demonstrates a commitment to addressing environmental sustainability alongside economic growth. This demonstrates proactive steps toward sustainable industrial development.

2.5.3 Laws

2.5.3.1 Law on environment No 48/2018 0f 13/08/2018

The Law No 48/2018 on Environment determines the protection, conservation and promotion of the environment in Rwanda. It makes provision for Environmental Impact Assessment, Strategic Environmental Assessment, and Environmental Audit. It highlights that every plan, strategies, programme and policy must undergo strategic Environmental Assessment while projects that are subject to environmental impact assessment before obtaining authorization for implementation and environmental audit (during and after implementation) are listed by the ministerial order (currently M.O. No 001/2019 of 15/04/2019). This includes a list of projects in various sectors such as infrastructure, agriculture and animal husbandry, mines and works in parks and park buffer zones. The Environment Law provides the strongest protection measures for Rwanda's natural resources and assets and includes specific measures to be implemented. Through the law, the State is responsible for reserving wetlands for purposes of protection, conservation, and

rehabilitation. However, the Law does not stipulate what defines a 'reserved wetland.' Decentralized government entities are responsible for determining efficient management and effective use of wetlands. In terms of limiting activity within wetlands, the law prohibits development within 20 meters from wetland boundaries by setting a buffer zone that restricts structures within proximity to wetlands. If structures in wetlands are deemed necessary for tourism purposes, the Organic Law stipulates that the Minister, under their responsibility, should grant approval to build a structure. In protected wetlands, the law prohibits all uses, apart from scientific research. This Law confirms that wetlands are the domain of the State, and a distinction is made between protected wetlands under public State domain and unprotected wetlands under private State domain. Under the law, use of wetlands may be granted to individuals, based on an agreement with the government. The law stipulates that a Ministerial Order will provide the terms of wetland uses by individuals and modalities for their protection.
Specifically, the Law provides the following:

- Article 12 stipulates that swamps with permanent water shall be given special protection. Such protection shall consider their role and importance in the preservation of biodiversity. The law recognizes the importance of wetlands for biodiversity preservation and imposes strict regulations to ensure their protection. Provisions such as the prohibition of dumping untreated wastewater and hazardous waste into wetlands, as well as the establishment of buffer zones, demonstrate a commitment to safeguarding these ecosystems.
- Article 42 prohibits dumping the following into wetlands: (1) waste water, except after treatment in accordance with instructions that govern it and (2) any hazardous waste before it has been treated.
- Article 42 stipulates that no pastoral activities that require agricultural activities in swamps shall be carried out without respecting a distance of ten (10) meters away from the banks of rivers and fifty (50) meters away from the lake banks. Cattle kraals shall be built in a distance of sixty (60) meters away from the banks of streams and rivers and two hundred (200) meters away from the lake banks. The location of fish ponds as well as species of fish to be used in fish farming shall require authorization from the Minister having environment in his or her attributions or any other person the Minister shall

delegate to. The law provides clear guidelines on permissible activities within wetlands, such as agricultural practices and tourism development. By delineating specific distances from water bodies for various activities, it aims to prevent ecological degradation while allowing for sustainable use.

- Article 42 stipulates a 20 meters' construction-free buffer zone around all "swamps". If it is considered necessary, construction of buildings intended for the promotion of tourism may be authorized by the Minister having environment in his or her attributions. It also stipulates that the use of wetlands shall be preceded by EIA's. The law addresses various aspects of environmental protection, including Environmental Impact Assessment (EIA), Strategic Environmental Assessment (SEA), and Environmental Audit. This comprehensive approach ensures that environmental considerations are integrated into decision-making processes at different levels.
- Article 44prohibits burning or eliminating waste in wetlands through any process without respecting rules applied in Rwanda.
- The Environmental Law also prohibits a range of activities in the country's wetlands (in urban or rural areas) including construction of buildings, sewage plants, dumping of untreated waste water and hazardous waste as well as cemeteries (Republic of Rwanda, 2018). The prohibition of certain activities in wetlands, coupled with the requirement for Environmental Impact Assessments prior to any development, indicates a commitment to enforcing environmental regulations. However, the effectiveness of enforcement mechanisms depends on the capacity and resources available for monitoring and compliance.

Despite its strengths, the law has some limitations and ambiguities. For example, the definition of 'reserved wetlands' is not provided, which could lead to inconsistencies in interpretation and implementation. Additionally, the extent of penalties for non-compliance with environmental regulations is not specified, raising questions about the deterrence effect of enforcement measures.

Broadly, the Law No 48/2018 on Environment in Rwanda reflects a strong commitment to environmental protection and sustainable development. However, addressing the identified limitations and strengthening enforcement mechanisms will be crucial to realizing its objectives

effectively. Additionally, continuous monitoring and evaluation of the law's implementation are essential to adapt to evolving environmental challenges and ensure its long-term success.

2.5.3.2 Rwanda Water Law Determining the use and management of water resources in Rwanda

The general principles of this law No 49/2018 of 13/08/2018 are that "Water is a good belonging to the State public domain. Its use constitutes a recognized right in force to all in the scope of laws and regulation in use". According to the Article 7, this law provides the following principles:

- prevention of pollution with priority to source;
- precaution, according to which activities considered or suspected to have negative impacts on water resources shall not be implemented even if such impacts have not yet been scientifically proved. Scientific uncertainty must not be taken into consideration for the benefit of destroyers of water resources, instead it may be used in conservation of water resources;
- integrated management of water resources within catchment, taking into account the interests of all water users, land and other natural resources and related ecosystems;
- participation, according to which all interested stakeholders, including water users through their representatives, are entitled to participate in water resources management and planning;
- "user-pays and polluter-pays" principles, according to which the user of water and the polluter must support a significant part of expenses resulting from measures of prevention, of pollution reduction and restoration of the water resources in quality and in quantity;
- Subsidiarity, whereby development and protection of water resources is planned and implemented at the lowest appropriate level.

Article 11 of the Law provides that river streams, underground water, springs, ponds, swamps and lakes are part of the state's public domain.

Article 14 indicates that boundaries of national waters shall be considered as follows: for streams, rivers and lakes, boundaries are delimitated by the line reached by the highest waters before overflowing, while for wetlands delimitation is demarcated by a line reached by the highest water in normal circumstances (Republic of Rwanda, 2018).

Generally, the Law No 49/2018 establishes a robust framework for water resources management in Rwanda, emphasizing sustainable use, equitable access, and environmental protection. However, the effective implementation of these principles will depend on adequate resources, institutional capacity, and stakeholder engagement. Ongoing monitoring, evaluation, and adaptation will be essential to address emerging challenges and achieve long-term water security and resilience.

2.5.3.3 Law Governing Land in Rwanda N° 43/2013

Similar to the Environment Law NO 48/2018, this Law provides that State land in public domain includes land occupied by lakes and rivers; shores of lakes and rivers; springs and wells; and protected swamps; whereas State land in private domain comprises unprotected swamps. This recognition of state ownership underscores the government's responsibility for managing and protecting these critical resources. “Swamps land tenure” is defined in terms of swamp land belonging to the State, which shall not be allocated to individuals. However, it may be lent/rented to a person based on agreement reached between both parties. The Prime Minister shall draft a list of swamp land, their classification and boundaries and set up modalities of their use, development, and management (Republic of Rwanda, 2013).

The distinction between state land in the public domain (e.g., shores of lakes and rivers, protected swamps) and private domain (e.g., unprotected swamps) ensures clarity in land tenure arrangements and facilitates effective management. By categorizing certain lands as public or private domain, the law delineates rights and responsibilities for different stakeholders.

By outlining modalities for the use, development, and management of swamp lands, the law provides a framework for sustainable utilization and conservation. This may include measures to regulate activities, protect biodiversity, and mitigate environmental impacts. Clear guidelines and procedures help ensure that swamp lands are utilized in a manner that balances economic development with ecological integrity.

2.5.3.4 Law Governing Biodiversity in Rwanda

In 2013 the Biodiversity Law was issued for implementing the Biodiversity Policy of 2011. The Biodiversity Law determines modalities for management and conservation of biological diversity within Rwanda. This includes a set of criteria for developing biodiversity strategies and management plans by government institutions and other stakeholders. Specifically, the Law:

- ❖ Determines modalities for management and conservation of biological diversity within Rwanda. Promotes biodiversity strategies at a national scale to identify priority areas for conservation and protection.
- ❖ Promotes Bioregional Plans for geographic regions with several nested ecosystems.
- ❖ Promotes Biodiversity management plans related to an ecosystem, indigenous species or alien and migratory species.

A Ministerial order should set out ecosystems/species in need of protection, as well as species threatening biodiversity (Republic of Rwanda, 2013).

By determining modalities for the management and conservation of biological diversity, the law lays down a foundation for coordinated efforts to safeguard Rwanda's rich biodiversity. This likely includes measures for habitat protection, species conservation, and sustainable resource use, among others. Establishing clear guidelines and procedures for biodiversity management is crucial for effective implementation and enforcement.

The promotion of biodiversity strategies at a national scale underscores the importance of comprehensive planning and prioritization in conservation efforts. Identifying priority areas for conservation and protection enables targeted interventions to address threats and vulnerabilities to biodiversity. However, ensuring that these strategies are evidence-based, participatory, and adaptive is essential for their success.

I sum, the Biodiversity Law in Rwanda provides a legal framework for proactive and coordinated action to conserve and manage biological diversity. Effective implementation of the law requires strong institutional capacity, stakeholder engagement, and adaptive management approaches to address emerging challenges and ensure the long-term sustainability of Rwanda's biodiversity.

2.5.4 Orders

2.5.4.1 Ministerial Order determining the list of prohibited plains for construction

This Ministerial Order provides (in annexure) a list of plains on which construction activities are prohibited, as well as their geographic coordinates. Article 3 of this Order stipulates that activities within those plains should be removed within a period not exceeding three years, after the promulgation of this Order in the Official gazette (Republic of Rwanda, 2010).

The Order's provision to prohibit construction activities in designated plains indicates a proactive approach to environmental protection and land management. By identifying specific areas where construction is prohibited, the government demonstrates a commitment to preserving critical habitats, ecosystems, or landscapes from degradation or destruction.

The prohibition of construction activities in certain areas may have socio-economic implications, particularly for individuals or businesses already operating within the designated plains. The requirement to remove activities within a specified timeframe may necessitate relocation, compensation, or alternative livelihood options for affected stakeholders. Balancing environmental protection with socio-economic considerations is essential for sustainable development and equitable outcomes. All things considered, the Ministerial Order is a proactive step to protect environmentally sensitive areas from unwarranted development. However, for it to be implemented successfully, there needs to be constant dedication to sustainable land management and conservation, as well as coordinated efforts among government agencies and stakeholder participation.

2.5.4.2 Prime Minister's Order drawing up a list of swamps lands, their characteristics and boundaries and determining modalities of their use, development and management

This order No. 006/03 of 30 January 2017 provides for a buffer zone for each wetland/swamp, as the requirements of the Law on Environment N° 48/2018 of 13/08/2018 determining the modalities of protection, conservation and promotion of Environment in Rwanda.

According to this order the overall management of swamp lands is attributed to the Ministry of Land which is currently that later became Ministry of Land and Forestry and currently Ministry of Environment. In contrast, implementation of this Order was given to the Ministry of Natural Resources, currently Ministry of Environment. Furthermore, this Order highlights that Ramsar sites (e.g. Rugezi wetland) and certain proposed sites are fully protected and no one is allowed to use these swamps. However, in reality some of the proposed Ramsar sites are classified as swamps that can be used under specific conditions, and some sites are being cultivated e.g. Gashora-Mugesera-Rweru wetland complex (Republic of Rwanda, 2017).

2.6. Wetlands-related International Treaties and Agreements

The purpose of defining institutional arrangement for wetland management is to evaluate whether existing institutional arrangements are sufficient and effective in addressing the threats

to wetlands. Based on the gaps identified, an institutional arrangement for implementation of the management plan is developed.

2.6.1 Ramsar convention 1971 and protocol 1972

Ramsar convention is an international treaty with a mission of promoting the conservation and wise use of worldwide wetlands by employing local, national and International actions and cooperation for the purposes of achieving sustainable development. Rwanda ratified this convention in 1st April, 2006 and currently has one wetland (Rugezi wetland) gazetted as a Ramsar site that covers a total surface area of 6736 hectares and a number of other wetlands of International importance which have been proposed to be gazetted to the convention as Ramsar Sites. (The Ramsar Sites) covering a total surface area of 6736 Hectares (Ramsar, 1991).

The Ramsar Convention's mission of promoting the conservation and wise use of wetlands aligns with Rwanda's goals of achieving sustainable development. By recognizing the importance of wetlands as critical habitats for biodiversity, water resources, and livelihoods, the convention emphasizes the need for coordinated action at local, national, and international levels. While Rwanda's commitment to Ramsar is commendable, the effective management and conservation of designated sites require addressing various challenges, including habitat degradation, pollution, and conflicting land uses. Enhanced capacity building, stakeholder engagement, and enforcement mechanisms are essential for overcoming these challenges and realizing the full potential of wetland conservation efforts.

In summary, Rwanda's ratification of the Ramsar Convention and designation of Ramsar Sites reflect its commitment to wetland conservation and sustainable development. By leveraging international frameworks and cooperation, Rwanda can enhance its efforts to protect and manage its valuable wetland ecosystems for the benefit of current and future generations.

2.6.2 The United Nations Framework Convention on Climate Change

For the purposes of this Convention: “Adverse effects of climate change” means changes in the physical environment or biota resulting from climate change which have significant deleterious effects on the composition, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare (UN, 1998).

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (UN, 1998).

2.6.3 Convention on Biological Diversity

In the case of biological diversity, the Convention recognizes the value of all the components of biodiversity in the way they work together to create an ecosystem and accepts as a goal that all the components must be conserved and sustainably used. The Treaty, moreover, considers what this might mean and how the conservation and sustainable use of biological diversity might be achieved. More importantly, the Treaty recognizes a third objective, which is the equitable sharing of the benefits of biodiversity, achieved by the transfer of technology and by financing (UN, 1995).

2.6.4 The United Nations Convention to combat desertification

The objective of this Law is to ratify the United Nations Convention to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach which is consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in affected areas (UNEP,1999).

2.6.5 Convention concerning the protection of the world culture and natural heritage

The Convention concerning the Protection of World Cultural and Natural Heritage is an international convention that was adopted by UNESCO in 1972. Concern over the preservation of the world's cultural and natural heritage for future generations formed the main foundation for the Convention. The aim of the Convention is to identify, safeguard, preserve and present the world's most valuable cultural and natural heritage through international collaboration. World

heritage belongs to all humanity, and all nations are thereby charged with its protection. Finland ratified the Convention in 1987. In Finland, the Convention is governed by the Ministry of Education and Culture, but the Finnish Heritage Agency is in charge of its implementation. By early 2017, 193 nations had ratified the Convention (UNESCO, 2000).

2.7 Main Challenges Related to Wetland Management

Human impacts within a wetland may result in erosion and lead towards wetland degradation. The removal of sediment is related to the eroding power of the water flow versus the forces of resistance, or inherent erodibility, of the land. Human impacts relate to the removal of vegetation, which normally acts as a resistance to the erosive power of water, and cultivating the wetland soil, which leads to wetland degradation. Other impacts include excavation of artificial channels through a wetland, which changes the local base level and may result in wetland drainage; and the construction of dams, which trap sediment and may initiate erosion in wetlands. In order to mitigate for the change or degradation of wetlands by both human, and other natural impacts, a rehabilitation strategy needs to be implemented. Rehabilitation can be focused towards restoration, rehabilitation or protection of a wetland depending on the goals of the strategy (Ellery et al., 2009).

Overall, the main challenges related to wetland management stem from human activities that disrupt natural processes and degrade wetland habitats. Addressing these challenges requires a combination of proactive measures, including sustainable land use practices, restoration efforts, and effective policy and governance mechanisms to ensure the long-term conservation and resilience of wetland ecosystems.

2.7.1 Agricultural intensification

Agricultural development often results in diffuse sources of pollution and can have a significant effect on wetlands. Whilst it is difficult to control diffuse source pollution, attempts should be made to limit the extent of run-off of nutrients and pesticides from agricultural land to wetlands. The overwhelming majority of Rwandans rely primarily on agriculture for livelihoods (Nabahungu, 2012). Rwanda’s high population growth rate and limited area for agricultural expansion (the average land holding per household is less than 0.5ha) has resulted in strong land pressure on the available upland arable areas, resulting in reducing productivity (Nabahungu, 2012). Consequently, the use of wetlands (marshlands10) has become a food security imperative

which is clearly confirmed by the increasing intensive agricultural production in many of the country's valley bottom and floodplain wetlands (REMA, 2010).

Rwanda's high population growth rate and limited land availability per household result in strong land pressure, leading to reduced productivity of upland arable areas. This land pressure drives agricultural expansion into wetlands, particularly valley bottoms and floodplain areas, as farmers seek to meet food security needs and sustain livelihoods.

Addressing the challenges associated with agricultural development and wetland conservation in Rwanda requires a multifaceted approach that considers the interconnectedness of socio-economic, environmental, and governance factors. By integrating conservation objectives into agricultural development strategies and promoting sustainable land management practices, Rwanda can strive towards achieving both food security and environmental sustainability goals.

2.7.2 Over Exploitation of Natural Resources

The extensive use of wetlands for the purpose of generating hydropower and as mine for clay, sand, gravel and peat include the most direct threats which are faced by wetlands in Rwanda. The hydropower plants usually require sufficient amount of water which and are mostly connected to the wetland schemes. The hydroelectric power plants are usually more susceptible to sedimentation which as a result damages turbines and tubing due to the inadequate storage capacity of wetlands. The drop of water levels has serious economic losses. A good example of this is seen in the Rugezi wetland (REMA, 2010).

The example of Rugezi wetland highlights the real-world impacts of over-exploitation and degradation of wetland ecosystems in Rwanda. The degradation of Rugezi wetland due to hydropower generation and associated sedimentation underscores the need for sustainable management practices and conservation efforts to protect and restore valuable wetland habitats.

To sum up, the over-exploitation of wetland resources for hydropower generation and mining activities poses significant threats to environmental sustainability and socio-economic development in Rwanda. Addressing these challenges requires concerted efforts to promote sustainable management practices, protect valuable wetland ecosystems, and ensure the equitable use of natural resources for the benefit of present and future generations.

2.7.3 Reclamation and encroachment

Wetlands in Rwanda are mainly threatened by reclamation and degradation, especially those outside national parks. Human activities threatening wetlands in Rwanda include settlements and road construction, drainage, unplanned conversion to agriculture, industrial pollution sewage and excessive harvest of products. Land use practices such as trampling of stocks, human disturbances, burning of vegetation, soil excavation processes have devastated vegetation cover to such an extent that the soil surface of areas has become susceptible to erosion (MoE, 2021). The reclamation and degradation of wetlands, particularly those outside national parks, are significant threats to their ecological integrity and biodiversity. Human activities such as settlements, road construction, drainage, and unplanned conversion to agriculture contribute to the loss and degradation of wetland habitats.

The expansion of human settlements and infrastructure into wetland areas encroaches upon valuable ecosystems, leading to habitat loss and fragmentation. Road construction, in particular, can disrupt natural hydrological patterns, alter water flow regimes, and exacerbate sedimentation and pollution in wetlands.

The conversion of wetlands to agriculture, often without proper planning or management, results in the loss of wetland habitats and associated ecosystem services. Agriculture in wetlands can lead to soil erosion, water pollution from agrochemicals, and habitat destruction, threatening biodiversity and ecological functions.

Briefly, the threats facing wetlands in Rwanda are complex and multifaceted, driven by a combination of human activities, land use practices, and environmental pressures. Protecting and conserving wetland ecosystems requires coordinated efforts to address these threats through sustainable land management practices, policy interventions, and stakeholder engagement, ensuring the long-term resilience and sustainability of wetland ecosystems for current and future generations.

2.7.4 Urbanization and industrial activities

Urbanization, and industrial activities not only destroy wetlands but also keep the wetlands from doing their important tasks in the ecosystem. These activities reduce the water quality in the wetlands with the waste they generate, cause depletion of food resources and consequently threaten all living beings in this ecosystem. The interaction of urbanization and industrial

activities with wetlands causes irregularity of the flow regimes of rivers and streams feeding wetlands, disruption of the water cycle of wetlands, the increase in the salinity level of water, the accumulation of chemicals such as pesticides and industrial waste. As a result, it causes poisoning of aquatic organisms and damage to other living beings interacting with the wetland (REMA, 2012). Increased housing developments associated with urbanization, directly affects the soils physical characteristics thus lowering water infiltration and increasing runoff and soil erosion with increased potential for floods. This has happened in Kigali and to a lesser extent in other provincial towns across the country. Roofing of housing complexes and paving of roads and other access routes has reduced the surface area available for soil infiltration. During the rainy season much of the run-off flows to the valleys below with minimal infiltration which is one of the main ground water recharge pathways (REMA, 2022). In urban areas wetlands are most likely to be used as dumping sites for wastes or wetlands may be converted to other forms of land use, such as residential and industrial development, road construction, or aquaculture. Addressing the challenges posed by urbanization and industrial activities requires integrated approaches that prioritize the conservation and sustainable management of wetlands. This includes implementing effective land use planning measures, adopting pollution control strategies, promoting green infrastructure and sustainable urban development practices, and raising awareness among stakeholders about the importance of wetland conservation for ecosystem health and human well-being. By mitigating the impacts of urbanization and industrialization on wetlands, Rwanda can safeguard these valuable ecosystems and ensure their resilience in the face of growing urban pressures.

2.7.5 Lack of awareness on the values of wetland ecosystem goods and services

Rwanda's wetlands consist of marshes, lakes and rivers and water, they represent about 14.9% of the national territory. Wetlands provide a number of ecosystem services for instance they offer surface water detention which yields flood protection services; stream flow maintenance that yields water supply services; nutrient transformation that yields water quality services; sediment and other particulate retention which is also associated with water quality service; provision of habitat for fish which is associated with subsistence and commercial fishing; provision of habitat for wildlife which is associated with recreation and tourism, and biodiversity protection and conservation; carbon storage and sequestration which is associated with climate stability among

(ARCOS, 2021). Despite these ecosystem services that wetlands offer, they suffer serious degradation mainly due to infrastructure development, over-use, land conversion, pollution, water withdrawal, climate change, eutrophication, pollution, and the introduction of invasive alien species and the main reason for the continued loss and degradation of wetlands throughout the world is because they (wetlands) have been traditionally considered to be of little or no value, or even at times to be of negative value. This lack of awareness of the value of conserved wetlands and their subsequent low prioritization by the decision-making process has resulted in the destruction or substantial modification of wetlands at an unrecognized social cost (ARCOS, 2021).

Despite their importance, wetlands in Rwanda face serious degradation and threats from various human activities, including infrastructure development, over-use, land conversion, pollution, water withdrawal, climate change, eutrophication, and the introduction of invasive alien species. The lack of awareness regarding the values of wetlands contributes to their continued loss and degradation, as decision-makers may prioritize other development objectives over wetland conservation.

Incorporating wetland values and ecosystem services into decision-making processes, policy development, and land use planning is critical for ensuring their long-term conservation and sustainable management. By recognizing the multiple benefits provided by wetlands and prioritizing their protection, Rwanda can work towards safeguarding these valuable ecosystems for future generations.

In summary, addressing the lack of awareness regarding the values of wetland ecosystems in Rwanda requires concerted efforts to educate and engage stakeholders, integrate wetland values into decision-making processes, and promote policies and practices that prioritize wetland conservation and sustainable management. By recognizing the importance of wetlands and their ecosystem services, Rwanda can enhance efforts to conserve these vital natural resources and promote environmental sustainability.

2.8 Concepts and approaches for stakeholder analysis

It is generally acknowledged that the community involvement and participation in the management of natural resources is a condition of their sustainable use. In the case of wetlands, they are recognized as fundamental principles of wise use by the Ramsar Convention (Ramsar Convention Secretariat, 2004).

2.8.1 Definition of Stakeholders

Broadly speaking, stakeholders are defined as the people and organizations who are involved in or affected by an action or policy and can be directly or indirectly included in the decision-making process (Freeman 1984; Annan 2007; Sterling et al., 2017) A particular organization may further define situation-specific groups of stakeholders for its projects. For example, the U.S. National Park Service defines a stakeholder as a group or individual that should be present in order to reach the desired outcome or overall team purpose (U.S. National Park Service, www.nps.gov/ncrc), while the United Nations Environment Programme identifies and engages with nine specific major stakeholder groups for sustainable development projects under their oversight: farmers, women, scientific and technological community, children and youth, indigenous peoples and their communities, workers and trade unions, business and industry, nongovernmental organizations, and local authorities (UNEP 2015).

Grimble and Wellard (1997) define stakeholder analysis as "holistic approach or procedure for gaining an understanding of a system, and assessing the impact of changes to that system, by means of identifying the key actors or stakeholders and assessing their respective interests in the system". In the development context, stakeholder analysis is used by International Development Agencies as a project management tool to identify the consequences for stakeholders of the implementation of a particular project or policy (Grimble and Wellard, 1997). In a research context, stakeholder analysis is used as an analytical tool to understand complex situations, its potential evolution and trade-offs between various objectives (Grimble et al. 1995; Grimble 1998).

Stakeholder analysis has become increasingly popular with a wide range of organizations in many different fields, and it is now used by policy-makers, regulators, governmental and non-governmental organizations, businesses and the media (Friedman and Miles, 2006). Approaches to stakeholder analysis have changed as tools have been progressively adapted from business management for use in policy, development and natural resource management. It is perhaps this variety of different approaches that has given rise to widespread confusion over what is really meant by stakeholder analysis (Donaldson and Preston, 1995, Stoney and Winstanley, 2001). Weyer (1996) described it as a "slippery creature", "used by different people to mean widely different things". Donaldson and Preston (1995) put this confusion down to a "muddling of theoretical bases and objectives".

2.8.2 Steps of Stakeholder Analysis

Stakeholder analysis (stakeholder mapping) is a way of determining who among stakeholders can have the most positive or negative influence on an effort, who is likely to be most affected by the effort, and how you should work with stakeholders with different levels of interest and influence. It involves a number of steps that need to be considered while performing a stakeholder analysis.

2.8.2.1 Identify issues

The first necessary step in SA is to define the system or issue under study (Grimble, 1998, Prell et al., 2009), which in land management is related to land use problems. Knowledge of the issue itself suggests which stakeholders are relevant and should be involved (Dougill et al., 2006). Therefore, it is recommended to first articulate the problem and probable causes and to establish objectives and desired outcomes (Bernhart, 1992). Once the key issues have been identified and defined, stakeholders can be identified who will affect or be affected by these issues, with assessments of their levels of interest and influence (Brugha and Varvasovszky, 2000). However, partly due to the difficult dialectic between issue definition and stakeholder identification (Prell et al., 2009), this step is easily ignored in practice. Therefore, issues might not be distinguished clearly (e.g., mixing social issues and stakeholder issues) (Clarkson, 1995), or issues might be pre-identified in a top-down manner by project managers and may therefore reflect their interests only and cause biases (Prell et al., 2009).

2.8.2.2 Identify stakeholders

Stakeholders are individuals, groups or organizations that can affect or are (positively or negatively) affected by a decision or action (Bryson et al., 2011; Freeman, 1984; Grimble, 1998). In the field of Sustainable Land Management (SLM), stakeholders are land users, agricultural advisors, researchers, government authorities, civil society, and decision makers at all levels (Hurni, 2000; Schwilch et al., 2012b).

Detailed criteria must be developed in each case to determine the stakeholders relevant to the research being undertaken (Grimble, 1998). Clarkson (1995) proposed to distinguish primary stakeholders and secondary stakeholders according to their importance in cooperation. Mitchell and his colleagues (1997) suggested the need to assess the urgency, legitimacy, and power of

stakeholders in relation to the issues under study. Such an approach might lead to a situation in which powerful stakeholders are prioritized, and the marginalized groups are underrepresented (Grimble and Chan, 1995).

- Primary stakeholders are defined by Clarkson (1995) as “one without whose continuing participation the corporation cannot survive as a going concern". These groups mainly include shareholders, employees, customers, and suppliers, and the public sector: the governments and communities that afford infrastructure, regulate organizational activity, and enforce taxes. Mitchell et al. (1997) state that these groups of stakeholders possess power that influences managerial decisions. Due to the contractual relationships firms have with primary stakeholders, they are highly visible: choices, opportunities, decisions, and the valuation of their demands are required by firms (Hult et al., 2011). Fassin (2012) notes that primary stakeholders enjoy a direct and contractual relationship with the firm.
- Clarkson (1995) defines Secondary stakeholders as “those who influence or affect, or are influenced or affected by, the corporation, but they are not engaged in transactions with the corporation and are not essential for its survival”. Secondary stakeholder groups include competition, media, trade associations, and support groups (special interest). Although these groups have no contract or authority with the firm, and the firm is not dependent upon these groups for their survival, they can cause significant disruption to the firm.
- Key stakeholders, who might belong to either or neither of the first two groups, are those who can have a positive or negative effect on an effort, or who are important within or to an organization, agency, or institution engaged in an effort. The director of an organization might be an obvious key stakeholder, but so might the line staff – those who work directly with participants – who carry out the work of the effort. If they don’t believe in what they’re doing or don’t do it well, it might as well not have begun. Other examples of key stakeholders might be funders, elected or appointed government officials, heads of businesses, or clergy and other community figures who wield a significant amount of influence (Friedman and Miles, 2006).

2.8.2.3 Investigate stakeholders' interests

The identification of stakeholders' interests will deepen the understanding of stakeholders' needs and enhance their motivation to improve the problem situation. Grimble's (1998) principal guide provides a reference for the key topics to explore, and Reed et al. (2009) review provides various tools, amongst others focus groups, semi-structured interviews, interest-influence metrics, social network analysis. However, the interests of all types of stakeholders may be difficult to define, especially if they are "hidden" or in contradiction with the openly stated aims of the organization or groups involved (ODA, 1995). There is a need for continuously updated analysis (Pouloudi and Whitley, 1997). Thus, a resulting dilemma for project managers is whether to invest more time and resources to dig for the "true" information or to keep the project in motion (Jepsen and Eskerod, 2009).

2.8.2.4 Investigate interrelations among stakeholders

Exploring the networks and interactions among stakeholders involves understanding the relationships between stakeholders to enhance transparency in decision making and to provide some clues for implementation, particularly in action-oriented projects. Centralized networks are helpful for forming groups and providing support for collective action in the initial phase, and more decentralized structures are beneficial for long-term planning (Crona and Bodin, 2006; Prell et al., 2009). Stakeholders who have similar communication patterns or belong to homogeneous groups are better able to communicate and reach mutual understanding (Prell et al., 2009). However, homogeneity may be problematic, as successful joint decision making requires different views and opinions to be recognized and brought into the discussion (Crona and Bodin, 2006). It is claimed that marginalized people in the network should be represented and given attention (Grimble and Chan, 1995).

Chapter 3. RESEARCH METHODOLOGY

Introduction

This chapter outlines the methods and techniques that were used in this study. Those methods consist of semi and unstructured interviews with local population, wetland users and those who guide them in the management of the wetland. Participant observation, literature search review (secondary data) and analysis were also used to find answers to the research questions.

3.1 Study Area Description

The Rugeramigozi wetland is located in Muhanga District (02° 07'40'' S, 29º 45' 20''E), in the Southern Province. It is located in the central plateau in the 7th agro-ecological zone at around 1650m and covers an area of 225 ha (MINAGRI, 2010).

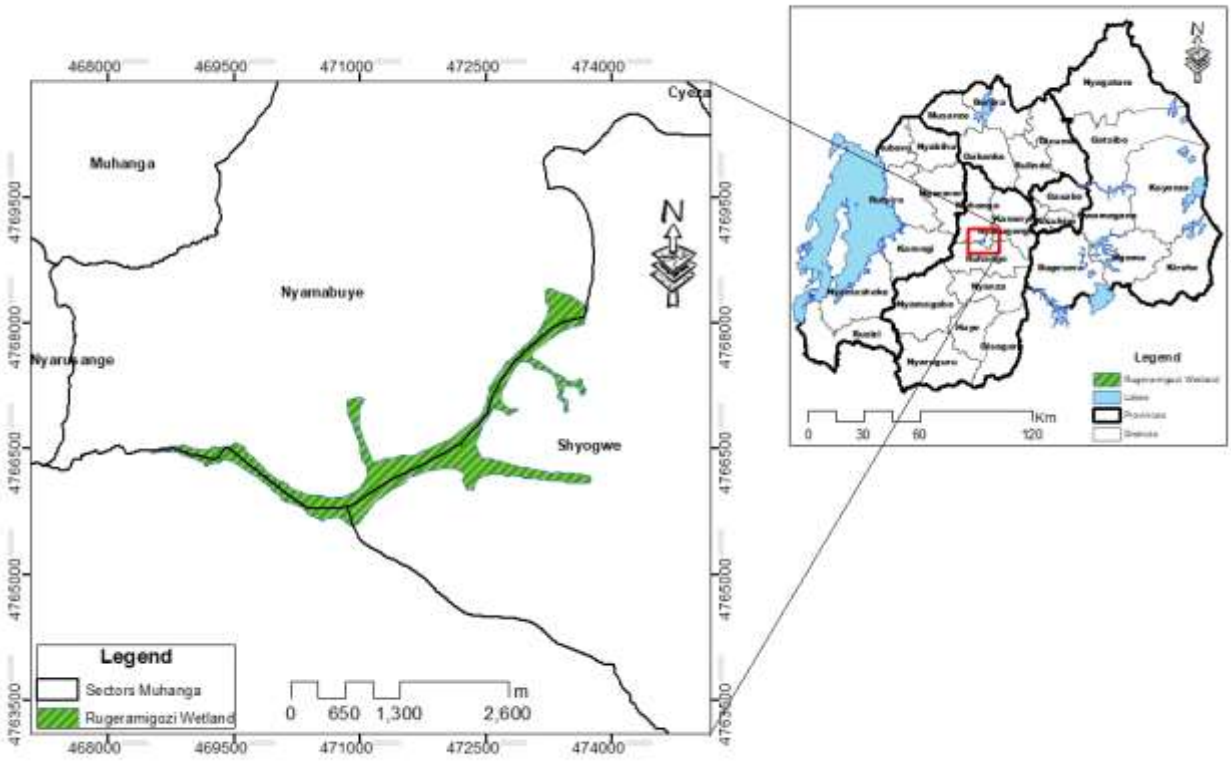

Figure 1: Study area map of Rugeramigozi

Data source: (National Institute of Statistics of Rwanda (NISR) & Centre for Geographic Information Systems, 2017)

3.2 Data Collection

Local communities played a central role in the collection of primary data through participatory research methods such as participatory mapping, transect walks, and household surveys. Community members were trained and mobilized as citizen scientists to collect field data on land use, crop production, water quality, biodiversity, and socio-economic indicators within the wetland area. Stakeholders contributed local knowledge, observations, and experiences to complement scientific data collection efforts, providing valuable context and insights into ecosystem dynamics and human-wetland interactions.

3.2.1 Secondary Data Sources

The study used existing literature such as publications, textbooks, magazine articles, book reviews, papers, Government documents related to stakeholder analysis in wetland management.

3.2.2 Primary Data Sources

3.2.2.1. Household survey

The household survey was used to gather primary data for farmers of Rugeramigozi wetland. Furthermore, household questionnaire was mainly used to get the opinions of local farmers practicing farming in Rugeramigozi wetland about its role in terms of its stakeholder's interests over the wetland use using the list of questions where the researcher asked questions to the local farmers and wrote down the answers.

In this section, the researcher draws a connection between Rugeramigozi wetland stakeholder's categories, their relations with the wetland resources and describes how they influence its use, and the potential conflicts. In this junction, we will also need to collect data regarding stakeholder groups attitudes, their patterns of interactions concerning the efficiency/inefficiency allocation and use of the wetland resources; thus, finding ways of handling conflicting interests that may result from its use to sustainably use its resources and decide whether to maintain or revise the decision-making process for all stakeholder's groups.

3.2.2.1.1. Population of the Study

The study targeted Rugeramigozi wetland resources users at a given specific period of time. The targeted population of the study comprises 1,408 farmers grouped in two cooperatives called

KIABR and KOKAR undertaking the agricultural activities consisting of plantation of rice on 60 hectares and maize and vegetables on 30 hectares: The wetland is divided into two parts: There is Rugeramigozi 1 (KIABR) which is used by 858 farmers and Rugeramigozi 2 (KOKAR) which is used by 550 farmers.

3.2.2.1.2. Sample Size

The sample size for this study was determined based on the above total population consisting of the current users of Rugeramigozi wetland. We randomly sampled 90 householders out of 1408 individuals. This sample was derived using the following formula which is applied in the selection of the sample from the finite population and seeking generally acceptable level of confidence and standard error as defined by Krishnaswamy et al., (2006) as follows: determining the number of observations. By using stratified random sampling, we will take a sample of 90 farmers representing the total number of 1408 farmers operating in Rugeramigozi wetland.

$$n = \frac{z^2 * p(1-p)/e^2}{1 + (z^2 * p(1-p))/\ z^2 * N}$$

Where:

Z = is the value assigned for the confidence level of 95%, with 1.96 as a confidence level score;

p = the desired proportion for the sample size n, which is 0.5; e = the marginal error (10% in this study);

N = population size in the study area.

By applying each corresponding value in the formula above we obtain the following:

$$n = \frac{(0.95)^2 * 0.5(1-0.5)/(0.1)^2}{1 + (0.95^2 * 0.5(1-0.5))/\ 0.95^2 * 1408}$$

$$n = \frac{0.9025}{0.01}$$

Then according to the formula above;

$$n = 90.25$$

$$n \simeq 90$$

As was previously mentioned, two cooperatives oversee Rugeramigozi. As a result, these cooperatives will receive an equal distribution of the 90 farmers in this sample. Based on their participation in the two cooperatives, the farmers are classified into two strata. The sample size was distributed in accordance with the size of each stratum. The researcher divided the 45 samples between the two cooperatives in the study area, each of which had equal management authority over the Rugeramigozi wetland.

In order to obtain a total sample size of 90, the researcher randomly picked 45 farmers from each cooperative because the population is stratified. He guarantees that the sample accurately reflects the diversity found in the population.

3.2.2.1.3. Administration of the questionnaire

The questionnaire employed in this study was meticulously designed to gather insights from two distinct groups: local farmers residing in Rugeramigozi 1 and 2, and experts, local government officials, and policy/decision makers involved in wetland resource management in Muhanga District. Local communities and other stakeholders were actively engaged in the initial stages of the research to identify key issues and concerns related to wetland management and agricultural practices. Participatory workshops, focus group discussions, and key informant interviews were conducted to gather insights from a diverse range of stakeholders, including farmers, community leaders, government officials, NGOs, and researchers.

For the local farmers, the questionnaire adopted a face-to-face completion model, reflecting a hands-on approach where the researcher directly interacted with the respondents. These interactions were facilitated either by visiting the farmers' communities or through collaboration with local organizations and cooperatives. The questionnaire began with open-ended inquiries, allowing farmers to express their views freely. Subsequently, it transitioned to more focused queries aimed at elucidating the primary activities conducted within the Rugeramigozi wetland.

In contrast, the questionnaire administered to experts and stakeholders in wetland management followed a targeted approach. The researcher identified and contacted relevant individuals, including policy/decision makers, local government representatives, and specialists from various organizations involved in wetland resources. These questionnaires were delivered through hand delivery or conducted via face-to-face interviews.

Through these participatory processes, stakeholders provided input on the selection of research topics, prioritization of research questions, and identification of knowledge gaps relevant to wetland management and environmental sustainability.

3.2.2.2. Interviews

In this research project, interviews are complemented with direct observations of stakeholder's practices. At this stage it will be important to understand what the uses of the wetland are, the direct and indirect goods and services people derive from it, the rules of access to the resources and constraints people experience in using it, the form of management of the resources, and the context in which each stakeholder group take its decisions. In addition to the above, stakeholder actors are asked questions regarding their interests, influence or power versus the allocation of the resource use rights and assess if their decisions comply with the sustainability of the biophysical resource use.

For the interviews, a predesigned survey form was used with a mixture of closed and open-ended questions. This semi-structured questionnaire is organized around the main topics, but room for new questions was available within a topic depending on the responses of the interviewee. The later was asked questions regarding his/ her patterns of interactions concerning the allocation of the resource use rights and the taken decision. For the second step, tools used in participatory rapid appraisal (interviews of key informants, focus group discussions, timeline and participatory mapping, transect walks, seasonal diagrams, preference ranking and Venn diagram) was particularly adapted.

In the interview with users of the wetland and other stakeholders, we asked local farmers in cooperative union operating in Rugeramigozi wetland about its historical background, how it was cultivated and the current cropping system and ask them how they interact with other wetland users. Furthermore, we interviewed different officials from Government agents, District,

Ministry etc. and investigate how the wetland is managed, the management rules to be followed by its users and see how they are established, how the monitoring compliance is done, existing challenges and assess how they are solved. We further had interview with local retailers of crop products at the local market in other to ascertain their expectations from the wetland management.

3.2.2.3. Field observation

The field observation focused on the bio-physical status of wetland and landscapes' management in order to get a general picture of the current situation. In this fashion, regular field visits to wetland users were organized to better understand people's attitudes, interests, needs and social relations. Moreover, this technique was applied so as to observe the characterization of the relationships between the various Rugeramigozi wetland stakeholder groups as conflict or cooperation and assessing the intensity of these relationships towards the wetland management rules. Additionally, the field observation helped us to see the manifestation of the stakeholder activities and assess whether they are carried out in a way that promote the sustainable use of the wetland and check if conflicting interests/uses that may be resulting from the allocation of the resource use rights are mediated or solved to sustainably use the wetland.

3.3 GIS application

In this fashion, the land use/land cover map of Rugeramigozi wetland was prepared using Muhanga District satellite imagery. We mapped different land uses in and around the wetland so as to analyze its spatial distribution and be able to assess new problems of wetland degradation and suggest alternative solutions that may help decision makers to sustainably use the wetland.

3.4. The analytical framework

This study relies on the stakeholder analysis approach consisting of characterizing the relationships between the various stakeholder groups as conflict or cooperation and assessing the intensity of these relationships. We then ask a sample of stakeholders to define a stakeholder as well as identify their role and determine how impactful the resource use rights are allocated in relation to the sustainable management of the wetland.

Generally, the starting point for the analysis is the rules as shown on the figure below.

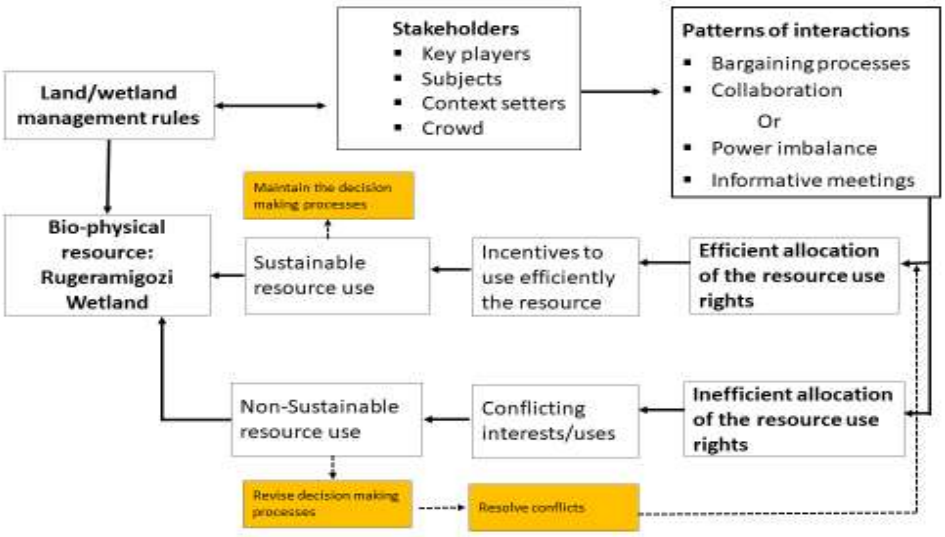

Figure 2: Analytical framework

Adaptated from: Ostrovskaya, Douven, Mukuyu, Schwartz, Pataki, et al., (2012), add. 2005a; Ostrom, (2005). Andersson, (2006), etc.

1) **Wetland management rules:** Rules are set to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individual's dependent on their actions (Osrtom, 1997;Ostrom, 2005b). Those rules are crafted at several three levels namely constitutional, collective-choice, and operational levels determining decision-making eligibility, actions, aggregation rules, procedures, information provision, and payoffs. Stakeholders represents the individuals to which the rules apply and those who have to enforce them (Ostrom, 2005a; Ostrom, 2005b). The purpose of these rules is to define task execution and resource allocation methods.

2) **Stakeholders**: These stakeholders can be organized in different groups based on the interest-influence matrix. This matrix considers the relative interest of the stakeholder in the management of the wetland versus their level of influence in order to create a stakeholder map (Smrekar & Polajnar Horvat, 2012). They are placed in four quadrants and stakeholder groups: key players, subjects, context setters and the crowd. This

classification allows for the determination of stakeholder categories that demand priority attention. In this fashion, the analysis focuses on the stakeholders located in the upper-right quadrant and they are described as follow:

- Key players, i.e. stakeholders with high interest and high influence/power. They are the ones that are involved in decision making and consulted regularly. If they influence negatively other stakeholder groups, they will tend to over possess the wetland resource uses and not complying with the wetland management rules. This can lead to the inefficiency of the allocation resource use rights, thus resulting to conflicting interests/uses. The reason behind this is that other stakeholder groups were not taken into consideration in using the available biophysical resources. In this case, the decision making process has to be revised for resolving these conflicts.

- Subjects are stakeholders with high interest but low power. They are affected by the wetland and are keen to influence the process but they do not have power to change decisions. They are engaged in the ongoing communication about the project's progress and involved in the management rights on a regular basis.

- Context setters are stakeholders with the low interest but high power. They affect the wetland but they can have little interest; therefore, they are informed via general communications, to increase their level of interest.

- The crowd represents the stakeholders with the low interest and low power. They are not interested in the resources management and do not have the power to influence decisions. They are kept informed about the development of the wetland resources. For better biophysical resources use, all stakeholder groups have to comply with the wetland management rules, their patterns of interaction have to consider the desires of every stakeholder by balancing their power and interests to efficiently allocate the resource use rights which can lead to the sustainable resource use, thus maintaining the decision making process of the biophysical resource.

3) **Patterns of interactions:** They includes agreements between stakeholder groups about the wetland uses compared to their needs and interests. Those patterns are described as follows:

- Bargaining process: As not all stakeholders are equally important throughout the whole systems/stakeholders analysis, some may gain importance during the process, others may become less important. We need to compare resource use and interests of different stakeholders, identify current and potential conflicts, determine common interests and areas for cooperation. If stakeholders interact positively or their decisions responding to the desires and aspirations of everybody; i.e.: their collaboration, power/interests complying with the wetland management rules, the allocation of the resources use rights is efficient. In this case, the stakeholders are receiving the incentives to use efficiently the available resources.

- Collaboration: Collaborative processes are most likely to succeed when there is room for negotiation; when stakeholders need each other to achieve both individual and shared goals; and when there is a willingness to participate. In this fashion, the wetland resources are used sustainably and decision-making process of the biophysical resources has to be maintained.

- Power imbalance: In this mode of interaction, we assessed the "capacity that A has to influence the behavior of B so that B acts in accordance with A's wishes." It is seen as a potential, in other words that is does not have to be exercised but is the capacity to do something. The people falling under power (B) have a dependency on the people with the power (A) and the stronger this imbalance, the higher the power "A" has over "B". In this situation, stakeholders interact negatively, and their decisions do not address the needs of all categories of resource uses desires; i.e.: disagreement about the wetland uses; then the allocation of the wetland resources use rights may be inefficient and leads to conflicting interests/uses. Thus, the wetland resource use is not sustainable.

- Informative meetings: Creating communication channels facilitates the stakeholders to understand the wetland management goal and its benefits, building trust and helping them get support. We want to have a good idea of how the concerned people organizing meetings are going to keep each stakeholder group informed. Ensuring all stakeholders have relevant information available when they search it out is crucial to keep them interested. Whenever stakeholders have difficulties finding information, it becomes more likely that they will lose interest in the wetland management.

This framework provides a structured approach to wetland management, integrating rules, stakeholders, and interaction patterns. By understanding stakeholder dynamics, identifying their interests, and fostering collaboration through effective communication and adherence to rules, sustainable resource use can be achieved. The framework emphasizes the importance of balancing power and interests among stakeholders to maintain efficient decision-making and ensure the long-term viability of wetland ecosystems. It provides a comprehensive approach to guide the analysis of wetland management by considering various factors such as stakeholders, rules, and patterns of interaction.

3.5 Data Processing

Remote sensing analysis with Landsat image classification was the main research method used for this study. This classification was made based on a supervised classification approach, which is an essential tool for extracting quantitative information from remotely sensed data (Mugabowindekwe and Rwanyiziri, 2020). Maximum Likelihood Classifier algorithm (MLC) was also used basing on the assumption that each spectral class can be described by a multivariate normal distribution. The image classification exercise led to the identification of both spatial and temporal changes which, over the time, have been taking place in Rugeramigozi wetland. The following table presents the accuracy assessment of the classified images where both the Producers and Users' Accuracy were calculated. Apart from the above calculation, another calculation of Kappa coefficient and an overall accuracy of classified images were also done and established, respectively. The results of image classification for the period of 30 years for the year 1992, 2002, 2012 and 2022 are in the table below.

Table 1: Accuracy Assessment for Rugeramigozi wetland image classification

Sensor	Acquisition date	Classified image statistics	Over all accuracy	Kappa
Landsat 4 TM	1992	Cropped Land 1992	82	0.670
Landsat7 TM+	2002	Cropped Land 2002	83	0.69
Landsat 8 OLI	2012	Cropped Land 2012	85	0.75
Santinel2 USGS	2022	Cropped Land 2022	88	0.80

3.6 Data Analysis and Interpretation

The data we analyzed considering the predetermined identification of key stakeholders' responses (field work was done through interviews and questionnaire). A potential list of stakeholders (with their characteristics, such as: sector of activity/field of intervention, institution, stakeholder classification, relationships with other stakeholders, major conflicts among stakeholders in relation to Rugeramigozi wetland resources uses) was developed.

Data analysis included the transcription of recorded information through interviews and household surveys. Transcripts are organized through the use of three steps mainly: determining who are the stakeholders, i.e. the list of potential stakeholders, grouping and prioritizing these stakeholders by categorizing them in terms of their influence; interest and levels of participation in the project through the power/interest grid, figuring out how to communicate with and win buy-in from each type of stakeholder by thinking strategically about how best to earn the ongoing support of each of these stakeholder types.

Spatial statistics and map algebra tools of ArcGIS were used in producing qualitative maps and analyzing the spatial-temporal dynamic multiplicity in the Rugeramigozi wetland. The checking of all collected data from individual stakeholders were performed using the use of satellite imagery for inventory and monitoring of wetlands and providing information surrounding the Rugeramigozi wetland use and changes overtime.

Throughout the research process, stakeholders were actively involved in the interpretation and validation of research findings to ensure relevance, accuracy, and credibility. Participatory data analysis workshops and feedback sessions were organized to collaboratively analyze research results, identify patterns, and draw conclusions.

Local knowledge holders and community representatives provided contextual understanding and alternative perspectives on the implications of research findings for wetland management, livelihoods, and community well-being. Moreover, stakeholders contributed to the co-creation of actionable recommendations and strategies for sustainable wetland management based on a shared understanding of research outcomes and their implications for decision-making and policy development.

3.7 Study Limitations

During this study the researcher could not easily find data for the production of the main crops produced in the study area. Because of the turnover of accountants for both KIABR and KOKAR some data related to production for the period of 30 years were missing and for that reason the researcher chosen to ask the cooperative representatives to make estimates. Thus, relying on estimates from cooperative representatives introduces potential biases and inaccuracies in the data, as these estimates may be subjective or based on incomplete information. This could compromise the reliability of the findings and subsequent analysis.

Additionally, Stakeholders' views, attitudes, and priorities regarding wetland management may vary widely and could be influenced by personal biases, organizational affiliations, or socioeconomic factors, potentially impacting the accuracy and reliability of the stakeholder analysis. Moreover, the selection of stakeholders for analysis may not adequately represent the diversity of perspectives and interests within the community, leading to skewed or incomplete insights into stakeholder dynamics.

Chapter 4. RESULTS AND DISCUSSION

This chapter presents the findings based on the output of the methodology used. The discussion section of this research is based on the outputs from the analytical framework and stakeholder analysis. The results are interpreted and discussed in terms of the existing setting of Rugeramigozi wetland management. The suggestions for the efficient use of the wetland are given in the details. From this point conclusion and recommendations are drawn.

4.1 Results

The current section gives a detailed account of the main findings and their discussions. As far as the analysis of the data is concerned, the findings are presented and analyzed according to the order in which the questions were asked. In fact, it deals with the presentation, analysis and interpretation of the responses from respondents. The framework for wetland management outlined in this research serves as a lens through which data can be interpreted and findings synthesized. The tables and figures showing the frequencies of responses of questions were constructed; percentages of responses to particular questions were calculated. The displayed data in form of figures and tables are originated from field survey done by the researcher in June 2022.

4.1.1 Understanding Wetland Management Rules in Rugeramigozi wetland

In the context of wetland management in Rwanda, understanding the regulatory framework and governance mechanisms is essential for effective stakeholder engagement and sustainable conservation practices. This section delves into the intricate web of wetland management rules within the framework of our study area, the Rugeramigozi Wetland in Muhanga District. By examining the policies, laws, and institutional arrangements governing wetland use and conservation, we aim to uncover the dynamics of stakeholder interactions and their implications for sustainable wetland management in Rwanda.

4.1.1.1 Spatial-temporal LULC Change

4.1.1.1.1 Land Use History

Research findings show that Rugeramigozi wetland has been largely threatened by human activities such as crop cultivation, deforestation and borehole drilling amongst others which disturb its components and integrity. The historical land use practices in Rugeramigozi have

influenced the current state of wetland management rules and regulations. In this junction, past decisions have also shaped resource allocation and stakeholder dynamics. Even though the wetland was cultivated before the land reform, the land was the property of the family. Basing on the analyzed images, we noticed that the wetland started to be cultivated in early 1950 on individual basis acquired through traditional land tenure system where every famer had his/her plot. Based also on the conduced field survey, the wetland was utilized without regulations where farmers used to plant mix crops like sweet potatoes, cabbages, rice, beans, sorghum, maize, Irish potatoes etc. All these crops were cultivated for subsistence purposes.

Findings from key informant interviews and focus group discussions with stakeholders in the Rugeramigozi wetland revealed that in the 1950s farmers could not cultivate near the wetland shores. As the forest was cleared, farmers recall, the land turned into a wetland during flooding of the area and the population started increasing. The land use dynamics in Rugeramigozi wetland was manifested by the fact that farmers used to have recalled large chunks of land for either cultivation or grazing. There were communal lands including wetland, where cattle would be grazed. Areas around the Rugeramigozi wetland for so many years were left for grazing animals, roofing grass for thatching houses, grass for mulch in the gardens, and women would collect fuel wood from such places and medicinal plants to cure illness such as stomach pain and fungal infections. Farmers were not cultivating in wetlands because there was enough arable land available. Wetlands were used as fishing grounds especially for cat fish to meet the community's livelihood needs.

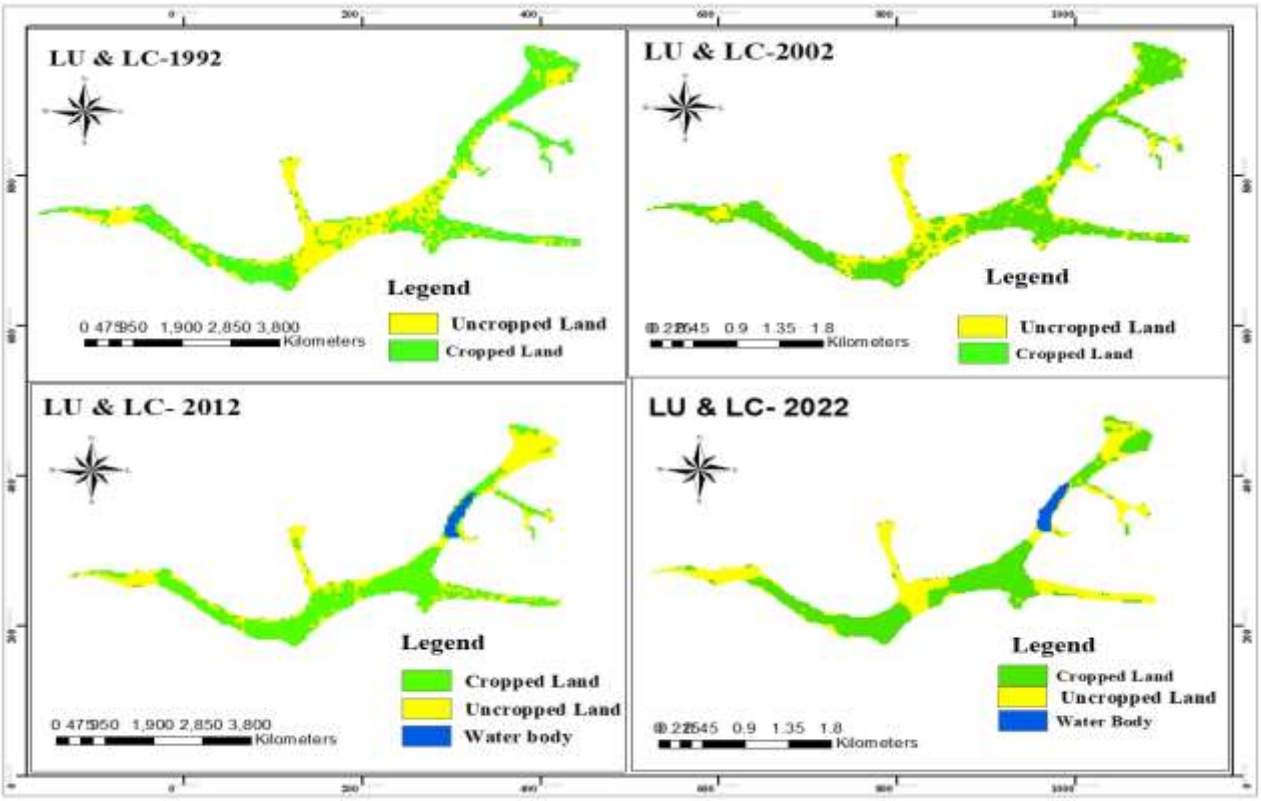

Figure 3: Land Use Dynamics in Rugeramigozi Wetland (1992-2022)
Data source: RLUMA, 2021

The table 2 below represents the result of the land use and land cover change of Rugiramigozi wetland from 1992-2022. Based on the land sat image, before 2010 there was no water bodies visible on the image because Rugeramigozi Dam was constructed in 2011.

Table 2: LULC detection in Rugeramigozi wetland (1992-2022)

Class Name	1992	2002	2012	2022
Cropped Land	2204.053282	1655.984339	1880.795875	2063.064106
Uncropped Land	1968.187499	1872.476572	1835.854988	1752.63984
Forest	291.853115	682.448456	336.868707	230.394146
Built Up	107.151996	360.335558	510.753749	517.609713
Water Body	2.532688	2.368477	10.773048	10.613126
Total Area	4573.77858	4573.613402	4575.046367	4574.320931

This table clearly presents the Land Use and Land Cover (LULC) data for Rugeramigozi wetland from 1992 to 2022, with each class name listed alongside the corresponding area in hectares for each year.

An analysis of the existing data indicated that there has been a considerable number of changes in terms of land use trends and land cover types in Rugeramigozi wetland in the last 30 years, resulting into a high rate of expansion of the cropped land compared to other LULCs (Figure 3). In 1992 there was a decrease of 0.75% of cropped land compared to the cultivated surface in 2002 due to increase in population, the remaining surface were left uncropped except a small portion containing water body. The same scenario was observed between 2002 and 2012. As presented in figure 3 and table 2, in 2012 and 2022 there was a 0.9% increase in cropping land and the same increment was observed for built up between those years. The reason behind this increase is the population growth and its associated infrastructure development. As for water body, the increase started rising from 2012 because Rugeramigozi dam was constructed in 2011, before then there was insignificant amount of water observed.

While the increase in cropped land is noted, Agricultural Intensification has impacted the biodiversity, soil health and water quality of the wetland due to its significant changes in land

use patterns overtime observed in Rugeramigozi wetland. This has been manifested in the following ways:

Biodiversity Impact: Agricultural intensification, characterized by the expansion of cropped land and increased use of agrochemicals, has led to habitat loss and fragmentation, resulting in biodiversity decline. Wetland ecosystems are particularly vulnerable to changes in land use, as they support diverse flora and fauna adapted to specific hydrological conditions. Conversion of wetland habitats to agricultural fields reduces habitat availability for wetland-dependent species, leading to population declines and loss of ecosystem services such as pollination, pest control, and nutrient cycling.

Soil Health: Intensive agricultural practices, including excessive tillage, mono-cropping, and use of synthetic fertilizers and pesticides, degraded soil health over time. Soil erosion, nutrient depletion, compaction, and loss of organic matter were the common consequences of unsustainable farming practices, leading to decreased soil fertility, reduced crop yields, and increased vulnerability to drought and flooding. Soil degradation not only compromised agricultural productivity but also contributed to sedimentation of water bodies, eutrophication, and degradation of aquatic habitats in the wetland ecosystem.

Water Quality: Agricultural intensification have had significant impacts on water quality within the wetland and downstream water bodies. Runoff from agricultural fields containing sediment, nutrients (e.g., nitrogen and phosphorus), pesticides, and other agrochemicals contaminated surface water and groundwater resources, leading to eutrophication, algal blooms, and impaired water quality. Pollution from agricultural sources have had detrimental effects on aquatic biodiversity, human health, and the provision of ecosystem services such as drinking water supply, fisheries, and recreation.

In summary, while agricultural intensification increased crop production and improved livelihoods in the short term, its environmental sustainability in Rugeramogozi Wetland was questionable due to its negative impacts on biodiversity, soil health, and water quality. To ensure the long-term viability of agriculture and wetland ecosystems, it found essential to adopt more sustainable land management practices that minimize environmental degradation, conserve biodiversity, and promote ecosystem resilience. This may include agro ecological approaches such as conservation agriculture, integrated pest management, crop diversification, and

sustainable water management techniques that prioritize ecological integrity and human well-being.

4.1.1.1.2 Challenges associated to the wetland historical land uses

There have been various difficulties as a result of the aforementioned dynamical changes that have been seen throughout time through survey and image analysis in the utilization of the wetland. They are explained as follows:

- **Wetland loss and degradation**: The wetland for so many years was used without regulations (no management rules), this has led to its gradual degradation and loss of its natural function. In this context the wetland was used inefficiently because farmers were used to crop traditionally where they accustomed to grow according to their choice. This has led to the low productivity as their cropping system was mixt. After official reclamation in 1999–2000, the land was redistributed by the wetland cooperative. Since the beginning of the 19th century until official reclamation for rice production, the wetland was cultivated only in the dry season (Season C) from June to September
- **Resource allocation and use rights**: The wetland resources have been further used with power imbalance between its users and there was no available information to all concerned stakeholders. Analyze Rule Effectiveness:
- **There were no means of mediating conflicting interests between wetland users**: This has led to its inefficient use and non-sustainable resource of its use. For instance, water use has been the source of many conflicts between wetland users which has led to the drainage degradation. This scheme has been undergoing different problems that resulted in poor crop production. The major constraints identified by farmers were water shortage and the unreliable water flows which leads to non-equitable distribution of available water where some fields experienced water shortage whereas others received an excess of water.

4.1.1.1.3 The nature of the wetland use change

Based on the above challenges, there was a change of the land reform whereby the State land in private domain comprising unprotected wetlands “Swamps land tenure” this type of land became the State land in 2008, and the latter shall not be allocated to individuals. However, it may be

lent/rented to a person based on agreement reached between both parties. Nowadays, the wetland has been rehabilitated with a legal and institutional framework which is operational.

4.1.1.2 Current wetland management

Findings from the survey and observation indicated that Local farmers in agricultural activities are the primary stakeholders interested by the wetland resources use. For that reason, various crops are grown in Rugeramigozi wetland during the dry and wet seasons, implying that the wetland is being cultivated throughout the year. As earlier said, crops commonly grown include rice (60%), maize (25%), beans (10%), and vegetables (5%) as ranked by the cooperative representatives for both Rugeramigozi I and II as clearly show on figures 9 and 10 respectively. These crops were leading because they are used for household food consumption and business purposes. Also, there were other crops, which were cultivated in small proportions such as sweet and Irish potatoes, sorghum beans but are not among the main commonly known crops grown in Rugeramigozi wetland.

Additionally, after the assessment of the way the wetland was managed and used in way that is not well regulated, the District in collaboration with other institutions like RAB, RSSP, REMA, Rwanda Natural Resources Authority (now National Land Authority) mobilized all local farmers through meetings so as to form cooperatives. They started with people who already had plots in the wetland, they were organized and have put in place regulations that must be implemented and followed by all stakeholders so as to prevent conflicts that may arise among them, hence using it sustainably and leading to the protection of the environment. Furthermore, a committee in charge of resolving all kind of conflicts was established.

Currently the Rugeramigozi wetland is managed in a sustainable and environmental equitable manner benefiting all its stakeholders. This is explained by the fact that current farming systems consists of rice farming intercropped with many other food crops, and lowland maize, millet and beans. The main land-use type is cropland with mainly rice and maize cultivation and vegetables. In the valley bottom, the land-use change involves encroachment of wetlands by cropland (See figure 3&4).

By considering the factor of production, use and environmental protection of the study area before and after the wetland rehabilitation, i.e.by comparing the land use history and current land

use, the researcher finds out that by the time the wetland was not rehabilitated, according to the head cooperative representative they could not produce even 50 tons of rice per year.

Figure 4: Rice cultivation within Rugeramigozi wetland
Data source: Field survey, December 2022

Apart from that, the annual gain in term of income was also increased compared to the time the wetland was not rehabilitated: "we used to earn 50000 Rwandan francs in a season on average when we used traditional farming but by the time the wetland was rehabilitated we are now earning more than the double by season," said one farmer. Moreover, water is abstracted from the dam and directed through the rice fields via ditches. Thus, stakeholders perceived wetland services differently and the researcher has found necessary to discuss about those services, and their importance to the local community.

The historical background of the wetland characterized by its degradation overtime has changed because concerned institutions (central and local government institutions, NGO's and local population have identified stakeholders who will have roles in the rehabilitation and monitoring of the management and use of the wetland resources. In the case of Rugeramigozi wetland, stakeholders engaged in wetland management are: Farmers (KIABR&KOKAR), WASAC, Muhanga District, RAB, REMA, RSSB and VTC Mpanda, Water Users and retailers at local market etc. Each stakeholder or actor has a specific role in the management and use of the wetland. Furthermore, when it comes to the use of the wetland especially at the beginning of a given season, extension Officers and agronomists assist farmers in daily agricultural activities mainly farming of different crops and, those farmers are called to meet and have discussions about the utilization of the available resources.

After the users of the wetland started collaborating, there was an improvement in the wetland management. It is indicated by the fact that the land was subdivided into different uses like agriculture, conservation, forests, infrastructure development (roads, schools etc.), industries etc. (see figure 5).

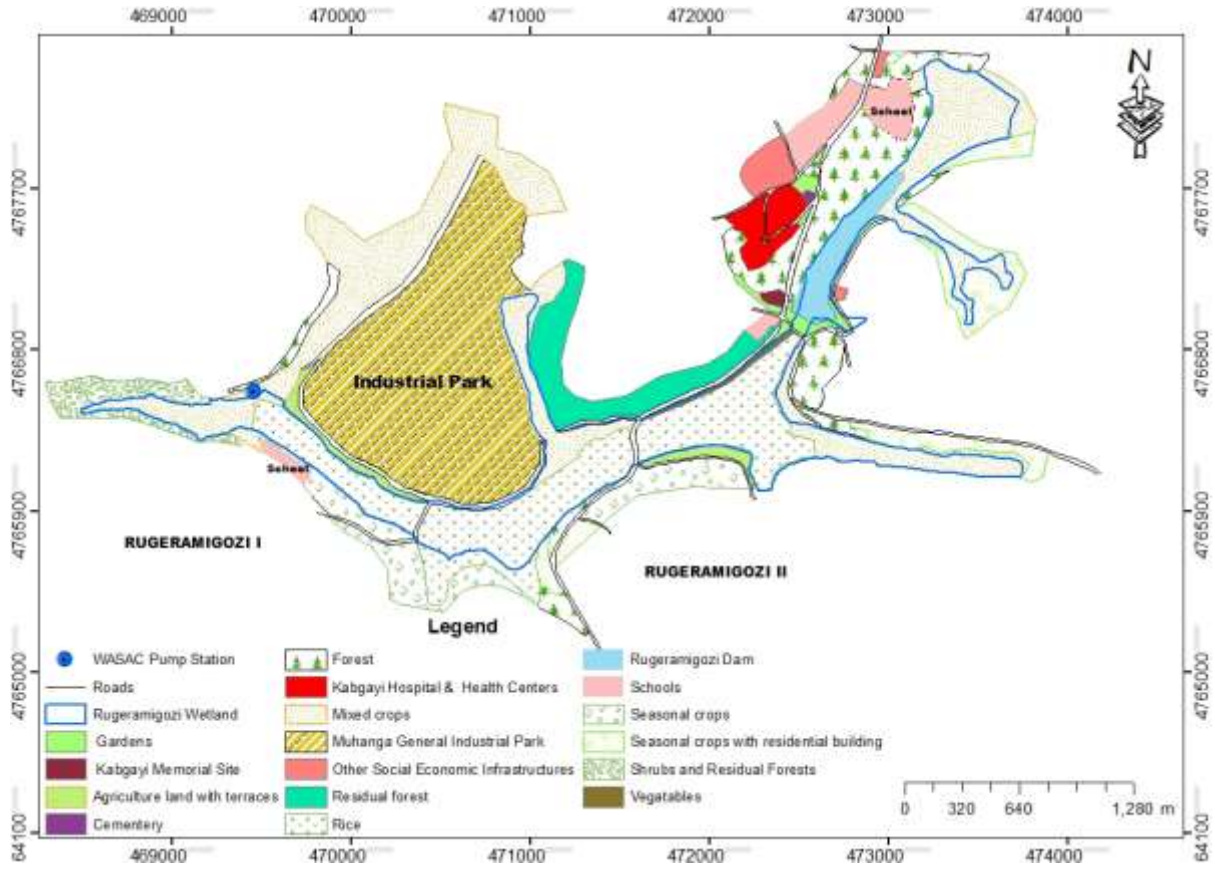

Figure 5: Rugeramigozi land use map

Data source: Field survey, June 2022

The analysis of the existing data as presented in Figure 5 shows the LULC in the study area. It further depicts other land uses and their delimitation. Given that Rugeramigozi wetland is classified among urban wetlands, this benefits economically its stakeholders in sense that it is one of the major wetlands that provide cabbages to the city and its surroundings. The cultivated wetland has a surface area of 120 hectares, 80 of them are used for rice while other 40 are used for mixed crops like vegetables, maize and beans. Much of the wetland is utilized for small-scale agriculture, with multiple drainage channels, and water is pumped for distribution in Kabgayi and the town of Muhanga. Brick-making is undertaken within and adjacent to the wetland. Grevellea, Cedrella and Acacia mearnsii trees have been planted along some of the drains.

This wetland is intensively exploited and the predominant remaining wildlife is common bird species. Main Rugeramigozi ecosystem services are cultivation. In addition, other land uses like forest and vegetation cover, built up area (residential and business areas), terraces surrounding the wetland can be distinguished (See figure 5).

In the current management of the wetland, there was also land allocation where there is land use for agricultural production activities mainly rice, maize, beans, vegetable etc. This production increased due to the adoption of the program called Crop Intensification Program (CIP). A primary indicator of productivity is crop yields and their growth. In general, agricultural productivity in Rugeramigozi wetland increased at a moderate rate between 2017 and 2019, although there are variations in the rate of growth in land and labor (figure 6).

The information obtained from field further indicates that there are two main activities involved in Rugeramigozi wetland resource uses namely: agriculture and fish farming but responses given by the key respondents indicated that fish farming is giving a poor harvest because they are in the essay phase.

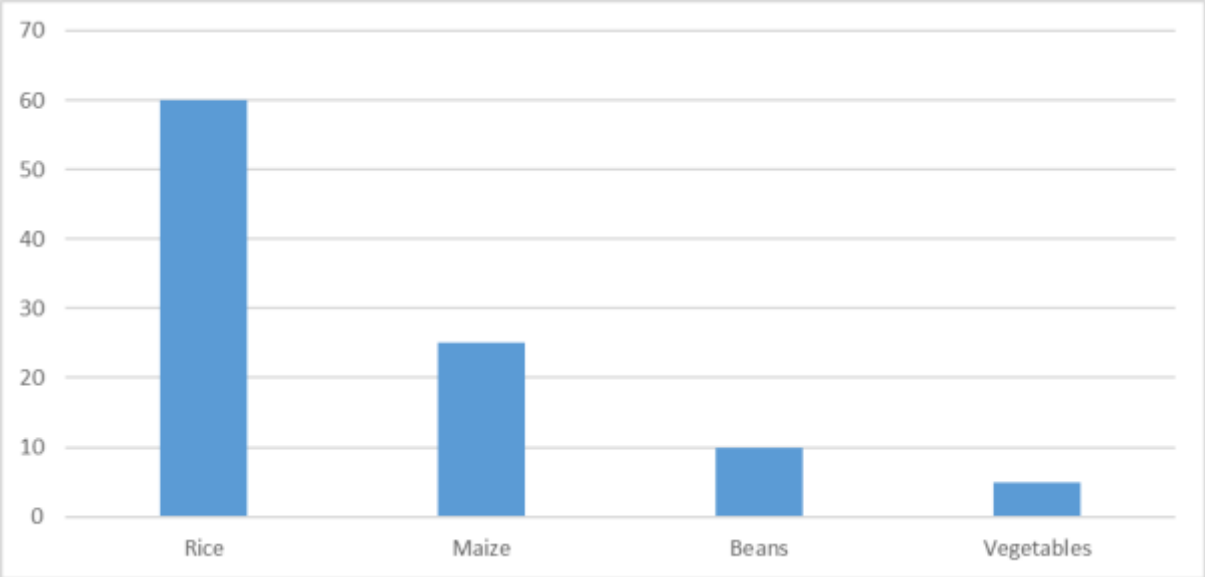

Figure 6: Major Crops produced in Rugeramigozi Wetland
Data source: Field Survey, June 2022

At first, Rugeramigozi wetland was cultivated by farmers to grow food crops like soya beans, maize, sweet potatoes and vegetables. In 2001, Welthungerhilfe (the former Germany Agro Action) started to support the agriculture in this wetland and the landowners founded the farmers' cooperative KIABR (Koperative Imparaniramusaruro y'Abahinzi Borozi ba

Rugeramigozi). Rehabilitation and extension works were done and rice crop was introduced in some fields. Their main objective was to increase the productivity.

Based on the findings from the survey and observation, Rugeramigozi II comprises 121ha in upstream, while Rugeramigozi I covers 66ha in the middle in the down-stream (Figure 7). Furthermore, the crop productivity in Rugeramigozi wetland depends on soil humidity, access to irrigation, use of fertilizers, crop protection and other factors.

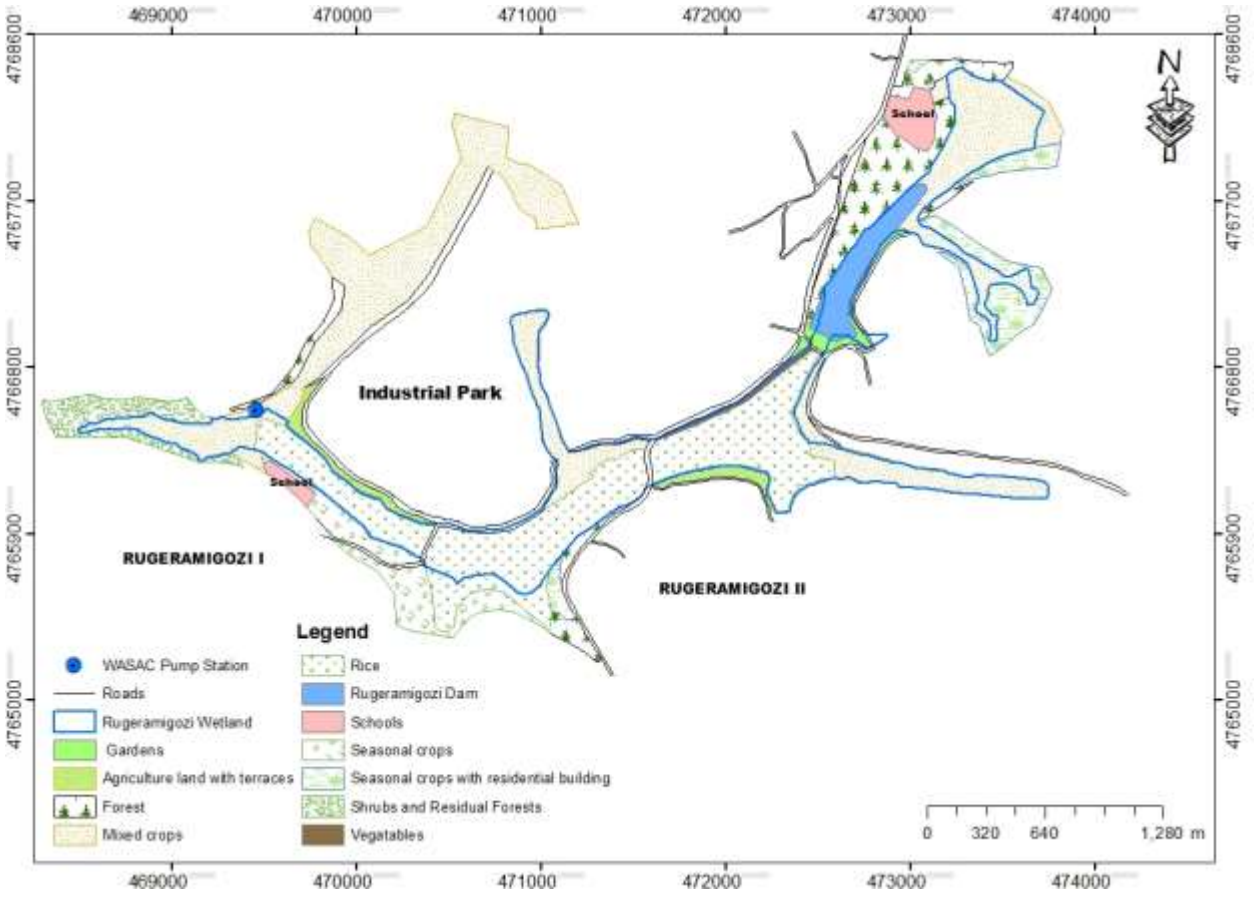

Figure 7: Rugeramigozi wetland practiced crops
Data source: Field Survey, June 2022

In Rugeramigozi wetland, local farmers are organized into two cooperatives namely KIABR and KOKAR operating in Rugeramigozi I and II respectively. These cooperatives play a pivotal role in facilitating collective action and decision-making among the farmers in their respective areas. They are made up of farmer groups where each group has to grow one different crop (See Figure 7). Furthermore, when you go around the wetland you observe different crops grown by zone. The study further illustrates that those farmers yield more than those who work individually

because they receive much attention and support services from the government and other stakeholders. Two seasons were recorded as very important in Rugeramigozi wetland. The first is season A in which Maize and Rice crops are cultivated and the farming activities start from September to November and the harvest period is March to May for Maize. As for Rice the farming activities start from August to December and the harvest period is December to January, the second is season C which starts from June to October and the crops grown during this season are vegetables. Season B is not considerable as important in Rugeramigozi wetland as it mainly meant for growing beans in upland farms. Fish farming yields more production and benefits (88% of total portion) because it benefited a lot from the water from the dam used by water users cooperative. The latter interact positively with Local farmers' cooperatives especially in the dry season when they need to use canals for irrigation. While agricultural activities of rice and maize of the earlier mentioned cooperatives KIABR and KOKAR occupy over 39% portion of the wetland resource use benefits.

4.1.2 Patterns of Interactions between Stakeholders in Rugeramigozi wetland:

In the multifaceted landscape of wetland management, understanding the intricate patterns of stakeholder interactions is paramount for fostering collaboration, resolving conflicts, and achieving sustainable outcomes. This section delves into the nuanced dynamics of stakeholder interactions within the context of our study area, the Rugeramigozi Wetland in Muhanga District, Rwanda. By examining the diverse relationships, power dynamics, and communication channels among stakeholders, we aim to uncover underlying patterns that shape decision-making processes and influence the overall management of wetland resources.

4.1.2.1 Stakeholders Identification and Engagement in Rugeramigozi wetland

The information obtained through field survey illustrates the interventions of different stakeholders involved in Rugeramigozi wetland management. They are grouped as follows (see also figure 8).

REMA: It elaborates guidelines related to environment so as the resources are used and managed efficiently.

RAB: (Rwanda Agricultural Board), Given that Rugeramigozi has been undergoing a poor production due to water scarcity, lack of improved seeds and soil fertility decline, at present RAB conducts research in this area on different seed varieties in order to identify the best crop

types which can adopt the area. In addition to this at the harvest farmers sell their harvest (maize and beans only but rice is sold to other private companies) to RAB in return they get money and improved seeds at beginning of the season.

RSSP: Founded in 2001, RSSP (Rural Sector Support Project) is a government program working under MINAGRI. Their mission is to support the rural area by increasing the agriculture production and marketing in marshland and hillside in an environmentally sustainable manner (MINAGRI, 2011). It provides a technical, financial and managerial support to the use of the marshland. It also helps the farmers to fully exploit the productivity, ensure effectiveness and sustainability of farming practices in this wetland.

WASAC: (Water and Sanitation Corporation) It has many branches in the whole country and one of them is Muhanga branch where this research was conducted. It supplies water to the consumers after a long process of treatment of raw water. In this regard one of the sources of raw water used by WASAC is from the Rugeramigozi stream and the WASAC station (where the water pumps are installed) is located in the downstream of the wetland.

Muhanga District: by ensuring that the wetland is exploited according to norms and standards related to farming practices. Its concern is the exploitation and management of Rugeramigozi wetland resources leading to the development of the livelihood of the community.

Water Users Association: They are in charge of all field work of irrigation in the whole wetland. They decide which day and quantity of water to be directed to the plots. They control and regulate the water flow from the dam to the fields.

Local Farmers (KIABR and KOKAR): As explained before, these are legally recognized cooperatives of farmers of Rugeramigozi wetland. They are made of 1408 registered farmers and the main crops grown are the rice and the dry crops like maize and beans in the terraces surrounding the wetland. They have been using this wetland several years under the support of Germany Agro Action even before construction of the current irrigation dam.

Extension Officers: They assist farmers in daily agricultural activities mainly farming of different crops.

VTC Mpanda: It is a Vocational Training Centre where people come and get short courses and trainings on entrepreneurship. This centre is located alongside the wetland of Rugeramigozi

which makes them easy to grow some vegetables on 1ha for the students. This is a rain fed agriculture of small area of 1ha but in dry period vegetables are irrigated by the dam.

Crops Sellers/retailers at local market: These are local venders who are especially interested in buying vegetables produced in Rugeramigozi wetland.

In the next section these stakeholders are described in details to define their relevance in the study area.

4.1.2.2 Interactions between different stakeholders

Previously, stakeholder's identification was described in a single approach, based on how different scholars understand it. We expand that description into main stakeholder's interactions that can be manifested, depending on the type and intensity of relationships between stakeholder groups over the use of resources management. The identified stakeholders are: Farmers (KIABR&KOKAR), WASAC, Muhanga District, RAB, REMA, RSSB and VTC Mpanda, Water Users and retailers at local market. Their interactions are described as follows:

- **Interactions between REMA, RAB, RSSP and Local farmers**:

The group of farmers supported by RSSP submits a proposal to expand agricultural activities in Rugeramigozi wetland. These farmers express their interest in maximizing agricultural productivity and improving their livelihoods. In this junction, the role of RSSP is to provide technical, financial, and managerial support to facilitate the proposed agricultural expansion.

The REMA conducts an environmental impact assessment (EIA) to evaluate the potential risks of the proposed agricultural expansion on wetland ecosystems by collaboration with RAB. It further assesses environmental risks and proposes remedial measures to mitigate degradation. Reciprocally, RAB works with REMA to ensure compliance with environmental guidelines and regulations, aligning agricultural activities with sustainable practices. Apart from that, REMA, RAB, and RSSP hold consultations with farmers to discuss the findings of the EIA and propose recommendations for sustainable agricultural practices in the wetland. Farmers provide input on their farming practices and adaptability to proposed changes whereas REMA and RAB offer guidance on environmental protection measures and agricultural best practices to minimize ecological impact while promoting productivity.

The Farmers implement recommended practices under the guidance of RSSP, while REMA and RAB conduct regular monitoring to assess compliance and environmental impact. Additionally, farmers implement sustainable farming practices to maximize productivity while minimizing environmental degradation. At this stage, REMA and RAB monitor compliance with environmental regulations and provide ongoing support and guidance to ensure sustainable agricultural development in the wetland. Through this collaborative approach, stakeholders work together to balance agricultural productivity with environmental sustainability, ensuring the long-term viability of farming activities in Rugeramigozi wetland.

- **Interactions between REMA, Muhanga District and Local farmers**

Based on REMA's core functions, Muhanga District collaborate with REMA as a local government institution having the mission of environmental safeguard of all activities executed in the District, REMA works with the district to ensure that guidelines and procedures aimed at promoting better environmental sustainability of developmental activities are implemented. The district also through its technical staff in charge of agriculture and environment supervises its sub district field technical staff regarding their guidance and instructions about farming activities that promote the efficient and sustainable resources by farmers in the wetland.

- **Interactions between RAB, Muhanga District and Local farmers**

Muhanga District, under the supervision of RAB, implements agriculture policies aimed at promoting sustainable agricultural practices within its jurisdiction. It also establishes and enforces policies to regulate agricultural activities, including those within the wetland area. The RAB provides oversight and guidance to the district in aligning agricultural policies with national goals and standards. It is in that regard that Muhanga District ensures a conducive environment for local farmers to engage in agricultural activities, including those within the wetland, while adhering to established rules and regulations. The District creates and maintains an environment that supports agricultural development while ensuring the efficient and sustainable use of the wetland. The Local Farmers are engaged in agricultural activities within the guidelines set by the district and RAB, aiming to increase productivity while maintaining environmental sustainability.

The RAB collaborates with Muhanga District through its technical staff to ensure that agricultural extension services benefit local farmers and promote sustainable practices. It

provides technical expertise and support to the district in implementing agricultural extension programs aimed at increasing productivity and quality of agricultural resources. The District works closely with RAB's technical staff to facilitate the delivery of agricultural extension services to local farmers, ensuring that they have access to resources and knowledge necessary for sustainable farming practices.

Through this interaction scenario, RAB, Muhanga District, and local farmers collaborate to promote sustainable agricultural development within the district's jurisdiction. By aligning policies, providing technical support, and fostering a conducive environment, stakeholders work together to enhance agricultural productivity while safeguarding the long-term health of the wetland and surrounding ecosystems.

- **Interactions between WASAC, WUA and Local farmers**

WASAC, the Water Users Association (WUA), and local farmers collaborate to effectively share water resources from the dam for agricultural irrigation purposes. The WASAC manages the water supply from the dam and ensures equitable distribution to meet the needs of various stakeholders, including local farmers. The WUA represents the collective interests of farmers in water management issues, including allocation and scheduling of irrigation activities. Local Farmers depend on water from the dam for irrigation to cultivate their crops and rely on the coordination between WASAC and WUA for efficient water distribution.

The Water Users, represented by field irrigators engineers, oversee field irrigation activities and regulate water flow from the dam to the fields. These are responsible for coordinating irrigation schedules, directing water flow to specific plots, and ensuring efficient water use for crop cultivation. These Field irrigators engineers collaborate with WASAC to adjust irrigation schedules and coordinate water release from the dam based on consultations and water availability. Their role is to communicate with WASAC to discuss irrigation needs, adjust schedules as necessary, and ensure timely and sufficient water supply for farmers. The WASAC: provides information on water availability, facilitates consultations with field irrigators engineers, and adjusts dam operations to accommodate irrigation requirements.

Through this interaction scenario, WASAC, WUA, local farmers, and field irrigators engineers collaborate to effectively manage water resources for agricultural irrigation in the wetland. By coordinating schedules, regulating water flow, and adjusting operations as needed, stakeholders

work together to ensure equitable water distribution and support sustainable farming practices. This collaboration helps prevent conflicts and promotes efficient use of water resources for agricultural production.

- **Interactions between WASAC and VTC Mpanda**

The WASAC (Water and Sanitation Corporation) communicates its reservoir filling schedule to VTC Mpanda (Vocational Training Center Mpanda) in advance. This schedule indicates when the reservoir will be filled with water from the dam of Rugeramigozi wetland. In this manner, VTC Mpanda informs WASAC of its irrigation needs based on the growth cycle of the vegetables in the wetland. This allows WASAC to factor in the irrigation requirements of VTC Mpanda when planning the filling of the reservoir. After that, WASAC adjusts its reservoir filling schedule to ensure that there is sufficient water for both its own needs and the irrigation requirements of VTC Mpanda. This may involve prioritizing certain periods for filling the reservoir to coincide with critical irrigation times for the vegetables grown by VTC Mpanda.

The WASAC's irrigation engineers work closely with VTC Mpanda to plan the distribution of water through canals in the wetland. They coordinate the timing and volume of water release to ensure optimal irrigation for the crops while maximizing water conservation. Throughout the process, there is continuous communication and feedback between WASAC and VTC Mpanda. Any changes in water availability or irrigation needs are promptly communicated, allowing both parties to adjust their plans accordingly.

By maintaining this collaborative approach, WASAC and VTC Mpanda can optimize water usage, maximize crop yields, and ensure sustainable management of the wetland resources.

- **Interactions between VTC Mpanda and Crops Sellers/retailers at local market**

The VTC Mpanda plans its vegetable crops according to market demand and seasonal variations. They consider factors such as popular vegetables, quantities needed, and timing of harvests. Once the vegetables are ready for harvest, VTC Mpanda ensures high-quality produce by adhering to proper harvesting techniques and quality control measures. This includes selecting the freshest and most appealing vegetables for sale. Before heading to the local market, VTC Mpanda conducts market research to understand current vegetable prices, demand trends, and competition from other sellers. This helps them in price negotiation and determining quantities to bring to the market.

At the local market, representatives from VTC Mpanda engage in price negotiations with crop sellers/retailers. They leverage their knowledge of crop quality, freshness, and market demand to secure favorable prices for their produce. Once an agreement is reached, VTC Mpanda sells its vegetables to the crop sellers/retailers. Transactions may involve cash payments or arrangements for later payments depending on the terms negotiated. After each sale, VTC Mpanda gathers feedback from crop sellers/retailers regarding the quality of their produce and market demand. This feedback informs future crop planning and pricing strategies.

Over time, VTC Mpanda builds long-term relationships with crop sellers/retailers based on mutual trust and respect. These relationships contribute to the stability and success of both parties in the local market ecosystem.

By actively engaging with crop sellers/retailers at the local market, VTC Mpanda ensures a steady source of income to support its operations while also meeting the needs of the community for fresh and nutritious vegetables.

- **Interactions between RSSP, Extension officers and Local farmers**

The RSSP identifies areas where local farmers require technical support to enhance their productivity. This could include training on new farming techniques, access to better seeds or tools, or assistance with pest management. It also collaborates closely with extension officers who have direct contact with local farmers on a regular basis. Extension officers understand the specific needs and challenges faced by farmers in their communities.

Both RSSP and extension officers work together to develop a plan for delivering technical support to local farmers. This plan may include organizing training workshops, providing demonstration plots, or arranging for expert consultations. Extension officers serve as the primary point of contact for local farmers participating in RSSP-supported programs. They communicate information about training sessions, workshops, and other opportunities for technical assistance. It is in that way that RSSP conducts training sessions and capacity-building workshops for both extension officers and local farmers. These Extension officers receive specialized training on new agricultural techniques and technologies, which they then pass on to farmers during their regular interactions.

Extension officers provide on-farm support to local farmers, helping them implement the practices they've learned and troubleshoot any challenges that arise. They also monitor the

progress of farmers and provide feedback to RSSP on the effectiveness of the support programs. The latter gathers feedback from both extension officers and local farmers to evaluate the impact of its support programs. This feedback is used to make adjustments and improvements to future initiatives, ensuring that they are tailored to the specific needs of the community.

By working closely with extension officers and local farmers, RSSP can effectively deliver technical support and assistance that helps improve agricultural productivity and livelihoods in rural areas.

- **Interactions between Local farmers and Crops Sellers/retailers at local market**

The Local farmers cultivate vegetables in Rugeramigozi wetland, carefully tending to their crops to ensure a good yield. Once the vegetables are ready for harvest, farmers gather and prepare them for sale. Farmers bring their harvested vegetables to the local market, where sellers and retailers gather to purchase produce for resale. They arrange their vegetables neatly on stalls or display tables to attract buyers.

Crop sellers and retailers browse the offerings of the farmers, examining the quality and freshness of the vegetables. They engage in negotiations with the farmers, discussing prices and quantities. Both parties aim to reach a mutually beneficial agreement. Once a price is agreed upon, the crop sellers/retailers purchase the vegetables from the farmers. Transactions may involve cash payments or arrangements for later payment depending on the terms negotiated. After purchasing the vegetables, crop sellers/retailers arrange for transportation to their own stalls or shops for resale. They may use vehicles or carts to transport the produce, ensuring that it reaches the market in good condition.

At their stalls or shops, crop sellers/retailers display the vegetables for sale to local residents and other customers. They employ various marketing techniques to attract buyers, such as advertising specials or offering samples. Throughout this process, there is ongoing communication between farmers and crop sellers/retailers. Feedback is exchanged regarding the quality of the produce, market demand, and pricing strategies. This helps both parties make informed decisions for future sales.

By collaborating in this way, local farmers and crop sellers/retailers contribute to the vibrant economy of Rugeramigozi wetland, providing fresh and nutritious vegetables to the community while also supporting livelihoods and income generation for both parties.

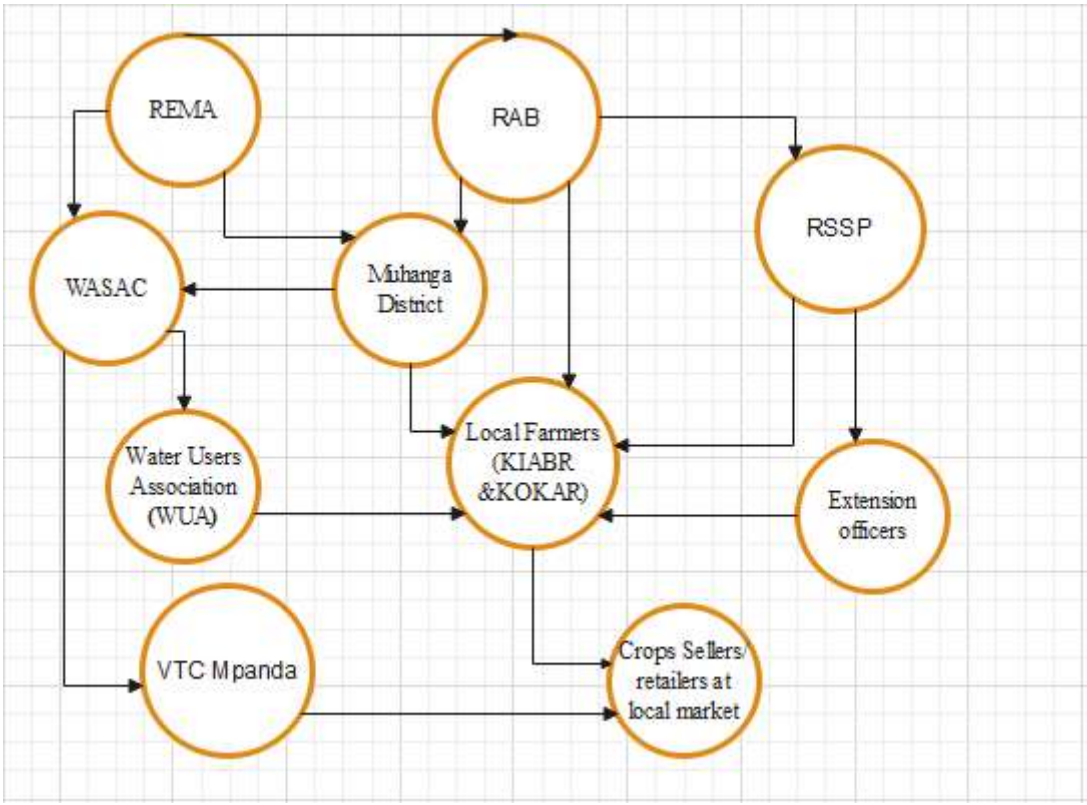

Figure 8: Stakeholder's interactions
Data source: Field Survey, June 2022

All the above described interactions certainly lead to different attitudes related to their power and influence over the use of wetland resources. All this often conduct to conflicts because they have various perceptions and or interests over the wetland use and management.

4.2 Conflicting interests in the use of Rugeramigozi wetland

Based on the interactions between different stakeholders, we have realized that there still persisting conflicts due to different perceptions and interests over the use and management of the wetland. Those conflicts are described as follows:

4.2.1 Conflicts related to the practice of mixed crops

The conflict arises from differing perspectives on the most effective approach to farming. On one hand, there are farmers who value the diversity and resilience provided by mixed cropping, particularly in dryland areas where multiple crops can thrive. They may resist the shift towards

monoculture farming in wetland areas, expressing concerns about potential yield losses and environmental impacts.

"Conversely, policymakers and proponents of land use consolidation argue that focusing on a single crop in consolidated land areas can lead to higher yields, more efficient resource utilization, and easier implementation of modern farming techniques such as mechanization and irrigation."

This conflict reflects broader tensions between traditional knowledge and modern agricultural practices, as well as competing priorities related to food security, sustainability, and economic development. Finding a resolution will require careful consideration of the needs and perspectives of all stakeholders, as well as the development of policies and practices that balance the benefits of crop intensification with the importance of preserving traditional farming methods and ecological diversity.

4.2.2 Conflicts related to water allocation and use

Farmers and field irrigators rely on consistent access to water for agricultural irrigation, following a schedule provided by Irrigation Engineers. However, this schedule is based on experience rather than precise calculations, leading to discrepancies in water distribution. WASAC, on the other hand, depends on water from various sources, including excess water from fields and canals, as well as allocated environmental flow. If WASAC begins to draw water directly from the dam, it could disrupt existing water allocations and exacerbate water scarcity issues, particularly during the dry season. Consequently, farmers feel their allotted time for irrigation is insufficient given the size of their plots, leading to ongoing complaints and potential conflicts over water usage.

4.2.3 Conflicts related to crop price determination

The conflict over crop price determination arises from discrepancies between farmers' expectations and the actual prices offered for their harvest. While farmers invest significant energy, efforts, and inputs into the production process, they often feel that the prices they receive do not adequately reflect these contributions. Farmers expect prices to align with existing market trends assessments, considering factors such as input costs and overall production efforts. However, when prices fall short of expectations, tensions arise between farmers, processing industries, and the government. To address this discordance, the government intervenes by

setting upper and lower limits for commodity prices. Despite these measures, conflicts persist as farmers seek fair compensation for their labor and investments, highlighting the ongoing challenges in price determination within the agricultural sector.

4.2.4 Conflicts related to the productivity

The conflict surrounding productivity revolves around the allocation of harvested yield between farmers and the regulatory bodies overseeing agricultural practices. According to a law adopted in the General Assembly, local farmers are required to bring the majority of their yield, 70%, to a designated collection center, leaving only 30% for personal use. However, this regulation has sparked discontent among farmers who prioritize meeting their family's needs before considering market sales. Farmers argue that the permitted quantity of yield to be kept at home is insufficient for sustaining their households, leading to tensions between farmers and the administrative or inspectorate committee tasked with enforcing the law. Despite being established through a formal decision-making process, the implementation of this regulation has resulted in misunderstandings and resistance from farmers who feel their livelihoods are being compromised.

The following table shows the possible stakeholder conflicts and their associated actors as indicated by farmers during the field survey.

Table 3: Wetland management conflicts in the study area

S/N	Conflict domain	Description of the conflict	Involved stakeholders
1	One type of cropping	Farmers do not have the right to grow what they want. They are given cultivation methods, crop selection, cropping systems, and alternatives to the selected crops mainly rice.	Between farmers and Extension Officers, District and RAB

S/N	Conflict domain	Description of the conflict	Involved stakeholders
2	Water use	During irrigation farmer must wait for water to cover the whole plot at a given level of water (say 2cm) according to the instructions given by the field irrigation Engineer. After irrigating the field is closed.	Between farmers and field engineer/ irrigators
3	Pricing of yields	Farmers would wish to negotiate prices based on all engaged agricultural inputs.	Between farmers, tender council and private companies/MINICOM
4	Collection of the yield	Farmers are still reluctant to respect bringing at home only 30% of their total harvest of any season.	Between farmers and administrative committee and or inspectorate committee

Data Source: Field survey: June, 2022

The above table describes each conflict domain as indicated by Rugeramigozi cooperative members namely KIABR and KOKAR during the field interview.

4.3 Factors contributing to Rugeramigozi Wetland Degradation

Apart from the conflicts resulting from stakeholder's interactions and effectiveness of the current wetland management, there still persisting challenges. They are discussed as follows.

4.3.1 Lack of Proper Watershed Management

The main challenge facing Rugeramigozi wetland is the lack of proper watershed management and this is most evidenced in seasonal flooding and soil erosion. The floods in Rugeramigozi wetland is due to unprotected watersheds and accidental relief that intensify run-offs during rainy seasons hence causing overflow of Rugeramigozi wetland and floods in the wetland.

Soil erosion is caused by inadequate of measures to control it on the hills surrounding Rugeramigozi wetland and this affect quality of water as well as destroying the wetland due to residue driven from the fields and reach into the dam. During the interview with District Agriculture Officer, he said that erosion is strongly influenced by activities in the surrounding area mainly from the upland agriculture and other activities.

4.3.2 Over exploitation of Natural Resources

The over-exploitation of plant and animal biodiversity in wetlands is also an issue impacting negatively on the services of the wetland. The reduction of vegetation cover leads to evaporation of water by direct radiation, a reduction of the function of sediments retention and flood control, a gradual erosion of biodiversity. This is also the case, since WASAC is still abstracting raw water material from the wetland and it will eventually lead to lowering the water level of the wetland, hence changing the natural wetland functions.

The principal threats to Rugeramigozi wetland are linked to the agricultural (mainly rice), mining activities, human settlements, exploitation of clay and sand quarries. Agricultural pressure is particularly important since most of the population depend on agriculture. There is pollution from sources such as domestic effluents, waste leachates (like wastes coming from Kabgayi garage: see figure 9), industries, agro-chemicals, and storm water. The impacts are the harmful effects on the wetland ecosystem observed as biodiversity loss and disturbance of the ecological functions of the wetland. The capacity of the wetlands to deliver services to the community is also greatly affected by the degradation (REMA, 2009).

The above challenge area is also associated with profit earned, pricing, bargaining power and land coverage of source of investment in other crops or off-farm activities in the study area.

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4.4 Problems hindering the sustainable use of Rugeramigozi wetland

Research findings show that Rugeramigozi wetland has been largely threatened by human activities such as crop cultivation, deforestation and borehole drilling amongst others which disturb its components and integrity. Some of those problems which still threatening Rugeramigozi wetland sustainability are the following:

- **Construction in the buffer zone**

According to REMA (2010), although wetlands management is prioritized in some Districts Development Plans, distances along river shores of respectively 10 metres for crops and 20 metres for housing are not always respected. This is explained by the setting of a business activity (installment of a restaurant and bar nearby which will in the long run harm or degrade the wetland in one way or the other (See also figure 9). The best way to sustainably use the wetland is to make sure that around this wetland at a buffer zone of 50 metres agro-forestry species have been planted, still annual crops often continue to be planted between trees and even between the wooded strips and in the wetland and the buffer zones cannot serve their purpose of erosion control and protection against flooding.

There are gaps in law enforcement of existing laws on wetlands management: The Organic Environmental Law No 04/2005 of 00/04/2005 determining modalities of protection, conservation and promotion of environment and in Rwanda as well as the current low on environment No 48/2018 of 13/08/2018 provided for a buffer to 20 m within which constructions are prohibited. However, some constructions violated the law and were put within the buffer after the law (2005). Likely enough all building being relocated or removed from wetlands and their buffer. Gaps in compliance and enforcement of other related laws and regulations have negative impacts on wetland. These include land law, land use master plans at different levels (national, City of Kigali, and District), water law, building code, forestry law, etc. In fact, non-

compliance has impact on land use and land use change which in turn affects catchment and connected wetlands.

- **Urban and infrastructures (roads, industrial park) development**

The effect of urbanization is also larger for more common rainfall events, because under undeveloped conditions common events typically generate no to very little runoff. Following urbanization, the change in the behavior of rainfall and runoff due to the increase in impervious surfaces is large. Urban areas are linked with wastewater and solid waste increase. This has a negative aspect on adjacent wetlands.

- **Peat mining and bricks making activities**

Manufacturing of bricks was also taking place within and adjacent to the Rugeramigozi wetland at Shyogwe Sector side, where wetland soil had a high clay content. Brick making is an issue of concern when brick makers have quarries near river banks or wetlands as the natural vegetation gets destroyed. Findings revealed that commercial peat extraction physically removes peat and the associated stored carbon from the ground at a rate which substantially exceeds the original rate of deposition and accumulation. It is estimated that modern extraction methods typically remove 100 x the peat accretion depth per year. Therefore, despite efforts being made towards sustainable management and post-harvesting restoration, the current manner of commercial peat extraction can be regarded as extractive mining, rather than sustainable harvesting. Peatlands are typically drained as part of the process. After extraction, a residual layer of peat of up to 1 m thick may remain, and the area may be flooded, becoming an open body of water.

The removal of peat and the creation of artificial open waters and other associated activities can induce significant changes (gain or loss) in certain wetland functions or key benefits. In summary the most important benefits, which will be affected negatively, include:

- ✓ Changes in flow augmentation;
- ✓ Changes in erosion control;
- ✓ Changes to the capacity of the wetland in terms of its capability to remove sediments;
- ✓ Change of efficiency in terms of nutrient and toxicant removal, recycling and storage;
- ✓ Changes to wetland capacity to serve as a carbon sink.

❖ **Limited and unsustainable use of wetland buffer zones**

The use of buffer zones is a commonly applied practice for reducing the impact of products derived from landscapes on receiving water bodies or to provide opportunities to protect the ecotones between "upland" and riparian/wetland habitats. The application of buffer zones has been advocated as a means of affording protection to wetlands, in the context of screening the systems from adjacent disturbances and protecting water quality by intercepting nutrients and sediments. When the buffers are vegetated, the corresponding canopy over water surface reduces water temperature and therefore favor dissolved oxygen (indirectly proportional to the water temperature).

Figure 9: Persisting barriers to sustainable wetland management

Source: Field survey, June 2022

In the context of sustainable use of Rugeramigozi wetland, local experts raised the concern of low-cost technological options identified for agriculture, such as terracing, use of manure as fertilizer, and water harvesting solutions, all of which can potentially have positive impacts on resource use and sustainability. At the same time, they noted that limited technology, low awareness and poor access to finance were considerable barriers to agricultural transformation in Rugeramigozi wetland. The key effects of agricultural expansion and infrastructure development on wetland among other thing are for example the loss of wetland habitat, decreased evaporation,

pollution and water scarcity. Apart from that, rain water coming from the newly constructed houses in the buffer zone will result to erosion that contribute to the wetland degradation in the future if no effective measures are taken to protect it (see figure 9). Additionally, other impacts of unsustainable use of the buffer zones include: water borne diseases, reduced wetland productivity.

Apart from the above mentioned problems, there are others related to the use of wetland by farmers, they are also considered as barriers to its sustainability. Some of them includes:

- **Lack of enforcement of management rules within the cooperative**

There are landowners like VTC Mpanda who grow other crop rather than rice according to the policy. By observing the whole wetland, you can notice different field which do not respect the cropping calendar according to instructions and deadlines given by extension officers. Normally, this lead to punishment. Additionally, weeding is one of the most frequent activity in which farmers delay to finish. Based on the survey conducted, fine is given to rule breakers (missing maintenance works, disrespect of cropping calendar, stealing water...), maintenance through community work, failure to keep the rules results in fine, no clear agreement on fee deducted from harvest for cooperative" said one cooperative representative operating in Rugeramigozi wetland. Note that the rules are approved by the GA.

- **Low participation in maintenance works and management of water resources**

There is not a clear image on the participation of all users in the management of water resource and maintenance of its infrastructures. Even though the Water Users Association is still new, but the water management seemed to be left in the hands of the farmers' cooperative (KIABR).

Basing on field survey, the wetland degradation and pollution has significantly impacted water quality and quantity. The declining capacity of wetland to provide critical ecosystem services has resulted in increased flooding and lives lost, damage to infrastructure, reduced productivity, and silting of water bodies. Climate change and population growth are additional threats to wetland and freshwater resources.

4.5 Sustainability of Rugeramigozi wetland

The integration of social, economic and environmental factors into planning, implementation and decision making so as to ensure that development serves present and future generations in Rugeramigozi wetland was verified. Moreover, the non-collaborative management of all engaged

stakeholders in its sustainable use has led to some problems which still threatening the wetland sustainability. Those issues are cultivation of the wetland, urban and infrastructures (roads, industrial park) development, harvesting of wetland plants for crafts and thatching, housing in the buffer zones, peat mining and bricks making, unsustainable use of wetland buffer zones. Based on the study findings, it is important to ask ourselves to what extent the use of the wetland by different stakeholders has altered (or is likely to alter) the following five components of the wetland's environmental condition: (1) the distribution and retention of water, (2) the erosion of sediment, (3) the accumulation of Soil organic matter (SOM), (4) the retention of nutrients and (5) the natural species composition of the vegetation in the wetland

In the context of Rugeramigozi wetland, the wise use of its natural resources is a prerequisite to achieve its sustainability. Wetland that does not has sustainable management system will be vulnerable to unsustainable use. Therefore, although focusing on ecological sustainability, the wetland users are encouraged to describe their broad socio-economic and institutional context within which the wetland is used. The study provides a simple framework to identify the key factors (operating from a household level to local level) that may be influencing the use of the wetland. It also provides a set of key questions relating to governance. Next, it requires that the perspectives of the Rugeramigozi users be sought regarding how they see their land-use activities affecting the wetland's condition. Once the five components of the environmental condition of the wetland have been assessed, the next step is to examine the consequences of this for the livelihoods of those that use the ecosystem. This requires that the specific use patterns and preferences of local users be considered as well as the context of the wetland in the broader catchment and landscape. The following general relationships apply.

1. Reduced distribution and retention of water in the wetland often results in greater opportunities for cultivation in wetland areas, but it impacts negatively on water supply, growth of plants for craft production, and on cultivation during dry periods (when drains may prevent the storage of water in the wetland).
2. Erosion in the wetland impacts negatively on wetland productivity, which in turn impacts on most provisioning services and on water quality for downstream water users.
3. Increased breakdown of SOM may result in short term benefits for crop production as the breakdown of SOM releases nutrients for crops. However, in the long term the impacts

are negative, resulting in reduced levels of both nutrient retention and soil water holding capacities.

4. Reduced retention of, and internal cycling of, nutrients in the wetland results in (a) reduced wetland productivity, which in turn will impact negatively on the supply of provisioning services (including cultivated food), and (b) reduced water quality for downstream areas.
5. A loss of native plant species generally reduces the resource base for medicine, crafts and thatching, although the opportunistic species that replace the lost species may also have some resource value.

Table 4: Key Environmental Components for Assessing Wetland Use Impact

Key components	Rationale
The distribution and retention of water in the wetland	Hydrology is the primary determinant of wetland functioning. The hydrological conditions in a wetland affect many abiotic factors, including soil anaerobiosis (waterlogging), availability of nutrients and other solutes, and sediment fluxes (Mitsch and Gosselink, 1986). These factors in turn strongly affect the fauna and flora that are present in a wetland.
The retention of sediment in the wetland	Wetlands are generally net accumulators of sediment, which affects the landform of the wetland, and this in turn has a feedback effect on how water is distributed and retained (i.e. hydrology). Sediment retention is also important for maintaining the wetland's on-site agricultural productivity, as well as being potentially important for downstream water users by enhancing nutrient retention.
The accumulation of soil organic matter SOM) in the wetland	SOM makes a significant contribution to wetland functioning and productivity, and contributes to (1) enhanced water holding capacity of the soil; (2) the physical strength of sandy soils, which increases their resistance to erosion, and (3) enhanced Cation Exchange Capacity (CEC) of the soil, which increases the proportion of nutrients held in the soil potentially available for

Key components	Rationale
	uptake by plants (Miller and Gardiner, 1998; Mills and Fey, 2003; Sahrawat, 2004)
The retention and internal cycling of nutrients in the wetland	Wetlands are generally effective in retaining and cycling nutrients, which is important for maintaining the wetland's on-site productivity in terms of growth of natural vegetation and crops, as well as being potentially important for downstream water users by enhancing nutrient retention and thus improving water quality (Mitsch and Gosselink, 1986).
The natural composition of the wetland vegetation	The particular composition of wetland vegetation is of significance in itself for biodiversity, and in addition provides habitat for a range of fauna. Particular plant species may also have direct economic importance (e.g. for use in craft production).

Source: Field survey, June 2022

Table 4 describes some general consequences of alterations to the different elements of ecological health on specific provisioning services and the consequences of this altered condition for the livelihoods of local wetland users and other stakeholders.

Based on the survey, 858 farmers made up of 309 men and 549 women in Rugeramigozi I and 550 farmers composed of 240 men and 310 women in Rugeramigozi II are encountered respectively. And this shows that women occupy an important part in the management of the area under study.

4.6 Limitations of Rugeramigozi wetland management

The lack of a clear figure about interrelation and connection between management rules and wetland use rights practices makes difficult to propose the strategies to guide decision making about wetland resources allocation, operation, maintenance and the sustainable development of the wetland. Other limitations that are existing include the following:

4.6.1 Weather variability

During the field survey, all interviewed farmers said that the main challenge that affect agricultural production is the weather variability. It was reported that during rainy season, the rain is highly abundant and Rugeramigozi wetland experiences flooding and damage the planted crops which leads to the drainage of used fertilizers in the farmland. In the other side, during the dry season the sun is sizeable and the wetland experiences drought especially from May to August. These factors rain crops and bring productivity down which leads to the reduced production cost that also adversely affects food security in the community. This has no negative impact on crops because, water users help a lot in directing water in plots through canals and crops are not affected by dry season. Note that there was no flood observed in the time of data collection (Dry season) but it used to occur during rainy season.

4.6.2 Lack of Capital

Capital is used by farmers to finance farming activities, such as buying production facilities/ inputs (seeds, fertilizers, and Pesticides), labor wages, and other operational costs. Some of local farmers in Rugeramigozi wetland do not get inputs at time because of financial difficulties and this leads to the late farming which in turn leads to germination failure and reduced production.

4.6.3 Delay of inputs

During interview with famers, they said that sometimes they get inputs later compared to the time they started farming activities and that have impact on their crop production. “Sometimes the supplier delay to deliver us the fertilizers and seeds, and when that happens we can do nothing, we just wait for them until they deliver and that cause the late planting because of that delay. When they delay, farmer’s activities also delay” said a cooperative representative.

4.7 Proposed solutions to conflicts and existing challenges

Based on the assessment done on stakeholder’s interactions in the management of Rugeramigozi wetland, we are interested in proposing solutions to the existing current wetland management conflicts and issues related to the use of wetland by farmers. Those solutions are respectively described as follows.

4.7.1 Negotiations and or consultations with farmers

Where seasonal food crops are grown, the Synchronized Crop Rotation system promoted for cooperatives under the Crop Intensification Programme, should continue to be expanded. This well-structured and supported programme provides the "vehicle" for the promotion and introduction of other conservation agriculture methods. The CIP appears to be the best vehicle for these innovations as it has a primary aim "the increase in agricultural productivity of high-potential food crops by creating incentives for producers to adopt new production technologies.

4.7.2 Enhancing communication among stakeholders

Strengthening communication among stakeholders when it comes to water resource sharing can be one of best way to deal with water related conflicts in the management of the wetland. WASAC should make consultation with the representatives of farmers about its schedule on weekly basis to supply its water plant. Then, from this schedule irrigation engineers will make their distribution plan of water into farmer's plots. The two schedules must be communicated to farmer's and WASAC representatives and if necessary amendment is needed, both parties should sit and come to a compromise and adjust it accordingly. Additionally, implementing wetland regulations can also help user of the dam to better us and protect this important resource as said bylaw on water resource say: "Article 49: provides that violation of required buffer zones is also an offence Furthermore, the law on water resources management (2018) also has provisions on protection of water resources.

4.7.3 Consultations of farmers with all concerned actors in price determination

The Rwandan Ministry of Trade and Industry is responsible for setting the price of crops each season after considering the investment made by farmers and assessing the market trends and forecast according to fluctuating crop prices. Moreover, prices should be set in consultation with stakeholders including the Ministry of Agriculture and Animal Resources, representatives of farmers processing factories, major crop buying firms, as well as districts that are big producers of a given crop. The government, through the Ministry of Trade and Industry should set the minimum of a crop price and let farmers feel free to negotiate pricing for as long as this does not go below the minimum set price. This will reduce farmer's complaints about lower price given to their crops every season.

4.7.4 Giving voice to farmers in the management of the wetland

Considering that the farmer's productivity is his/her property and the farmer must satisfy the family needs before sending the productivity to processing firms, farmers should have negotiations or consultation with decision makers. Thus, farmer's voice should be heard when it comes to take decision of his/her harvest.

4.8 Proposed solutions to the persisting problems of sustainability of the wetland

After having found that the efficient of use is below what is desired, the wetland users wish to enhance its wise use. The study proposes solutions for handling the persisting problems of sustainability. They are summarized as follows.

- **Collective decision-making**

This is also known as integrated decision making of all engaged stakeholders, group decision-making or collaborative decision-making in wetland management occurs when a group of stakeholders makes a decision, and it's no longer attributable to any single individual. This can prevent any conflicting and contradictory rules that have in recent years frequently created resource use problems in the study area.

- **Better weather forecasting**

More accurate weather forecasts should allow farmers to make better investment decisions. In villages, investment decisions respond to forecasts about the onset of the monsoon. "Whilst farmers who relied on forecasts had higher average profit levels, they also experienced greater profit variability. When rainfall realizations were high, they performed better than farmers without access to forecasts" said one farmer during the interview. More accurate weather forecasts will allow farmers to make better investment decisions. Overall, greater access to and accuracy of weather information appears to increase agricultural profitability on average.

- **Access to credit and insurance schemes**

In Rwanda there exist different financial markets where people can have access to money and invest depending on their financial or collateral capacity. Currently Rwanda has various insurance schemes for agriculture and livestock. The National Agriculture Insurance Scheme covers different crops like rice, maize, Irish potatoes, Green Beans and pepper. In the context of Rugeramigozi wetland farmers cultivating rice and maze should also use this scheme for their protection and security.

- **Timely provision of quality inputs**

Improved seeds and fertilizers are essential to raising productivity (yields per unit area planted) under both the rain fed and irrigated conditions. In addition, strong extension and advisory services are important for enhancing the adoption and efficiency of improved inputs The most commonly used consumable inputs are: High-quality seeds, Soil, Fertilizers, Insecticides, Pesticides.

- **Effective Watershed and Catchment Management**

The Rural Sector Support Program (RSSP) was introduced to develop a modified watershed approach and experience introduced for sustainable land husbandry measures on hillsides adjacent to the marshland on selected site. These measures were proposed to reduce soil erosion on cultivated hillslopes which were experiencing low productivity. Technologies introduced include soil bunds, terraces, cut-off drains, water ways, afforestation and reforestation as well as strengthening terraces with risers to develop appropriate land husbandry practices. These technologies were intended with the dual purpose of providing modern agricultural techniques for higher production, as well trapping silt from the hillsides so that it did not result in sedimentation of downstream irrigation dam or wetland.

- **Effective Framework for Wetland Governance/Management**

Reference is made to the project of "rehabilitation of marshlands" being implemented for wetland management in Rwanda, but the project focus is on rehabilitating the hillslopes surrounding the wetland so as to permit farmers raise productivity during the wetland crop growing season. The project is now continuing its activities in 22 existing rice wetlands including Rugeramigozi wetland for the intensive capacity building program in production, postharvest, marketing and value addition. Main project activities are being implemented in hillsides surrounding marshlands to be developed, where those hillsides' areas have been/ are being treated with comprehensive land husbandry technologies in order to control the severe soil erosion encountered in the region and increase productivity in treated areas.

4.9 Adaptation and Resilience Strategies in Rugeramigozi Wetland

In Rugeramogozi Wetland, community adaptation strategies and resilience in the face of environmental change are critical for sustaining both livelihoods and the ecosystem services

provided by the wetland. Here's a more detailed account of some key adaptation strategies and resilience-building efforts discussed as follows:

- **Traditional Ecological Knowledge (TEK)**

Local communities often possess valuable traditional ecological knowledge about the wetland ecosystem, including seasonal patterns, biodiversity, and sustainable resource management practices. Incorporating TEK into wetland management plans can enhance community resilience by leveraging centuries-old practices adapted to local environmental conditions.

- **Diversification of Livelihoods**

Given the vulnerability of agriculture to climate variability and environmental change, communities in Rugeramogozi may diversify their livelihoods to reduce dependence on a single source of income. This could involve activities such as ecotourism, handicraft production, aquaculture, or alternative agricultural practices like agroforestry.

- **Water Management and Irrigation**

As changing precipitation patterns and increased water scarcity threaten agricultural productivity, communities may invest in water management infrastructure such as small-scale irrigation systems, water storage facilities, and efficient irrigation techniques to ensure reliable access to water for crops during dry periods.

- **Community-Based Natural Resource Management (CBNRM)**

Engaging local communities in the co-management of natural resources can enhance their adaptive capacity and foster resilience to environmental change. Participatory approaches to wetland governance empower communities to make decisions about resource use, conservation measures, and sustainable development initiatives that align with their needs and priorities.

- **Ecosystem Restoration and Conservation**

Restoring degraded wetland habitats and conserving biodiversity can enhance the resilience of the ecosystem to environmental stressors while providing additional benefits such as flood mitigation, water purification, and carbon sequestration. Community involvement in restoration activities fosters a sense of ownership and stewardship over the wetland, strengthening resilience at both the individual and collective levels.

- **Capacity Building and Knowledge Exchange**

Investing in education, training, and knowledge exchange initiatives can enhance community resilience by equipping individuals and organizations with the skills, information, and resources

needed to adapt to environmental change. This could involve workshops, field demonstrations, experiential learning programs, and partnerships with research institutions or NGOs.

- **Social Cohesion and Networks**

Strong social networks and community cohesion serve as important buffers against environmental shocks and stresses by facilitating collective action, mutual support, and resource sharing during times of crisis. Building and maintaining social capital through community events, cooperative enterprises, and collaborative decision-making processes strengthens resilience and fosters adaptive responses to environmental change.

By embracing these adaptation strategies and fostering resilience within local communities, Rugeramogozi Wetland can navigate the challenges posed by environmental change while promoting sustainable development and biodiversity conservation for future generations.

Chapter 5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study has shed light on the institutional arrangements governing the management of Rugeramigozi wetland, encompassing legal frameworks, stakeholder engagement, decision-making processes, resource allocation, and conflict resolution mechanisms. By addressing the specific objectives outlined at the onset of this research, we have gained valuable insights into the dynamics shaping wetland management practices and the challenges encountered in achieving sustainable outcomes.

Firstly, the identification and analysis of key stakeholders have elucidated the diverse interests, roles, and perspectives at play in Rugeramigozi wetland management. Understanding the motivations and objectives of these stakeholders is essential for fostering effective collaboration and consensus-building towards shared conservation goals. The research revealed the intricate web of stakeholder interests, roles, and perspectives shaping Rugeramigozi wetland management. Key stakeholders include local communities, government agencies, NGOs, and private actors, each with varying priorities regarding wetland conservation, resource use, and livelihoods. Understanding these dynamics is crucial for fostering collaborative governance and addressing conflicts.

Secondly, the examination of decision-making processes has provided critical insights into the efficacy and sustainability of management strategies employed in Rugeramigozi wetland. By evaluating the alignment between decisions and wetland conservation objectives, this research has identified areas for improvement and optimization in governance structures and processes.

Thirdly, the exploration of conflicts among stakeholders has highlighted the complexities inherent in balancing competing interests and values in wetland management. By uncovering the root causes of conflict and understanding how they manifest in differing perceptions and priorities, this study has paved the way for the development of targeted conflict resolution strategies. Conflicts among stakeholders emerged as a significant challenge in wetland management, driven by divergent interests, values, and perceptions. Competition over resource access, land use rights, and economic benefits often leads to tensions and impairs decision-

making processes. Resolving conflicts requires nuanced understanding and effective mediation strategies to promote consensus-building and sustainable management outcomes.

Finally, the proposal of solutions for handling conflicts underscores the importance of mediation strategies in promoting consensus-building and sustainable management outcomes in Rugeramigozi wetland. By advocating for inclusive and participatory approaches to conflict resolution, this research seeks to empower stakeholders to collaboratively address challenges and work towards shared stewardship of the wetland ecosystem.

Agricultural intensification and land use changes have significant environmental implications for Rugeramigozi wetland. These include habitat loss, biodiversity decline, soil degradation, and water quality deterioration. Unsustainable practices exacerbate ecosystem vulnerabilities, threatening the long-term health and resilience of the wetland ecosystem. Addressing these impacts is essential for promoting environmental sustainability and maintaining ecosystem services.

In sum, the findings of this study contribute to a comprehensive understanding of institutional arrangements in managing Rugeramigozi wetland, offering valuable insights and recommendations for enhancing governance effectiveness, promoting stakeholder engagement, and fostering sustainable management practices. By bridging research with practice, this study aims to inform policy decisions, guide management interventions, and support the long-term conservation and wise use of Rugeramigozi wetland for present and future generations.

5.2 Recommendations

Based on the comprehensive findings and conclusion of the study on Rugeramigozi wetland management, the following recommendations are proposed:

1. ***Enhanced Stakeholder Engagement:***

- Develop mechanisms for regular consultation and collaboration among key stakeholders, including local communities, government agencies, NGOs, and private sector actors, to ensure their meaningful participation in decision-making processes.
- Facilitate dialogue and knowledge exchange platforms to foster mutual understanding, trust, and cooperation among stakeholders with diverse interests and perspectives.

- ❖ Incorporate traditional ecological knowledge and community-based approaches into wetland management strategies to leverage local expertise and promote culturally appropriate conservation practices.

2. ***Improved Decision-Making Processes****:*

- ❖ Strengthen transparency, accountability, and inclusivity in decision-making processes related to Rugeramigozi wetland management, ensuring that decisions are guided by scientific evidence, stakeholder input, and sustainability principles.
- ❖ Establish clear criteria and benchmarks for evaluating the effectiveness and sustainability of management strategies, allowing for adaptive management and continuous improvement over time.
- ❖ Enhance monitoring and evaluation mechanisms to track progress towards wetland conservation objectives and identify areas requiring corrective action or policy intervention.

3. ***Conflict Resolution and Mediation****:*

- ❖ Invest in capacity building and training programs for conflict resolution practitioners and mediators, equipping them with the skills and tools necessary to facilitate constructive dialogue and negotiation among stakeholders.
- ❖ Develop standardized protocols and procedures for managing conflicts related to wetland use, ensuring that disputes are addressed in a fair, transparent, and timely manner.
- ❖ Promote the use of alternative dispute resolution mechanisms, such as mediation, arbitration, and consensus-building processes, to resolve conflicts and build consensus around shared management objectives.

4. ***Environmental Conservation and Sustainability****:*

- ❖ Implement measures to mitigate the environmental impacts of agricultural intensification and land use changes, such as promoting agro-ecological practices, sustainable land management techniques, and habitat restoration initiatives.
- ❖ Strengthen enforcement of environmental regulations and compliance mechanisms to prevent illegal activities, mitigate pollution, and protect critical wetland habitats and species.

- ❖ Foster partnerships and collaboration with research institutions, conservation organizations, and local communities to support scientific research, monitoring, and adaptive management efforts aimed at improving wetland resilience and ecosystem health.

5. ***Policy Reform and Institutional Strengthening****:*

- ❖ Advocate for policy reforms and legislative amendments that support integrated, ecosystem-based approaches to wetland management, recognizing the interconnectedness of social, economic, and ecological factors.
- ❖ Strengthen the capacity and mandate of relevant government agencies responsible for wetland management through institutional reforms, resource allocation, and training programs.
- ❖ Promote cross-sectoral coordination and collaboration at the national, regional, and local levels to ensure coherence and synergy in wetland governance efforts and avoid fragmentation and duplication of responsibilities.

By implementing these recommendations, stakeholders can address the challenges identified in Rugeramigozi wetland management and work towards achieving sustainable outcomes that balance environmental conservation, socio-economic development, and community well-being.

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Appendices

Appendix 1. Questionnaire for Household Survey:

The purpose of this study is to identify, describe the key stakeholders and assess their interests in relation to the wetland management rules, ascertain if decisions taken promote the efficient management of wetland resources. Rugeramigozi wetland is used as the case study.

I. Identification

1. Questionnaire number
2. Sector:

II. Questions related to socio-economic aspects

Gender	1=Male			2=female	
Family size	1=1	2=2-3	3=4-5	4=5-6	5=Above 7

1. Do you possess the land in this region? 1=Yes ☐ 2= No ☐
2. How did you get your land?
   - 1=By inheritance ☐
   - 2=By rented ☐
   - 3=Purchase ☐
   - 4= Gift ☐
   - 5=By Government ☐
   - 6= other (specify)…….

How many plots/fields do you have.....

3. What is the location (topographical) of your plots/ fields?
   1= Wetland 2= Upland 3=both sides
4. What is the total size of your farmland? (Ha)
   a) Wetland……

b) Upland…….

5. What are your main sources of income?

1=Agriculture production	
2= Petty Trade	
3=Fish farming	
4=Masson	
5=Masson assistant	
6=Casual work	
7=State agent	
8=Other (specify)	

6. How have you acquired the land? Yes ☐ No ☐

Inherited ☐

Rented ☐

Purchase ☐

7. Where do you depend much on obtaining food for your livelihood?

1= Wetland 2= upland 3= both

8. What is the size of your land?

Wetland	1Ha	Less than 1Ha	Greater than 1Ha
Upland	1	2	3

III. Agricultural activities in Rugeramigozi wetland

9. What activities are carried Rugeramigozi wetland?

Activities	**Yes or No**
Rice cropping	

Maize cropping	
Vegetables cropping	
Fish farming	
Quarrying	
Recreation	
Others (specify)	

10. What are the main wetland crops do you produce?

Crops	
Rice	
Maize	
Beans	
Vegetables	
Others (specify	

11. What are the factors affecting wetland crop productivity?

a. lack of capital
b. lack of appropriate water management
c. water logging
d. Prolonged drought
e. Other

(specify)…….....

12. Is the choice of crop to be cultivated in the wetland done by you?

Yes ☐ No ☐

If No what decide for the type of crops to be cultivated and what benefits do you get from that choice?

Explain……

IV. Wetland management rules

13. Does the activity carried out in the wetland has wetland management rules related to its protection and management? ☐ ☐

14. How effective or adequate are the wetland management rules?

Very effective	Effective	Limited	Ineffective
1	2	3	3

V. Patterns of interactions/interests/benefits among stakeholders

15. How effective or adequate are the patterns of interactions of stakeholders?

Very effective	Effective	Limited	Ineffective
1	2	3	3

16. What are the main stakeholder's interests and benefits in the wetland?

Agriculture ☐

Fish farming ☐

Quarrying ☐

17. How effective or adequate are the incentives administered to wetland users?

Very effective	Effective	Limited	Ineffective
1	2	3	3

18. How effective or adequate are the modes of mediation or conciliation used for conflicting cases among stakeholders?

Very effective	Effective	Limited	Ineffective
1	2	3	3

Yes ☐ No ☐

19. What strategies must be adopted for a better protection and management of the wetland?

Strategies	Yes or No
Raise awareness of the wetland protection and management on wetland users (public	

awareness)	
Review and update of the wetland protection and management rules	
All wetland users must participate in setting the wetland management rules (participatory approach)	
Make a fair monitoring and follow up of the wetland management rules implementation	
Others (not mentioned in above table)	

VI. Challenges related to agricultural activities in Rugeramigozi wetland

20. What are the main challenges/problems in Rugeramigozi wetland?
    a. Erosion
    b. Flooding
    c. Soil infertility
    d. Other (Specify)
21. What can you suggest on how this wetland can be conserved sustainably so that it can continue to benefit you?

Thank you

Appendix 2: THE INTERVIEW PROTOCOL ADDRESSED TO RELATED POLICY/DECISION MAKERS, LOCAL GOVERNMENT OFFICIALS AND EXPERTS IN DIFFERENT INSTITUTIONS WITH REGARD TO WETLAND RESOURCES MANAGEMENT IN MUHANGA DISTRICT

1.Institution: …….

Position: .....

2. What are policies concerning and relating to the use and wetland management resources?

……

……

……

3. What are laws concerning and relating to the use and wetland management resources?

……

……

……

4. What orders concerning and relating to the use and wetland management resources?

……

……

……

5. What are instructions concerning and relating to the use and wetland management resources?

……

……

……

6. What are plans and strategies concerning and relating to the use and wetland management

resources?.....

.....

.....

7. What are the roles and responsibilities of your institution regarding improvement of quality and quantity of Rugeramigozi wetland resources?

……

……

……

8. What are the key stakeholders of Rugeramigozi wetland management and their interests?

1 ---------- 2 ---------- 3 ----------

4 ---------- 5 ---------- 6 ----------

9. How do they make decisions related to the use of this wetland?

……

……

……

10. Do those decisions promote the efficient/sustainable use/management of this wetland?

Yes ☐ No ☐

Explain:

…….

11. How do the conflicting interests related to Rugeramigozi wetland management are mediated or conciliated?

…….

What is your role?

……

……

12. How do you judge the effectiveness and relevance of the proposed solutions to those conflicts and strategies for the sustainable management of Rugeramigozi wetland?

a. Very effective ☐

b. Less effective ☐
c. Not effective ☐
d. Regulatory and legal framework Institutional framework ☐

13. How do you judge the efficiency and relevance of above regulations, policies, legal and institutional framework in managing, improving, maintaining and preserving the allocation of resources in Rugeramigozi wetland?

a. Very efficient ☐
b. Less efficient ☐
c. Not efficient ☐
d. Regulatory and legal framework Institutional framework ☐

14. What activities threaten the wetland?

1 ---------- 2 ---------- 3 ----------

4 ---------- 5 ---------- 6 ----------

15. What measures are being taken to protect the wetland?

……

……

……

Are these measures fair according to you? Yes ☐ No ☐

Explain:

……☐……☐……

Are these measures adequate according to you? Yes No

If yes, explain:

……...……

……

16. What is your role in protecting the wetland?

……

……

17. What are impacts of related legal and institutional framework on Rugeramigozi wetland resources use and management?

……..

18. What are constraints and challenges in implementing the legal and institutional framework regarding Rugeramigozi wetland management?

……

……

……

19. Are there things or issues showing you that sometimes and somewhere local community are not respecting or complying with these regulations and legal framework concerning the use and management Rugeramigozi wetland?

Yes ☐ No ☐

If yes Which ones?

…….

20. What should be possible solutions of the above challenges?

……

……

……

21. What should be done in terms of legal and institutional framework in order to improve and promote the sustainable resource management of Rugeramigozi wetland?

……

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THANK-YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION!